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C. R. Harington, editor

CLIMATIC CHANGE IN CANADA

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CLIMATIC CHANGE IN CANADA

National Museum of Natural Sciences
Project on Climatic Change in Canada
During the Past 20,000 Years
1977-78

Edited by C.R. Harington

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PREFACE

D.A. Russell*

Among the nations of the Earth, Canada is unusually vulnerable to changes in global climatic patterns. It has been postulated that a world-wide warming of less than 1°C, if continued over the next two decades, would melt the sea ice in the Arctic Ocean. This could affect the economic basis, for example, of the construction of large transcontinental oil pipelines. Should the polar ice caps also melt, mean sea levels would rise 60 m and large areas of agriculturally productive coastal regions of Canada would be rendered suitable only for mariculture. Conversely, if annual temperatures were to return to levels normal for 200 years ago, Canada would lose an estimated 75% of its grain export capacity. The historical record shows that such a decline could occur over a span of 20 years. The geological record further suggests that climatic changes leading to the onset and termination of major glaciations may take place over a span of only one to two centuries.

The temporal framework of the discussions which follow is from 20,000 years ago through the modern, historical period. Much has happened in Canada during this interval. Ninety-seven percent of the country was covered by glacial ice only 18,000 years ago. A diverse assemblage of large mammals, approximating those inhabiting East Africa today, was becoming extinct in northern North America as agricultural societies emerged in the Near East. In recent times an industrial civilization has spread *a mari usque ad mare* with geologically astonishing rapidity.

Thus the history of climatic change in Canada during the past 20,000 years is of great economic and theoretical interest. The integrity of Canadian society will almost certainly be stressed by significant alterations of weather patterns, perhaps within this century. It would be an enormous benefit to be able to predict these alterations based on a knowledge of past climatic fluctuations. The amplitude and tempo of climatic and biotic changes in Canada since 20,000 years ago also provide a fertile field for deriving concepts which will augment our understanding of more ancient environments. In this context, it is fascinating to note that the influence of astronomical factors on recent climates is a very active area of research, while climatic change in the remote past is more often interpreted as a result of geographical factors.

The study of climatic change clearly deserves a high place in the list of national research priorities. It is confidently predicted that the interest, excitement and creative thought, which characterized the meetings hosted by the National Museum of Natural Sciences, will animate similarly-oriented research and policy-making groups in research institutions throughout Canada.

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THE IMPACT OF CHANGING CLIMATE ON PEOPLE IN CANADA; AND THE NATIONAL MUSEUM OF NATURAL SCIENCES CLIMATIC CHANGE PROJECT

C.R. Harington*

The Impact of Climatic Change on People in Canada: Some Examples

Geographically, Canada is highly vulnerable to climatic change. This is because of such factors as its northern position and the important mountain barrier on its western margin that lies athwart the easterly moving storm tracks. Continental glaciers spread out from centres in Keewatin, Ungava and Baffin Island during the last glaciation. Indeed, remnants of the Baffin ice survive in the Barnes and Penny icecaps. Studies of lichen cover there indicate that such areas are liable to relatively rapid growth of ice (Barry et al. 1975).

To demonstrate Canada's vulnerability to climatic change, and its effect on human populations since the peak of the last glaciation, several cases will be mentioned. They apply to different regions of Canada (Figure 1) and have occurred at different times.

First, I wish to consider early human populations in unglaciated parts of the Yukon Territory. Evidently they entered the country from Eurasia prior to the peak of the late Wisconsin glaciation and became established in the Old Crow Basin. Yet, there is no evidence to show that they survived the coldest period from about 25,000 B.P.** to 13,000 B.P. If this observation holds true, could severe climatic conditions during the latter period have resulted in withdrawal of the population, substantial reduction in its numbers, or extinction? Or did these people disappear later? Toward the close of the Wisconsin glaciation, important changes in the environment occurred which ushered in a new group of people — Palaeo-Indians. Bering Strait reopened then, and apparently easterly-moving storm tracks shifted northward until their source lay in that region, producing warmer, wetter conditions in northwestern North America. Consequently, large tracts of cool, dry, steppe-like grasslands, occupied by such species as saiga antelopes (*Saiga tatarica*), gave way to expanding spruce forests and boggy terrain. More northerly areas, and those at higher elevations became tundra. Could such striking changes have led to the demise of large-horned bison (*Bison crassicornis* — apparently adapted to cool, dry grasslands), and the rise of western bison (*Bison bison occidentalis* — apparently adapted to moister, more heavily wooded habitat) about 12,000 years ago? Similarly, perhaps other Pleistocene mammals that flourished in the region during the late Wisconsin, such as woolly mammoths (*Mammuthus primigenius*) and Yukon wild asses (*Equus (Asinus) lambei*) also succumbed because of the rapidity of environmental changes at this critical period (Harington 1977). Presumably, these animals would have been confined to progressively smaller areas of suitable habitat, until they died out naturally or were exterminated by human hunters. In any case, there seem to have been important differences between the peoples that occupied the Yukon Territory before the peak of the Wisconsin

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** Radiocarbon years before present (present taken as 1950).

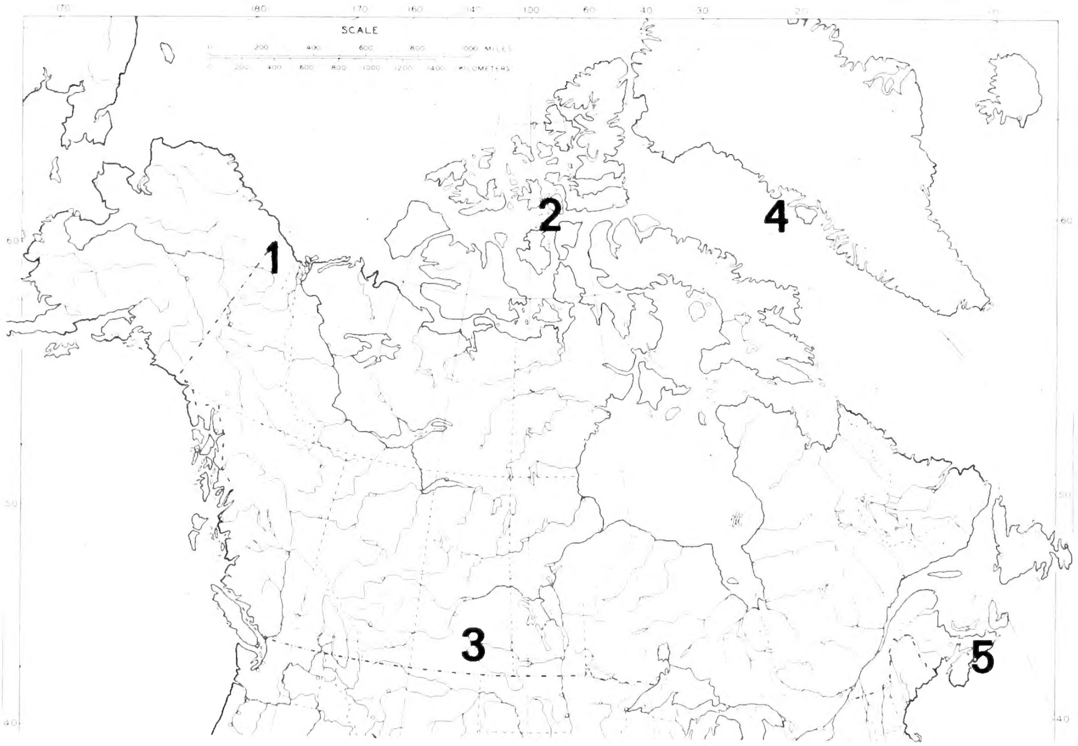

FIGURE 1: *Locality map showing places mentioned in the text. 1 - Old Crow area, Yukon Territory, 2 - Central Arctic, 3 - Prairies, 4 - Davis Strait - Baffin Bay area, 5 - Halifax area, Nova Scotia.*

glaciation and at its close. Such differences may have paralleled the striking changes in climate that occurred then. The earliest known occupants of the Yukon probably hunted woolly mammoths, horses, large-horned bison, and caribou (*Rangifer tarandus*). They were adept at making bone tools. Most of the recognizable tools could have been used for working hides to provide clothing and shelter (Harington et al. 1975). In contrast, the Palaeo-Indians in northwestern North America apparently preyed largely on western bison and caribou, using many stone tools, including lanceolate and fluted bifaces (Cook and McKennan 1970, Thorson and Hamilton 1977, Gordon 1975, Wright 1976).

Another case, involving the breakdown of a culture as a result of climatic change in the Canadian Arctic, is worth mentioning. People of the Thule culture were ancestors of the Inuit who now live in northern Canada and Greenland. The Thule culture arose in Alaska where people developed techniques for hunting large marine mammals, including the bowhead whale (*Balaena mysticetus*). The rapid dispersal of Thule people across the Canadian Arctic to Greenland (Figure 2) about 1000 years ago probably resulted from a warming climate that led to a widespread melting of sea ice in that region, which in turn provided fresh, suitable habitat for bowhead whales (McGhee 1970, Barry et al. 1977). Widespread winter settlements, each characterized by dwellings made from bones of several bowheads, and evidence of general use of the umiak*, indicate the former presence of open water in areas not navigable today because of heavy sea ice. The Thule people evidently abandoned the High Arctic by 1600 because of deteriorating climate, subsequent major expansion of sea ice, and reduction of their major prey species, the bowhead whale, in the central Canadian Arctic. Thule people moved south, abandoning open water whaling in most places, and turning to hunting of ringed seals (*Phoca (Pusa) hispida*) from snow houses near the sea ice in winter. In summer, they hunted caribou and muskoxen (*Ovibos moschatus*) inland. Presumably, ringed seals became more numerous and widespread in the Canadian Arctic as sea ice (to which the species is well adapted) became greater in extent and duration. Eventually, the remnants of the Thule culture were able to survive in 10 local bands, each having a slightly different dialect and way of life (Figure 3). The decline in art resulting indirectly from deterioration of climate is remarkable. Beautifully and intricately decorated ivory pendants, combs, needle cases and toys typical of the Thule culture contrast greatly with the relatively rough, highly functional hunting tools of the late Prehistoric Inuit (see for example McGhee 1978, Plates VII and VIII).

One of the most spectacular results of climatic change was the dry period in the Canadian prairies occurring between 1928 and 1937. Its effects were accentuated by an almost simultaneous worldwide economic depression. Average temperatures increased over most of Canada in the 1920s and 1930s — particularly on the prairies in winter. The temperature rise coincided with a marked decrease in precipitation, producing "dustbowl" conditions (Thomas 1974). The first signs of trouble appeared in 1928, when precipitation in many places was less than half that of 1927 (e.g. precipitation in Regina dropped by nearly one third). It was dry again in 1929, and subsoil moisture was nearly gone. In the spring of 1930, prairie

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* A large skin boat used for whaling and transport.

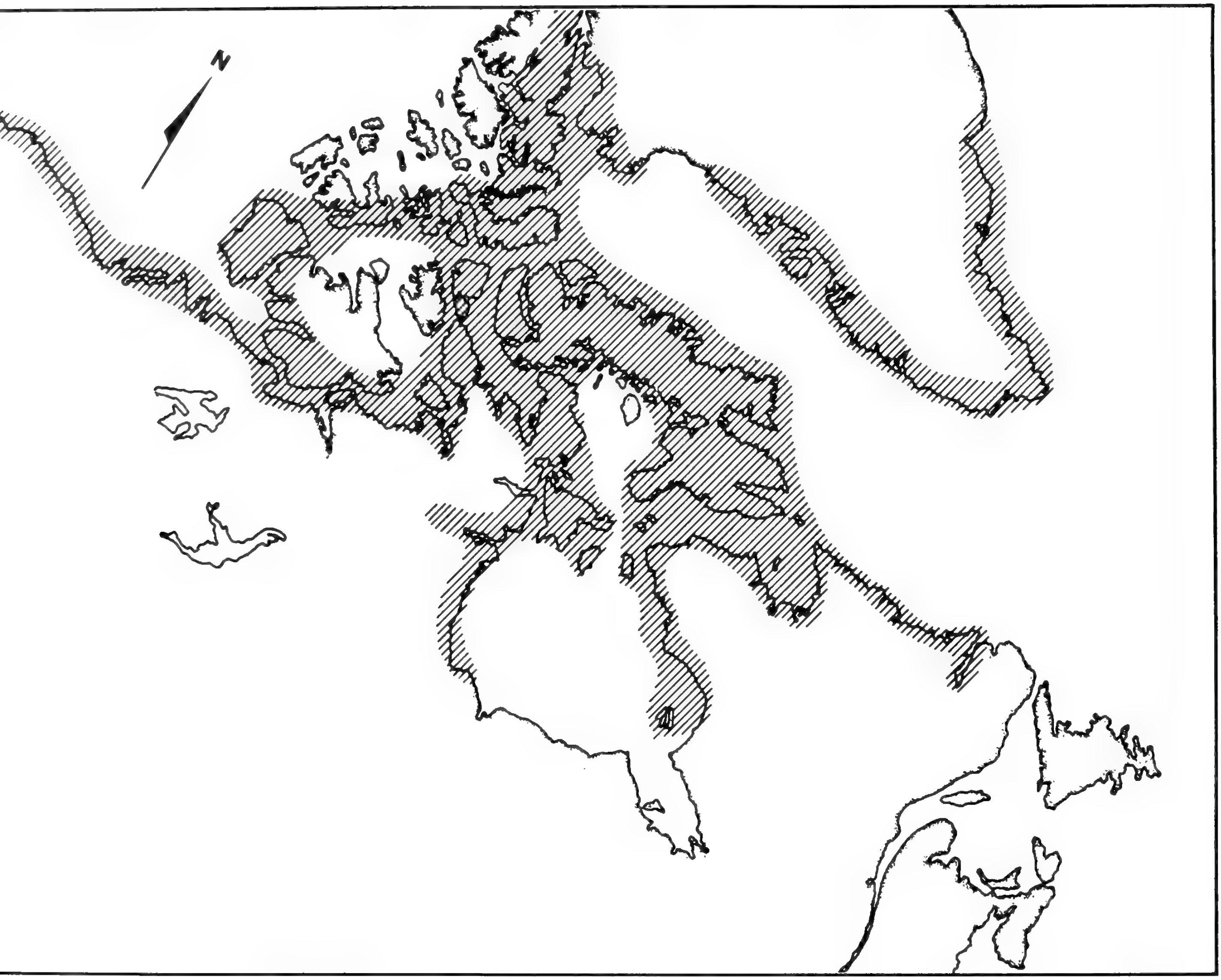

FIGURE 2: *Probable area occupied by people of the Thule culture, the ancestors of the Inuit. (Courtesy of R. McGhee and Van Nostrand Reinhold Ltd.).*

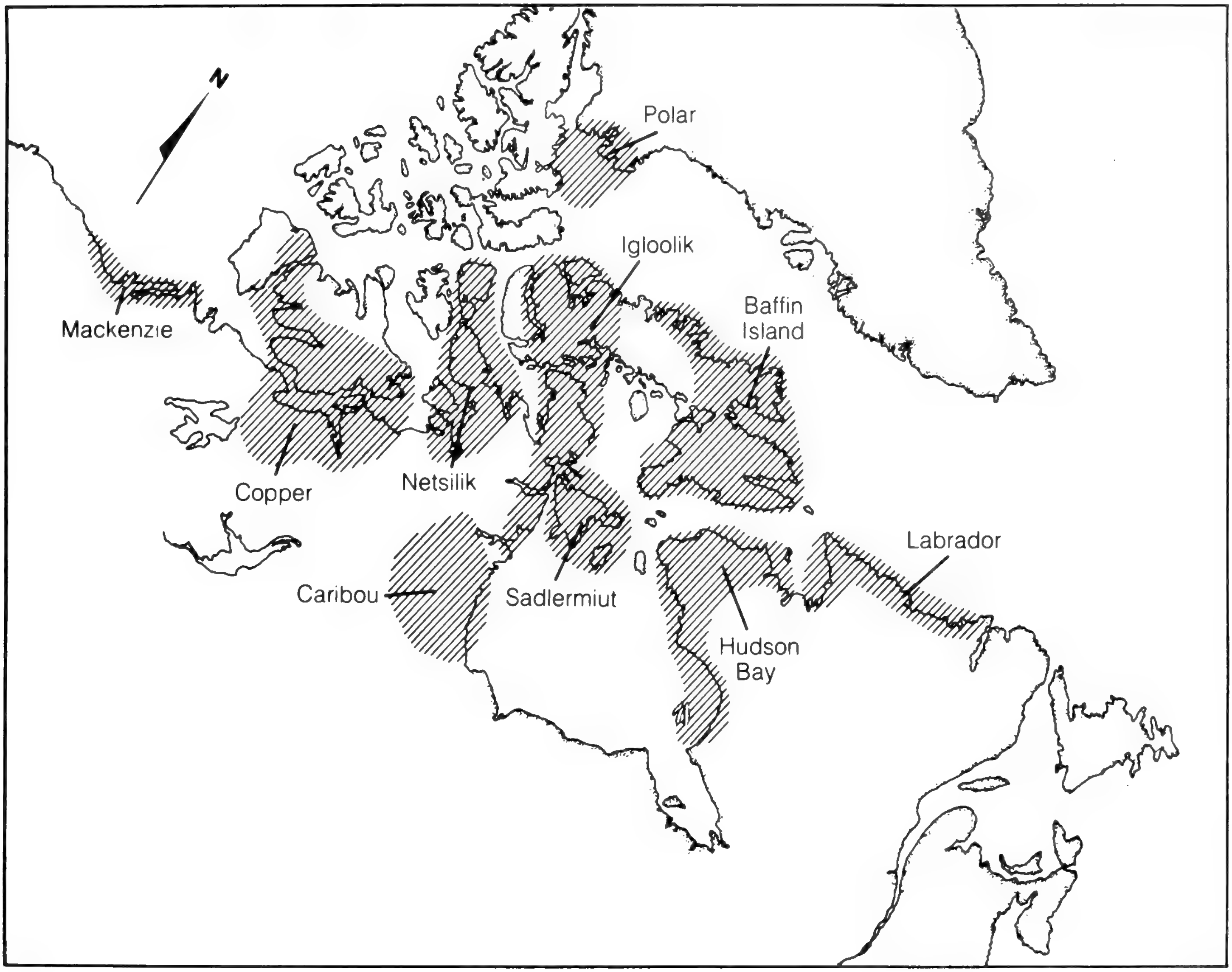

FIGURE 3: *Historic Inuit occupations of Arctic Canada. Areas occupied by 10 local bands derived from people of the Thule culture. (Courtesy of R. McGhee and Van Nostrand Reinhold Ltd.).*

farmers were worried, but optimistic enough to plant large crops. Then strong winds began. The winter was mild, and by the spring of 1931 great dust storms hit the prairies. Fine top soil blew away with newly planted seeds. It filled in ditches, buried fences, drifted up the sides of buildings and gouged giant holes in once productive fields (Figure 4). Dust sifted into all buildings in the region affected. It piled up in drifts on window sills and floors, penetrated closets and cupboards and even got into food. Prairie farmers specializing in wheat suffered some of the greatest hardships in the country. Unlike farmers in other parts of Canada who had more diverse crops, and who often had local markets for their fruit and vegetables, there was no place to sell wheat. Farmers' credit dried up like their fields.

In 1937, drought was unusually severe. Large sloughs that had never been dry in living memory lost their water and dust rose from their bottoms. Many farmers were unable to harvest. The average crop for Saskatchewan, including some fair crops in the north, was 2.7 bushels per acre. Many southern Saskatchewan farmers gave up. They left farms that had taken years to establish, loaded their belongings onto hayracks and drove away. Some went northwestward to Peace River or north to Prince Albert and Meadow Lake, where soil moisture was better. Others settled in the Fraser Valley of British Columbia, returned to Ontario, the United States, or even to Europe. Between 1931 and 1937, Alberta lost 21,000 people, Manitoba lost almost 34,000 people, and Saskatchewan lost some 66,000 people (Braithwaite 1977).

On the positive side, there was the constructive effort of the federal government in 1935, when it passed the Prairie Farm Rehabilitation Act to provide for the rehabilitation of drought and soil drifting areas in Manitoba, Saskatchewan and Alberta. Large irrigation developments, land-use diversification (e.g. encouraging livestock raising), and methods of controlling soil drifting are major features of the PFRA (Horn 1972). Archaeologists benefitted from the many valuable artifacts found exposed in "blow-outs" that occurred across the prairies after heavy wind storms. Many people, if they did not succumb, became philosophically "case-hardened" to poverty and disappointment. On the negative side, drought conditions coupled with the economic depression gave rise to social violence (e.g. the Dominion Day Riot in Regina on July 1, 1935, when some 3,000 relief camp deserters and their sympathizers clashed with police); political upheaval (e.g. the founding of the CCF party in Calgary in 1932 dedicated to the eradication of capitalism); the creation of an uprooted, drifting segment of society; increase in welfare handouts and loss of self-respect; and a tremendous sum of human anguish that cannot be neatly quantified.

The drought experienced throughout Western Canada in 1976 and 1977 equalled or exceeded in severity that of 1937. The former drought was generated by a "blocking" high pressure ridge (see Lambe 1972, pp. 107-109) over Western Canada that persisted for more than eight months and diverted weather systems carrying rain from the region. Despite the relative shortness of this drought and the many federal and provincial drought alleviation programs (see for example Collinson 1978, Appendices II and III), its continuation through most of 1977 — or experience of a drought lasting three years or longer at any time in the future — would have more serious consequences than the 1930s drought (Collinson 1978). Surely, more paleoenvironmental research systematizing evidence for droughts on the Canadian prairies since deglaciation of the region is justified.

FIGURE 4: *Drifted soil around a settler's house in the 1920s, Saskatchewan. (Courtesy of National Photography Collection, Public Archives Canada).*

Fluctuations in marine climate can also have an important effect on the way people in coastal regions make their living. A warming of the waters between Canada and Greenland is worth considering. Since about 1917, a strengthening of the relatively warm Irminger Current off western Greenland resulted in remarkable faunal changes (Dunbar 1955). Atlantic species that appeared, or increased in range, in West Greenland waters between then and 1940 include: Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), brosme (*Brosmius brosme*), ling (*Molva vulgaris*), Atlantic halibut (*Hippoglossus vulgaris*), herring (*Clupea harengus*), spiny dogfish (*Squalus acanthias*) and rosefish (*Sebastes marinus*). The pilot whale (*Globicephala ventricosa*), in addition to many planktonic animals and plants also invaded West Greenland waters. Simultaneously, some fishes (e.g. Greenland cod (*Gadus ogac*) and capelin (*Mallotus villosus*)) previously common in southern Greenland waters moved much farther northward. Harp seals became more common in waters off northwestern Greenland, probably because their prey, the capelin, had shifted its range. Arctic animals, such as the white whale (*Delphinapterus leucas*), narwhal (*Monodon monoceros*) and Greenland halibut (*Reinhardtius hippoglossoides*) moved north also. The shifting marine fauna meant that many Greenlanders who once lived mainly on marine mammals were forced to turn to coastal fishing. From 1940 to 1970, Dunbar (1976) notes a cooling trend in the region, accompanied by a southward retreat of whole marine ecosystems. He concludes that it is critically important to be able to predict such changes in marine environments.

Subtle changes in temperature, precipitation and air mass circulation may have widespread biological and economic effects. A few examples from the Atlantic Provinces (J.G. Ogden III, personal communication, 1976) are of interest. Spruce budworms flourish when conditions are warm and dry in June, whereas a few tenths of a degree increase in coastal water temperatures results in reduced lobster landings. A 0.5°C decrease in average winter (November-March) temperature requires the purchase of 10 gallons (38.5 litres) of heating oil per household in Canada. During the winter of 1971-72, the unusual coldness resulted in an additional consumption of some 15 million gallons (57.7 million litres) of fuel oil in the Halifax-Dartmouth region alone. The cost at that time amounted to more than 6 million dollars. Energy policies that ignore the possibility of a continuation of the climatic deterioration since 1940 threaten a serious energy shortfall, which may have widespread economic effects. The rapidly escalating price of fuel oil has exacerbated this problem.

I have mentioned only a few examples of how changing climate has affected and can affect people in Canada. Such examples demonstrate: (a) that the impact of such changes on human populations can be fast and hard; (b) that we must expect many more occurrences like those mentioned, or perhaps worse*: paradoxically, nothing is more constant than climatic change; and (c) that every major region of Canada is vulnerable. Can there be a stronger argument for supporting a comprehensive research program on climatic change in Canada during the past several thousand years?

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* Increasing human populations, with greater demands on natural resources, tend to aggravate problems resulting from climatic change.

The National Museum of Natural Sciences Project on Climatic Change in Canada During the Past 20,000 Years

Clearly, we need to know in some detail how climate has varied in Canada during the ice age and to see if there is any way of predicting, on the basis of systematic gathering and analysis of past climatic data, such important occurrences as times of: severe droughts, early frosts, increases in winter coldness, major changes of sea ice distribution and thickness, and changes in plant ranges and in the size and distribution of populations of humans and other animals as they are affected by such variations in climate.

A basic aim of the NMNS climatic change project is the publication of paleobiological (mainly paleobotanical), historical and meteorological data of significance to the study of climatic change in Canada since the peak of the last (Wisconsin) glaciation some 20,000 years ago. Compilation of a comprehensive, annotated bibliography on the subject is another important goal. Although data gathering will probably dominate the early stages of the project, it is hoped that interpretation of these data as they relate to climatic change will be emphasized later. Participants in the project must be alert to detect possibly significant economic implications arising from the study. In addition to acting as a basic fund of information for researchers beginning studies of climatic change in Canada, it may be possible to detect significant gaps in our knowledge. Some of these gaps could be filled, or partially filled, as a result of the project. Another goal is promotion within this country of expertise in the study of climatic change. Liaison with other groups interested in climatic change is also important.

To achieve these goals, we plan to step back gradually in time from the most accurate records from weather stations across Canada (see for example Thomas 1975), to climatic data inferred from journals and records of explorers, missionaries, officers of trading companies (e.g. Hudson's Bay Company) and the Royal Canadian Mounted Police, land surveyors, ranchers, farmers, etc., to climatic information derived from paleobiological sources (e.g. the best radiocarbon-controlled pollen profiles covering the past 20,000 years,* or parts of that period). Where possible, evidence from various disciplines should be checked against each other to test their reliability. Necessarily, such records must cover the same periods of time in the same regions. Work on the meteorological aspects of the project will be pursued in consultation with scientists at the Canadian Climate Centre of Environment Canada's Atmospheric Environment Service. A problem confronting the project is identification of parameters that are most capable of relating the paleobotanical and historical results. Perhaps the growing season, or the number of degree days above 42°F (6.7°C), will be useful in this respect.

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* The past 20,000 years has been chosen because it spans the time since continental glaciers last covered most of Canada, and because it is a period in which radiocarbon dates are considered to be most accurate, thus promoting chronological control of the data.

It is important that various regions of Canada be covered. For the sake of convenience and preliminary study, they are designated as follows: Western Canada (Manitoba, Saskatchewan, Alberta, British Columbia), Eastern Canada (Ontario, Québec, New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland), and Northern Canada (Yukon Territory and Northwest Territories). We hope that efforts to relate climatic trends among the major regions will provide useful information on past climatic patterns in Canada, so it is necessary that data published by participants are standardized to simplify correlation.

The climatic change project is entering its third year. An outline for the project was presented to Dr. Louis Lemieux, Director of the National Museum of Natural Sciences, in 1976. Funds were allotted for pilot studies in the various fields mentioned during the fiscal year 1977-78. The results of the pilot studies appear in this publication.

The first meeting of the NMNS climatic change project took place in Ottawa on November 14, 1977. Seventeen people attended, including five participants who gave talks on their work (A.J.W. Catchpole, University of Manitoba; L.V. Hills, University of Calgary; J.G. Ogden, III, Dalhousie University; and C. Hillaire-Marcel and G. Prichonnet, Université du Québec à Montréal). In addition, C. Wilson, a contractor to Atmospheric Environment Service, discussed her research on climatic change on the east coast of Hudson Bay. G. Hobson, Director of the Polar Continental Shelf Project, represented that institution. W. Blake, Jr., T.W. Anderson, and J. Foster represented the Geological Survey of Canada.

A second meeting took place on December 1, 1979. Eighteen people attended, talks being presented by the previously mentioned participants, in addition to new ones (S. Occhietti, L. Marchand and R. Rajewicz, Université du Québec à Montréal; L. Ghanimé, McGill University; and M. Parker, Western Forest Products Laboratory). In addition, talks relating to climatic change in Canada were given by C. Wilson; M.O. Berry, Atmospheric Environment Service; T.W. Anderson, Geological Survey of Canada; and D. Fisher, Polar Continental Shelf Project. Besides including work on palynological, historical and physical evidence bearing on climatic change, the NMNS project was broadened by the inclusion of work on tree rings and the beginning of an annotated bibliography on climatic change in Canada during the Quaternary.

In future years, we hope that tree-ring sampling from old trees surrounding Hudson and James bays will provide a preliminary chance for comparing historical (Hudson's Bay Company records) and dendrochronological data on climate in that region during the last 200 to 300 years. A.J.W. Catchpole and C. Wilson have already amassed much climatic data from historical records made at sites on James Bay and southern Hudson Bay.

Similar efforts are proceeding in the United States and the Soviet Union. In 1978, the Second Reciprocal U.S. - U.S.S.R. Conference on Climates of the Pleistocene and Holocene took place in New York. The purpose of these conferences is the meeting of Soviet and United States scientists to compare data on world climate in the last 18,000 years. To give an idea of the scale of the NMNS project, it is worth noting that there are more than 1,000 paleoclimatologists in the Soviet Union: the United States have about 20 principal workers in this field (West 1978).

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HISTORICAL EVIDENCE OF CLIMATIC CHANGE IN WESTERN AND NORTHERN CANADA

A. J. W. Catchpole*

INTRODUCTION

Among European and Asian climatologists, historical records have long been recognized as a major category of evidence of climatic change. In the mid-twentieth century Manley (1953) included certain types of historical sources in one of five general categories of climatic evidence. In 1977, the Climatic Research Unit at the University of East Anglia identified historical evidence as one of the three major categories of evidence available in the past 3000 years.

In contrast to the European and Asian experience, comparatively little use has been made of historical evidence in North America where it remains the least familiar type of evidence. This contrast between the old and the new worlds, however, cannot be entirely attributed to the recency of the development of literacy in North America, since this continent possesses certain historical sources which offer a rich, and largely undeveloped, potential as evidence of climatic change. It is, therefore, appropriate to commence with general discussions of the nature and role of this category of evidence in studies of climatic change.

Nature of Historical Evidence

There are essentially two reasons why history can yield evidence of past climates. The first involves man's ability to communicate information, and the second involves his sensitivity to environmental stimuli and his ability to adapt his behaviour to accommodate environmental changes.

At late stages in his cultural development, when man acquired artistic and literary abilities, he thereby acquired the means of communicating information to his descendants. One of the major sources of historical evidence is the information about weather or environmental conditions contained in the communications media. This general term is deliberately used because it embraces a wider array of sources than written documents alone. Cave paintings of prehistoric animals, or tales of past deluges in folklore, are each examples of non-documentary communications which might yield evidence, especially in the preliterary period.

Acknowledgements:

Many of the ideas and insights contained in this report developed in discussions with my colleague D. W. Moodie, but I am solely responsible for any errors of fact or understanding. I have benefitted from, and am grateful for, the advice and assistance received from Mrs. Shirlee Smith, Hudson's Bay Company Archivist. I acknowledge receipt of the Hudson's Bay Company's permission to consult and quote from its archives.

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The communicated historical evidence is distinguished from the inferential historical evidence which accrues from man's behavioural adaptations to climatic changes. The latter depends upon the assumptions that temporal changes in climate may have caused temporal changes in human behaviour, and that the nature of climatic change can be inferred from historical events.

Communicated Historical Evidence

Many historical sources contain direct references to the weather and related environmental conditions. These may occur in the direct and systematic form of a weather diary, such as those kept by Claudius Ptolemaeus at Alexandria in the second century A.D.; by William Merle, from 1337 to 1344, in eastern England; by W. Haller, from 1546 to 1576, in Zurich; and by Tycho Brahe, from 1582 to 1597, on the island of Hven in Denmark. However, the communicated historical evidence is not limited to weather diaries and it includes written sources that make only indirect, and non-systematic reference to the weather as well as works of art that portray the environment.

A summary of the various types of written sources that have been used in Europe and Asia as communicated historical evidence is given in Figure 1. Fragments of environmental information contained in novels, plays and poetry have been considered of sufficient scientific value to warrant climatological investigation and, so, this classification identifies fictional accounts as one category of this evidence. Of course, the greatest amount of historical evidence is embodied in factual accounts and Figure 1 distinguishes two broad categories, those written at sporadic intervals, and the chronicles written regularly at a particular place. The letters, memoranda, newspaper accounts or journals of expeditions which comprise the former category, can yield valuable pieces of information but they cannot yield these at regular intervals of time and this is a severe restriction in studies of climatic change. Therefore, the richest sources of evidence are the chronicles and the two broad categories shown in Figure 1 each have their fundamental strengths and weaknesses. As indicated previously, the weather journals focus directly on specific phenomena such as wind direction, cloudiness, raininess, warmth, frosts and snow; but these direct sources are rare. The general chronicles are diaries and journals kept for some purpose other than providing weather records, but which nonetheless contain incidental references to the weather. The general chronicle may be nebulous and incomplete in its climatic references, but it is comparatively common. European and Far Eastern research indicate that general chronicles are of greatest value for two types of climatic reconstruction:

(1) The identification of rare and extreme occurrences such as summer droughts, severe winters, floods or storms - since these tend to represent a bias of interest in general chronicles. An early study of this nature derives measures of the raininess in China during the past two millenia using references to the occurrences of drought and flood in two Chinese written chronicles (Co-Ching Chu* 1926). The validity of these measures of raininess was later discussed by Schove (1949) and a general assessment of Chu K'o-chen's

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* This name is correctly transliterated as Chu K'o-chen

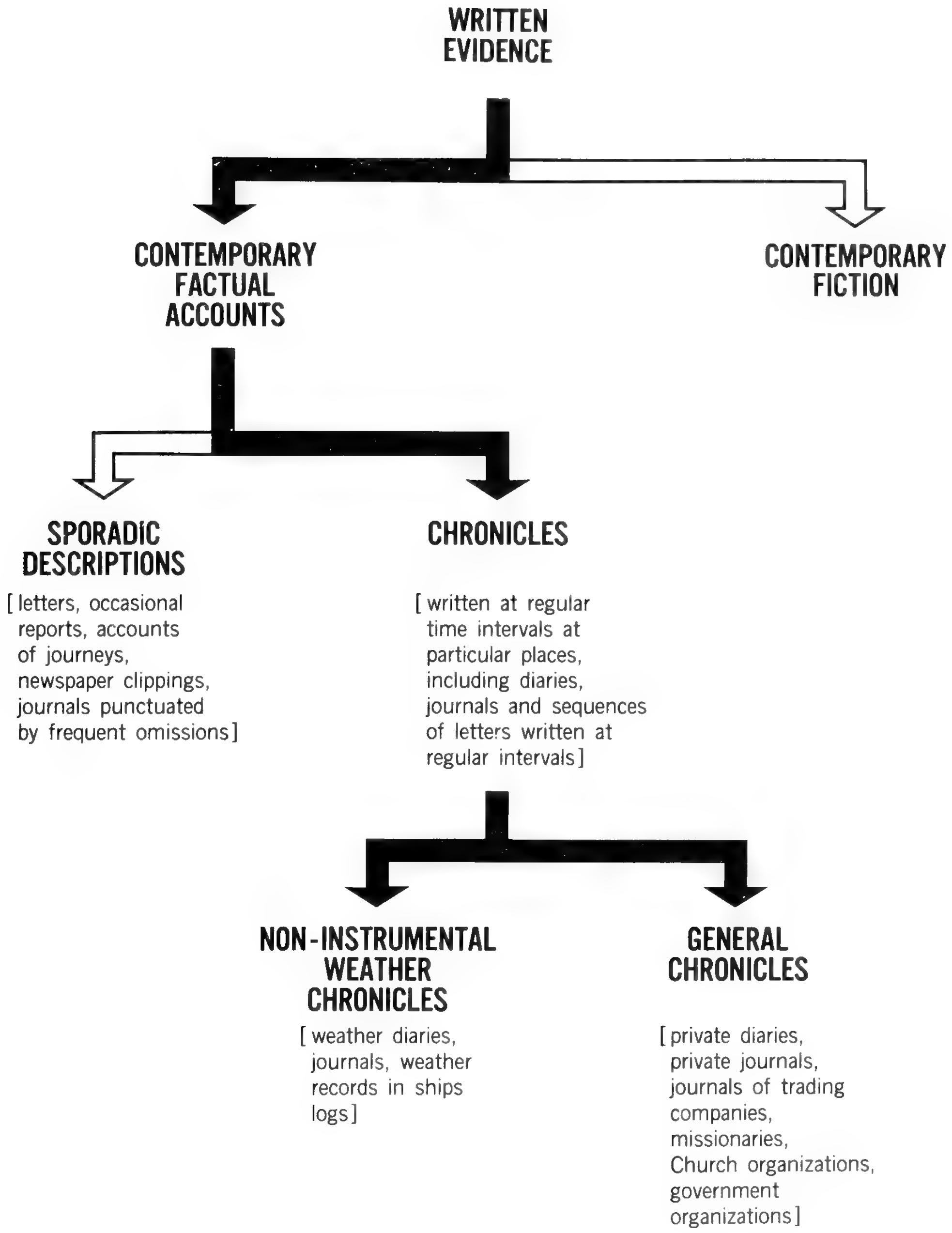

FIGURE 1: *General classification of types of written evidence of climatic change.*

historical climatic studies was given by Chiao-min Hsieh (1976). In a broad-ranging study of European climates since 1100 A.D. Lamb (1963) derives measures of the severity or mildness of winter, and of raininess or drought in summer. This is based upon references to the occurrence of extreme weather phenomena and environmental conditions in secondary historical documents. The latter comprise compilations of historical meteorological references using sources from eastern Europe (Buchinsky 1957), central Europe (Hennig 1904), western Europe (Easton 1928), Belgium (Vanderlinden 1924) and Britain (Britton 1937). The Climatic Research Unit (1977, pp. 9-18) has re-examined and questioned the validity of the results derived from these secondary sources.

(2) The study of such phenological indicators as the dates of first snow in fall, spring break-up, first blossoming of fruit trees, first ripening of fruit, first migrations of birds - since the passage of the seasons is a second focus of interest. Thus, Japanese historical documents yield dates of freeze-up of Lake Suwa from 1443 to 1954 (Arakawa 1954; Yazawa 1976), dates of first snowfall at Tokyo from 1632 to 1955 (Arakawa 1956) and dates of first blossoming of the cherry tree at Kyoto from the ninth to the nineteenth centuries (Arakawa 1957; Maejima 1966).

Inferential Historical Evidence

Knowledge about climatic change may possibly be inferred from any aspect of human behaviour that is sensitive to those changes. Table 1 contains a classification of this evidence according to aspect of human behaviour (settlement, cultivation, transportation, migration and health), and according to the climatic circumstance in which that behaviour is occurring. Four climatic circumstances are identified as being particularly favourable for the stimulation of human responses because they comprise the thermal or moisture limits to activities. These include temperature conditions near the poleward and altitudinal limits of development, and moisture conditions at desert margins and lake margins. Brief notes in Table 1 indicate regional applications of the various types of inferential evidence.

Role of Historical Evidence

A deficiency of the historical evidence is the comparative brevity of its time span and this is most apparent in the communicated evidence. The oldest written sources from the old world are limited to the past two to six millenia, an interval that comprises a small fraction of Quaternary time. Canadian sources are limited to three centuries, barely one per cent of the interval since 20,000 B.P. This raises the question that, while the historical evidence may be an interesting curiosity, it will have limited practical use and can add little to the knowledge that will be gained from ostensibly more scientific sources. However, it should be stressed that the utility of a type of evidence is dependent upon several major factors in addition to its duration, and prominent among these is its sensitivity or resolution. Many types of environmental evidence can give only a rough idea of the climatic differences between millenia or centuries. The historical

TABLE 1: *TYPES OF INFERENTIAL HISTORICAL EVIDENCE OF CLIMATIC CHANGE.*

ASPECT OF BEHAVIOUR	CLIMATIC CONDITIONS LIMITING HUMAN BEHAVIOUR			
	THERMAL CONDITIONS		MOISTURE CONDITIONS	
	Poleward Limits	Altitude Limits	Aridity Limits	Lake Margins
SETTLEMENT	Medieval Norse settlement in Greenland.	Deserted upland villages in England.	Indus and Sahelian civilizations.	Prehistoric Germany, Caspian Sea.
CULTIVATION	Medieval cereal cultivation in Iceland.	Upper limits of cultivation in Europe.	Indus and Sahelian civilizations.	-
TRANSPORTATION	Medieval voyages in North Atlantic & Arctic.	Trade routes over passes.	Trade routes over deserts.	-
MIGRATION	Migrations of Eskimos (Inuit).	-	Migrations of pastoralists in Asia.	-
HEALTH	Famine and disease in high latitudes.	-	Famine and disease in arid areas.	-

evidence, in contrast, can occasionally discriminate between decades and years. Thus, a very detailed picture of climatic change can be generated by this evidence and, in so doing, it may yield the type of information that is afforded by the instrumental evidence. Lamb (1977, pp. 22-34) proposes the term 'parameteorological phenomena' to embrace the weather and environmental information derived from communicated historical sources. The Climatic Research Unit (1977, p. 7) identifies three main sources of climatic data in the past 3000 years and defines 'proxy data' as "a blanket term applied to all other types of evidence (other than the instrumental and the communicated historical)".

While stressing the value of historical evidence in reconstructing climatic change in the past 3000 years, the Climatic Research Unit (1977, pp. 4-7) observes that: "Historical data are invariably more precisely dated than proxy data and the meteorological and climatological information obtained from historical sources is generally more direct and precise than that from proxy sources. ...The main disadvantages of proxy data are in dating, in their often slow (and frequently inadequately known) response time, in the complexity of responses to meteorological variables, and in the possible influence of Man."

The historical evidence in Canada may extend over a period which is two or three times larger than that spanned by the instrumental evidence. Both the instrumental and the historical evidence are available from minute parts of the past 20,000 years but these time periods are critically important to the study of present climatic changes and their potentially damaging effects on mankind. The present decade has witnessed a growing demand for improved long-term climatic forecasting. Given the present state of development of meteorology, climatic forecasting is founded on an empirical basis in which past trends are projected into the future. The key to improving forecasts lies in a fuller understanding of the past. In this context, the past of greater value is that spanned by instrumental evidence, but the historical past immediately preceeding the instrumental period is also of vital concern.

In summary, historical evidence is not to be relegated to a subsidiary role in which it merely adds a human perspective to knowledge of climatic changes detected and verified by more traditionally scientific types of evidence. Historical evidence has a fundamental role in detecting changes which might not be revealed by other types of evidence. It can yield knowledge of comparatively high resolution in the recent past that bears most directly upon the immediate future.

General Types and Sources of Historical Evidence in Western and Northern Canada

The first standardized weather observations occurred in the last three decades of the nineteenth century in western Canada and in the early twentieth century in northern Canada. Therefore, the period of historical evidence predates these times. The oldest western and northern Canadian written sources date from the late seventeenth century and so the maximum duration of the historical evidence is approximately 300 years. This period witnessed the rapid exploration, the settlement and the economic development of a large, previously unknown wilderness, by a literate and scientifically sophisticated people. The evidence produced under these circumstances conforms to the framework given in Figure 1, but differs in fundamental respects from that of the Old World. Fictional sources dwindle to insignificance in this context and the potential role of factual accounts is enriched whenever they reflect the interaction between the harsh Canadian climate and writers familiar with more equable European environments. In Canada, the explorer, settler, trader and missionary were pitted against adverse weather in winter and summer, often in circumstances of extreme isolation and their writings reflect a preoccupation with environmental stresses. This exploration and development was, in part, conducted by private individuals, but it was vigorously prosecuted by the servants of the major institutions. A general classification of the exploited and the potential sources of Canadian historical evidence is given in Figure 2.

I will examine each of these various sources separately. In discusssing the major sources I will briefly outline the nature of the evidence which they contain, then I will summarize the existing uses to which the evidence has been put and will indicate the potential for further use of the evidence. First, it is appropriate to examine in greatest depth the records of the Hudson's Bay Company, because they provide a corpus of chronicles that is unrivalled in Canada and, indeed, in North America. Although these records have been more extensively and rigorously employed in climatic reconstruction than any other Canadian historical sources, only a small part of their great potential has been developed.

Hudson's Bay Company Records

I begin this assessment of the records with an introductory outline of the Company's history, the logistics of its trading practices, and the nature of its archives.

History, Trade Logistics and Archives

The Hudson's Bay Company was created to develop an English fur trade centred on Hudson Bay at a time when the existing Canadian fur trade was in French hands and focused upon Montréal. In 1670, Charles II of England granted a charter to the Governor and Company of Adventurers of England trading into Hudson's Bay, which guaranteed proprietory rights and the monopoly of trade in Rupert's Land (the entire territory draining into the Bay). The Company sent its first ship into the Bay in 1668 and permanent Company settlement began on James Bay in 1672. With this development, a logistical system of movement of trade goods was initiated that remained in force for the first century of the Company's trading. Under this system, the Company confined its trading posts to the estuaries of rivers draining into Hudson Bay. These posts were entrepôts at the places where Indian traders coming down river met the ocean-going ships from London.

During the first century, the Company was stimulated to explore and increase its trade in the interior of Rupert's Land by the threat posed by the westward push of French Canadian traders. Therefore, the Company sent expeditions at sporadic intervals into the interior:

1690-1692 - Henry Kelsey reached the lower Saskatchewan;

1754-1755 - Anthony Henday penetrated to the western parklands of Alberta;

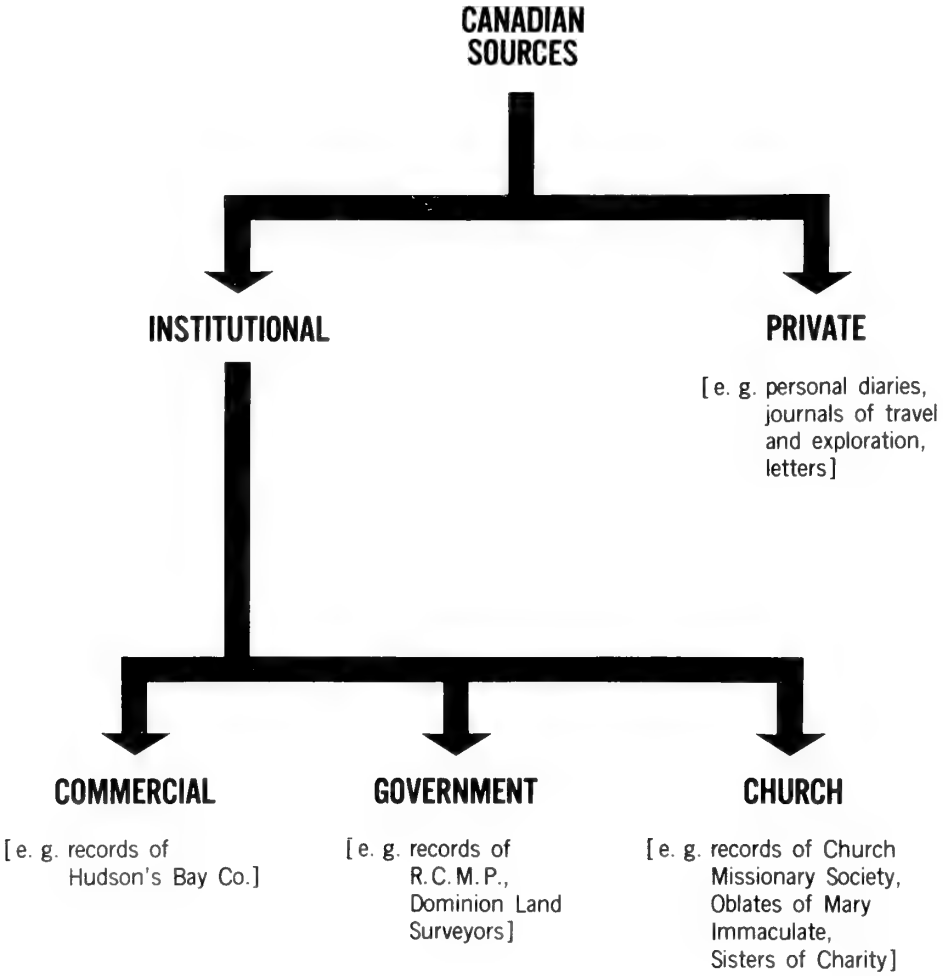

FIGURE 2: *General classification of sources of written evidence of climatic change in Canada.*

1754-1774 - A period when expeditions became almost annual events to draw the Indians to the Bayside trading posts. Prominent among those involved were Joseph Smith, Joseph Waggoner, William Pink and Matthew Cocking.

To meet the growing threat posed by competitors from Montréal following the collapse of New France, the Company established its first inland post, Cumberland House, on the Saskatchewan River in 1774 and the investigation of the interior was specifically assigned to explorers skilled in surveying. Prominent among this group of surveyor-explorers were David Thompson, Philip Turnor and Peter Fidler.

By the nineteenth century the rival North West Company was experiencing serious logistical difficulties related to the great distance between Montréal and the Athabasca district. This eventually led to union between the two companies in 1821, a union which allowed York Factory to eclipse Montréal as the focus of the trade. At the same time the Company obtained a license to monopoly privileges in the territory beyond Rupert's Land. There followed a period of relative stability until 1870 when the Company relinquished most of its chartered rights and the fur trade diminished to a shadow of its former proportions.

The logistics of the Company's trade are directly relevant because they have determined the general nature of the Company's documentary records. I will examine separately the maritime and the continental components of the trade.

Each year the Company dispatched a small fleet,which sailed directly from the Orkneys to Hudson Bay. These ships penetrated Hudson Strait in mid-summer when the strait was still congested with drift ice. On entering Hudson Bay the ships separated, one being destined for James Bay and the other for the west coast at York Factory or Churchill. The ships returned in September by which time Hudson Strait was comparatively ice-free. A first-hand account of the voyage of one such fleet was published by Chappell (1817), a ship's officer.

Prior to the move to the interior in the late eighteenth century, the continental trading system was a simple matter of maintaining permanent depots at the Bayside where furs were received and trade goods and provisions were stored. Eventually, seven such posts were established. However, the move inland created problems of communication and administration that led to the division of Rupert's Land into trading districts. Within each district was created a hierarchy of posts, involving district headquarters and local trading posts. Records are available from more than 200 posts. A summary of this hierarchy and of the research potential of its written records is given by Moodie (1977).

I have not identified a fundamental distinction between the Hudson's Bay Company and any other comparable company such as the North West Trading Company. Such a distinction emerges, in the context of sources of historical evidence, when the unique archival legacy of the Hudson's Bay Company is considered (Craig 1970). Throughout its history, the London headquarters of the Company required its servants to maintain meticulous records of its business operations in North America, including records of environmental phenomena that affected its business throughout its wilderness domain. The policies of the Governor and

Committee in London ensured, not only the keeping of detailed records in North America, but also their preservation in London, from which has evolved this unique corporate archives. The Company's archives contain records as varied as explorers' journals, Indian trade accounts, ships' logs, the records of subsidiary enterprises, letter books and even daily temperature records from instrumental observations. The records of greatest value for environmental reconstructions are the post journals and the ships' logs. Their value, like many other manuscript groups in the Company's archives, lies in the regularity of record-keeping in time and space, and in the wealth of environmental information that they contain.

The Company's Archives as a Resource for Historical Climatology

Both the maritime and the continental components of the Company's trade were conducted in a harsh environment. As a result, various records in its archives make frequent reference to weather and climate. I will examine the archival resources which offer the greatest potential for use, dealing with the maritime component first.

The Ships' Logs

The Company's ships voyaged annually through seas where ice posed a severe threat to navigation. It has been demonstrated elsewhere that ships' logs (Figure 3) can yield valuable information about sea ice and weather (Oliver and Kington 1970; Daney 1977), but it is hard to imagine more favourable circumstances for research of this nature than those provided by the voyages of these ships through Hudson Strait and Hudson Bay. The voyages occurred with almost clockwork precision and annually followed an almost identical route. This route focused on the bottleneck of Hudson Strait which annually experienced a cycle of ice conditions, ranging from close pack ice in winter to a cover of less than one tenth in late summer. The route through the strait hugged the north shore to gain most open leads, and it provided opportunities for fixing the positions of the ships using references to named landmarks. This is an important advantage, since many of the references in the logs can be precisely located geographically. Further, these spatial references focus upon a few recurring places. The voyages were made over a period that extended well into the Little Ice Age when ice conditions may have been significantly different from later ones. Furthermore, these voyages commenced in the North Atlantic (where eighteenth and nineteenth century ice conditions are known from Iceland sources) and extended into an area where these conditions are still relatively unstudied. It is true that Speerschneider (1931) has investigated sea-ice conditions in Davis Strait from 1820 to 1930, but his use of ships' logs is generally impressionistic. In the Beaufort, Bering and Chukchi seas of the western North American Arctic, sea ice conditions since 1870 have been studied using ships' logs (personal communication, E.C. Sobey* 1977).

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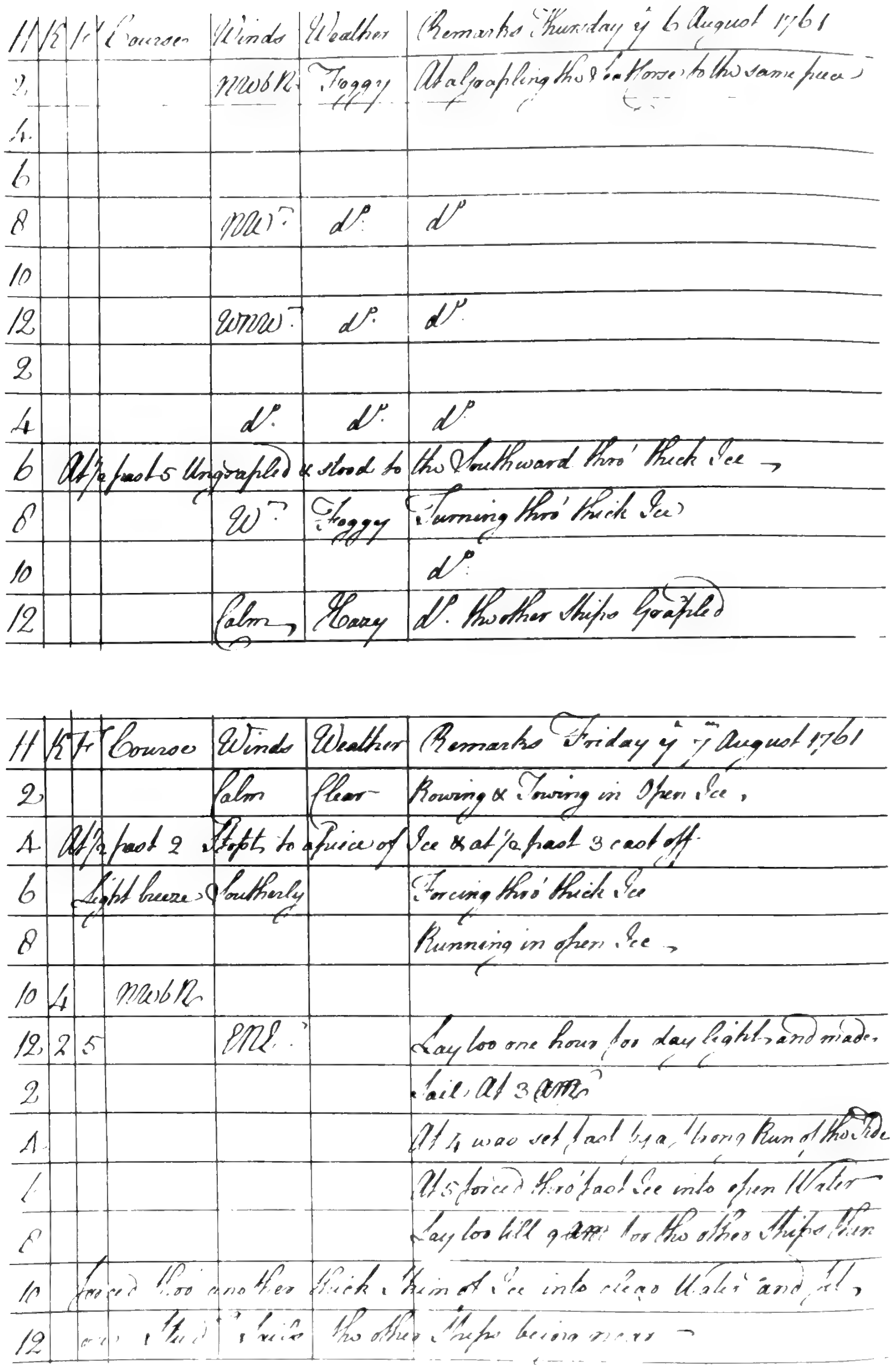
*Sobey indicates that the Outer Continental Shelf research program sponsored by NOAA (National Oceanic and Atmospheric Administration of the United States) includes examination of historical evidence of sea ice conditions. W.R. Hunt and C.M. Naske of the University of Alaska are conducting this work.



H	K	F	Course	Winds	Weather	Remarks Thursday ye 6 August 1761
2				NWbN	Foggy	At ½ grapling the Sea Horse to the same piece
4						
6						
8				NW	do.	do.
10						
12				WNW	do.	do.
2						
4				do.	do.	do.
6	At ½ past 5 Ungrapled & stood to the Southward thro' thick Ice					
8				W	Foggy	Turning thro' thick Ice
10						do.
12				Calm	Hazy	do. the other Ships Grapled

H	K	F	Course	Winds	Weather	Remarks Friday ye 7 August 1761
2				Calm	Clear	Rowing & Towing in Open Ice,
4	At ½ past 2 Stopt to a piece of Ice & at ½ past 3 cast off					
6		Light breeze		Southerly		Forcing thro' thick Ice
8						Running in open Ice
10	4		NWbN			
12	2	5		ENE		Lay too one hour for day light and made
2						Sail At 3 AM
4						At 4 was set fast by a strong Run of the Tide
6						At 5 forced thro' fast Ice into open Water
8						Lay too till 9 AM for the other Ships then
10	forced thro' another thick Skirt of Ice into clear Water and lay					
12	too [illegible] while the other Ships being near					

FIGURE 3: *Page from the log of the King George, written during the ship's passage through Hudson Strait, 6-7 August, 1761. Source: "A Journal of a Voyage in the King George of London from thence to York Fort in Hudson's Bay and back to the Port of London by Joseph Spurrell Master". 1761. Hudson's Bay Company Archives C1/365, folio 24d.*

TABLE 2: *FREQUENCY DISTRIBUTION OF ANNUAL NUMBERS OF SHIPS IN THE HUDSON BAY FLEET, FROM WHICH LOGS ARE AVAILABLE IN THE HUDSON'S BAY COMPANY ARCHIVES, 1751-1870.*

Number of Ships	Number of Years
0	3
1	4
2	46
3	54
4	12
5	2

The Company's archives contain logs of ships voyaging to Hudson Bay in every year from 1751 to the present century, with the exceptions of 1839, 1840 and 1841. In most of the 120 years preceeding 1871, logs are available from more than one ship, (Table 2).

The multiplicity of logs per year is compounded by the fact that on many ships more than one log was kept. This is significant since it implies opportunities for the verification of information derived from particular logs.

Logs are available from 27 different ships over the 121-year period. Figure 4 identifies each of the ships sailing in each year and indicates their destinations. In almost all years at least one ship sailed to York Factory and another to James Bay (usually Moose Factory). The destination was rarely Churchill after 1813. Several ships only made the voyage to Hudson Bay once, but some were involved for decades.

A second type of log is preserved in the Company's archives. These logs were kept on the schooners which remained at the Bayside posts throughout the year, ice-bound in winter, and conducting coastal traffic in summer. The logs of these coastal schooners are not housed among those of the ocean-going ships but are contained in the journals of the posts where the schooners were stationed.

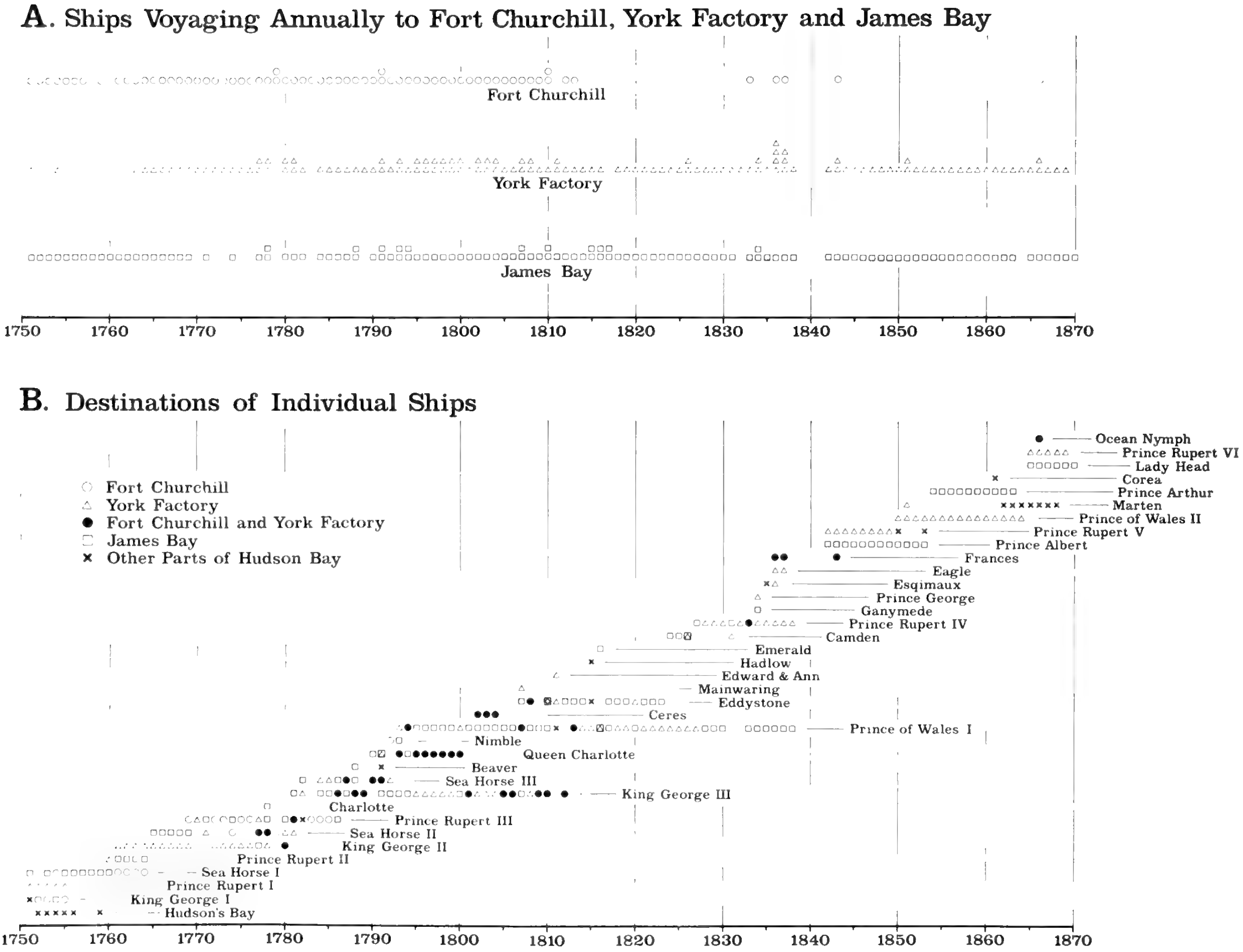
The most complete sequences of logs are housed in the post journals from Eastmain (a continuous record from 1736 to 1781) and from Churchill (1743 to 1744, 1748 to 1758, 1760, 1762, 1764 to 1780 and 1785 to 1790).

The ships' logs comprise the main archival holdings derived from the maritime component of the Company's trade and attention will now turn to the holdings derived from the continental component.

Records from Trading Posts

This component of the Company's trade was no less sensitive to climatic stimuli than the maritime trade. Only in Siberia are seasonal changes in temperature more extreme than those of Rupert's Land. These changes exercised a profound influence on the trade, as well as the day to day activities of its personnel. Just as the seasons and daily weather had a great impact upon the Company's personnel, so their daily journals and correspondence are replete with references to, and descriptions of, these conditions. The journals (Figure 5) were not written with scientific objectivity and systematization, but by individuals who were probably more sensitive to, and perceptive of, the weather than any who might write similar journals today. These physical considerations, allied to the Company's penchant for requiring the keeping of and preservation of these journals, have ensured that the journals are rich in climatic evidence. An insight into this potential is provided by the following directive concerning the contents of post journals from the board of directors in London to one of its post factors in 1814:

> These Journals are to contain nothing but a plain & simple memorandum of facts...They must however be distinct & full, containing all the particulars that may contribute to the better understanding of the transactions that are mentioned...Among the circumstances, which are always to be noticed in the Journals, is the weather & progress of the Season: - the date of the freezing in of the lakes and rivers; the chief falls of snow & their depth; the greatest thickness of the Ice; the commencement



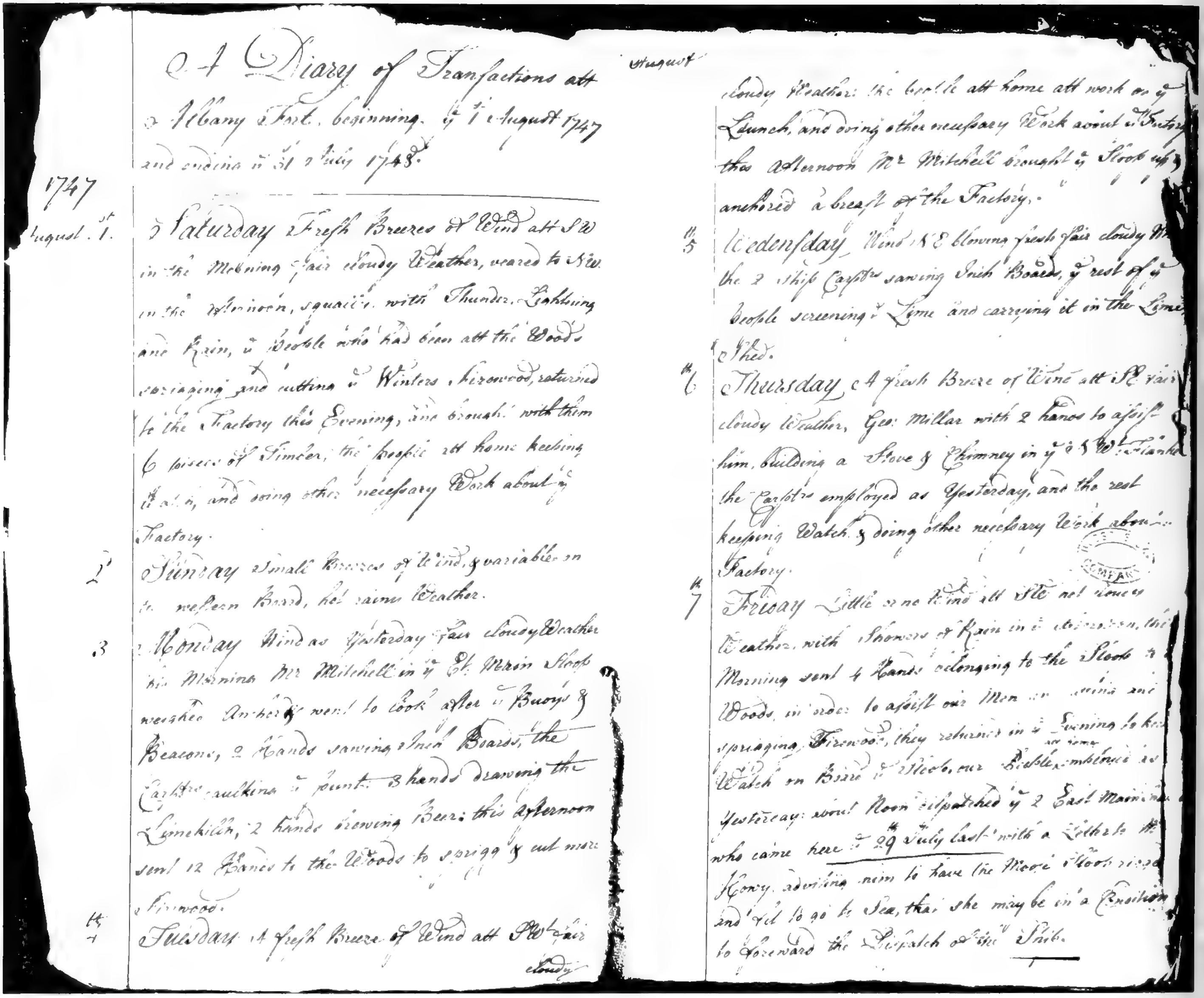
A. Ships Voyaging Annually to Fort Churchill, York Factory and James Bay

B. Destinations of Individual Ships

FIGURE 4: *Hudson's Bay Company ships voyaging from England to the Bay, 1750 to 1870. The diagram only includes voyages which yielded logs that are preserved in the Company's archives.*

TABLE 3: *FREQUENCY DISTRIBUTION OF DURATIONS OF JOURNAL RECORDS AT HUDSON'S BAY COMPANY POSTS, PRIOR TO 1871.*

Duration (Years)	Number of Posts	Duration (Years)	Number of Posts
1	61	71 - 80	2
2 - 5	53	81 - 90	0
6 - 10	29	91 - 100	1
11 - 20	21	101 - 110	1
21 - 30	20	111 - 120	0
31 - 40	9	121 - 130	0
41 - 50	3	131 - 140	2
51 - 60	4	141 - 150	1
61 - 70	2	151 - 160	1



A Diary of Tranſactions att Albany Fort, beginning ye 1st August 1747 and ending ye 31st July 1748.

1747 August 1st. Saturday Freſh Breezes of Wind att SW in the Morning fair cloudy Weather, veared to NW in the Afternoon, squally with Thunder, Lightning and Rain, ye People who had been att the Woods sprigging and cutting ye Winters Firewood, returned to the Factory this Evening, and brought with them 6 pieces of Timber, the People att home keeping Watch, and doing other neceſsary Work about ye Factory.

2 Sunday Small Breezes of Wind, & variable in ye western Board, hot [illegible] Weather.

3 Monday Wind as Yesterday fair cloudy Weather this Morning Mr Mitchell in ye Et. Main Sloop weighed Anchor & went to look after ye Buoys & Beacons, 2 Hands sawing Inch Boards, the Carptrs caulking ye punt, 3 hands drawing the Limekiln, 2 hands brewing Beer: this Afternoon sent 12 Hands to the Woods to sprigg & cut more Firewood.

4th Tuesday A fresh Breeze of Wind att SWt fair cloudy

August

Weather: the People att home att work on ye Launch, and doing other neceſsary Work about ye Factory this Afternoon Mr Mitchell brought ye Sloop up & anchored abreaſt of the Factory.

5th Wedenſday Wind NE blowing fresh fair cloudy We the 2 Ship Carptrs sawing Inch Boards, ye rest of ye People screening ye Lime and carrying it in the Lime Shed.

6th Thursday A fresh Breeze of Wind att SE fair cloudy Weather, Geo: Millar with 2 hands to aſsiſt him, building a Stove & Chimney in ye S W. Flanker the Carptrs employed as Yesterday, and the rest keeping Watch & doing other neceſsary Work about ye Factory.

7th Friday Little or no Wind att SE [illegible] Weather, with Showers of Rain in ye Afternoon, this Morning sent 4 Hands belonging to the Sloop to ye Woods, in order to aſsiſt our Men in cutting and sprigging Firewood, they returned in ye Evening to keep Watch on Board ye Sloop, our People employed as Yesterday: about Noon dispatched ye 2 East Main [illegible] who came here ye 29th July last with a Letter to Mr Henry advising him to have the Moose Sloop ready and fit to go to Sea, that she may be in a Condition to forward the Dispatch of the Ship.

FIGURE 5: *Page from the post journal kept at Fort Albany, 1-7 August, 1747. Source: "A Diary of Transactions att Albany Fort, beginning ye 1st August 1747 and ending ye 31st July 1748". Albany Fort Journal, Hudson's Bay Company Archives, B3/a/39, folios 1d-2.*

> of Thaw: the breaking up and clearing away of the Ice, the commencement of vegetation; the opening of the leaf of the most remarkable trees; the flowering of any remarkable plant...the ripening of any kind of native fruit, or of any species of cultivated produce; the commencement of frost in the Autumn & the fall of the Leaf...The observations are not to be considered as a matter of idle curiosity; but may be of very essential use...(Governor and Committee of Hudson's Bay Company, 1814).

The broad spatial and temporal distributions of the post journals are noteworthy. They are scattered across Rupert's Land, and extend temporally into the latter part of the Little Ice Age*. Although the posts were widely distributed, they were also occasionally close together, enabling assessment of the validity of these historical date by spatial homogeneity testing.

The holdings of post journals in the Company's archives commence with the Albany Journal of 1705. From that date to 1870, journals from 210 posts are preserved. However, the journal records from many of these posts are very brief (Table 3).
A general illustration of the temporal distribution of all post journals is given in Figure 6, and the distributions of the 28 post journals with a duration exceeding 30 years prior to 1871 is given in Figure 7. The latter group of journals offers the greatest potential for studies of climatic change, and in Figure 7 the duration of these journals between 1871 and 1940 is also given. The journal contents from this modern period are potentially valuable for extending historical trends to the present and for testing the historical data against their modern counterparts.

In the eighteenth century less than 10 post journals were kept in each year until the last two decades when the Company's move inland caused a rapid increase in the number of journals (Figure 8). In the nineteenth century, the number of journals kept each year ranged from 20 to 50.

Although the oldest journals were kept at posts on the Bayside, several of those spanning more than 30 years occur near the westward limits of Rupert's Land (Figure 9). It is noteworthy that the locations and site conditions of many of these posts changed, or are still unknown. This is especially true of the more ephemeral wintering posts. Site conditions are of particular importance in environmental studies since break-up and freeze-up dates, wind speed and direction, the duration of snow cover, and similar factors can change considerably between different sites in a particular location.

By virtue of their broad distribution in time and space, and their frequent climatic commentary, the post journals comprise the richest source of climatic evidence in the Company's archives. I now turn to a second source which concentrates more directly and systematically upon weather phenomena, but which is much rarer than the post journals. Mention has already been made of the Company's determination to acquire scientific information about Rupert's Land and this prompted the routine observation of the weather at a time which, even by European standards, was early. Several of these observational records were kept under the auspices of the Royal Society in London. In these cases, the

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* Ed. note: The Little Ice Age or Neoglaciation denotes a renewed phase of glacial advance since the late medieval period. Although some variability has been detected on a global scale, here it is considered to have commenced in the sixteenth century, reached its peak in the eighteenth century, and ended by the middle of the nineteenth century.

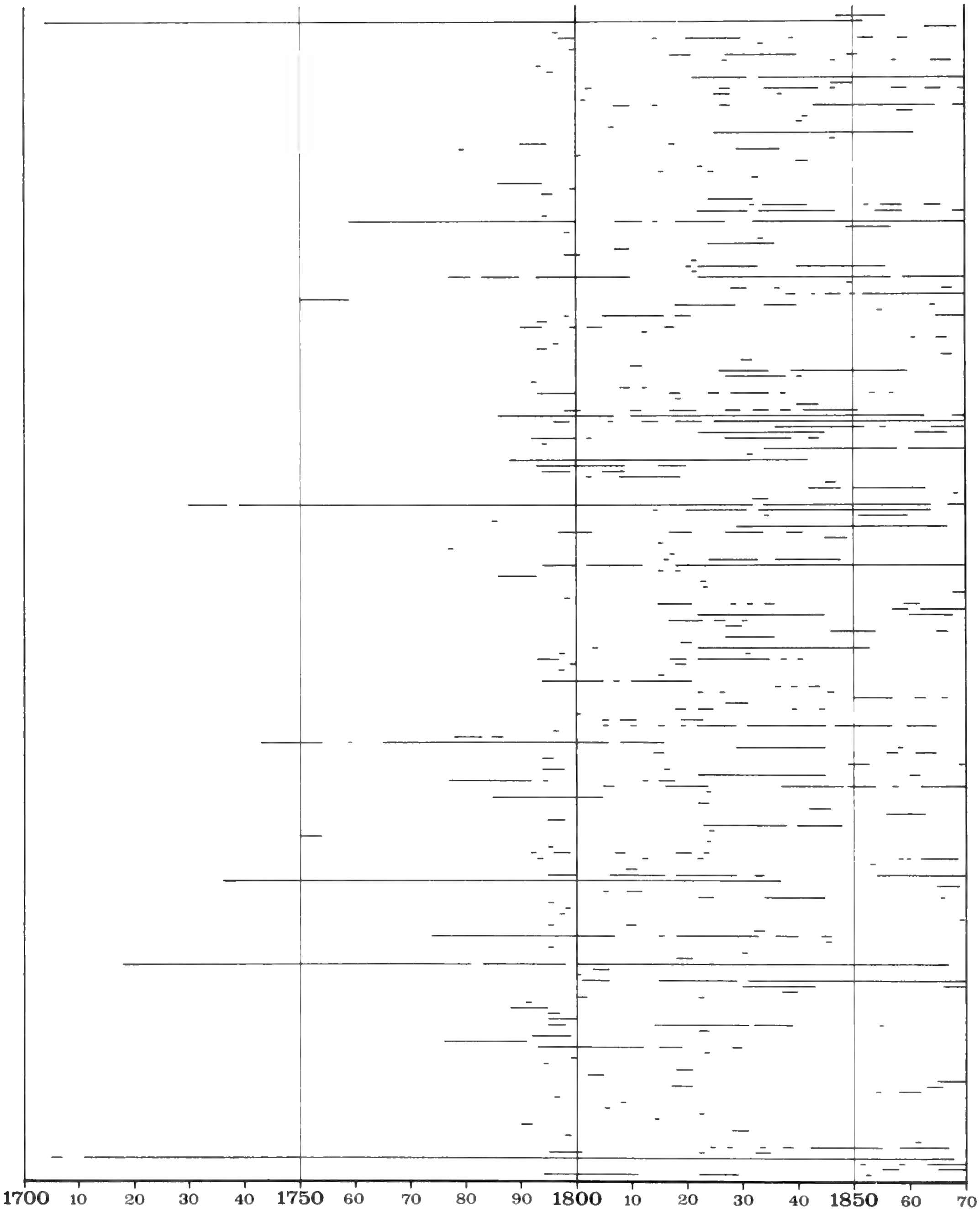

FIGURE 6: *Temporal distributions of post journals in the Hudson's Bay Company Archives, 1700 to 1870. More than two hundred post journals are shown, the duration of each being indicated by an intermittent line. Although posts are not identified, the diagram illustrates the longevity of a few journals, the fragmentary and brief nature of most, and the increase in journal keeping after 1790.*

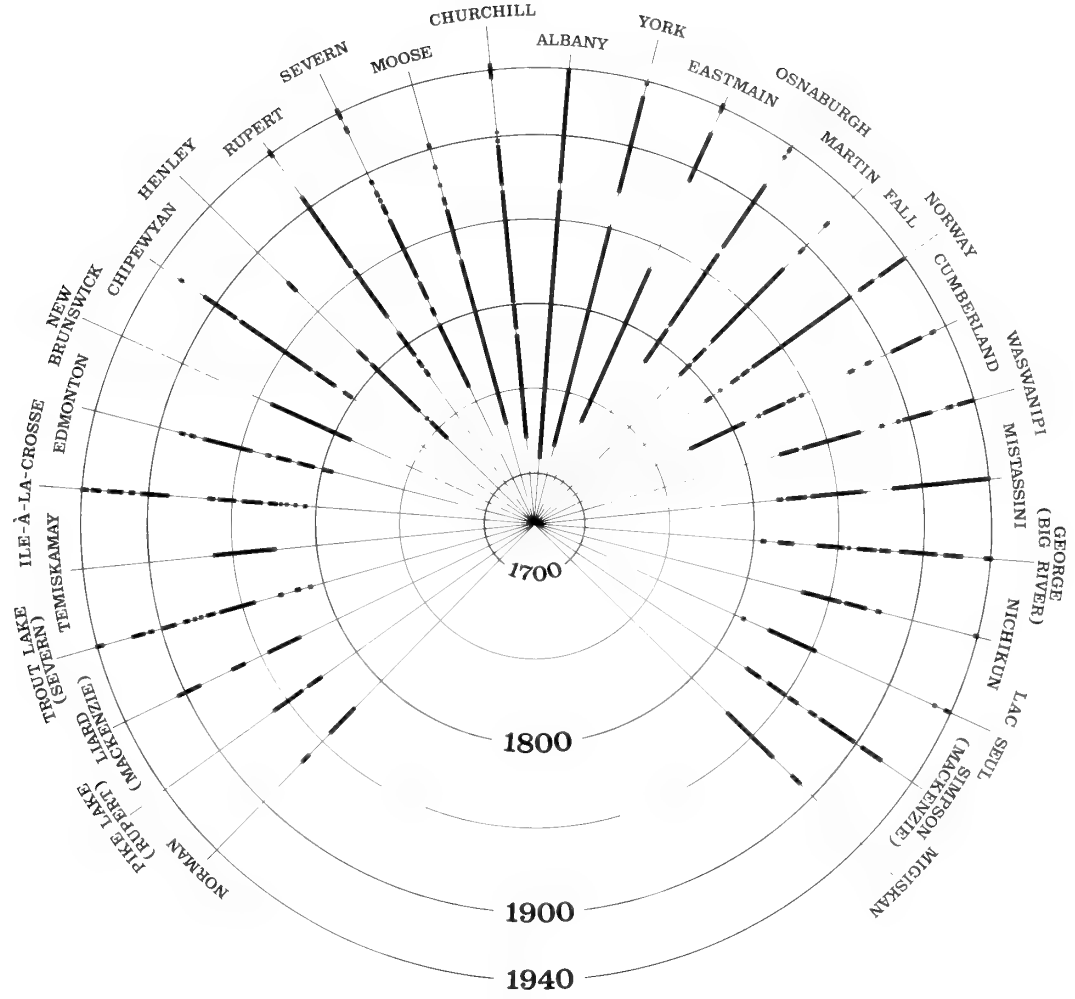

FIGURE 7: *Temporal distributions of selected Hudson's Bay Company post journals, from 1670 to 1940. These are the journals having the longest durations prior to 1870; all span at least 30 years in that period.*

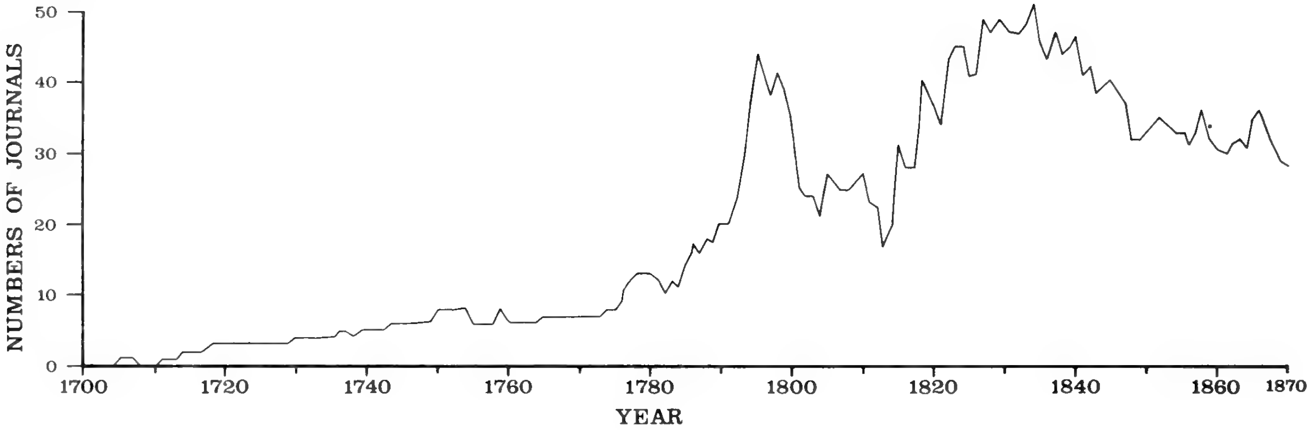

FIGURE 8: *Numbers of Hudson's Bay Company post journals available in the Company's archives for each year between 1700 and 1870.*

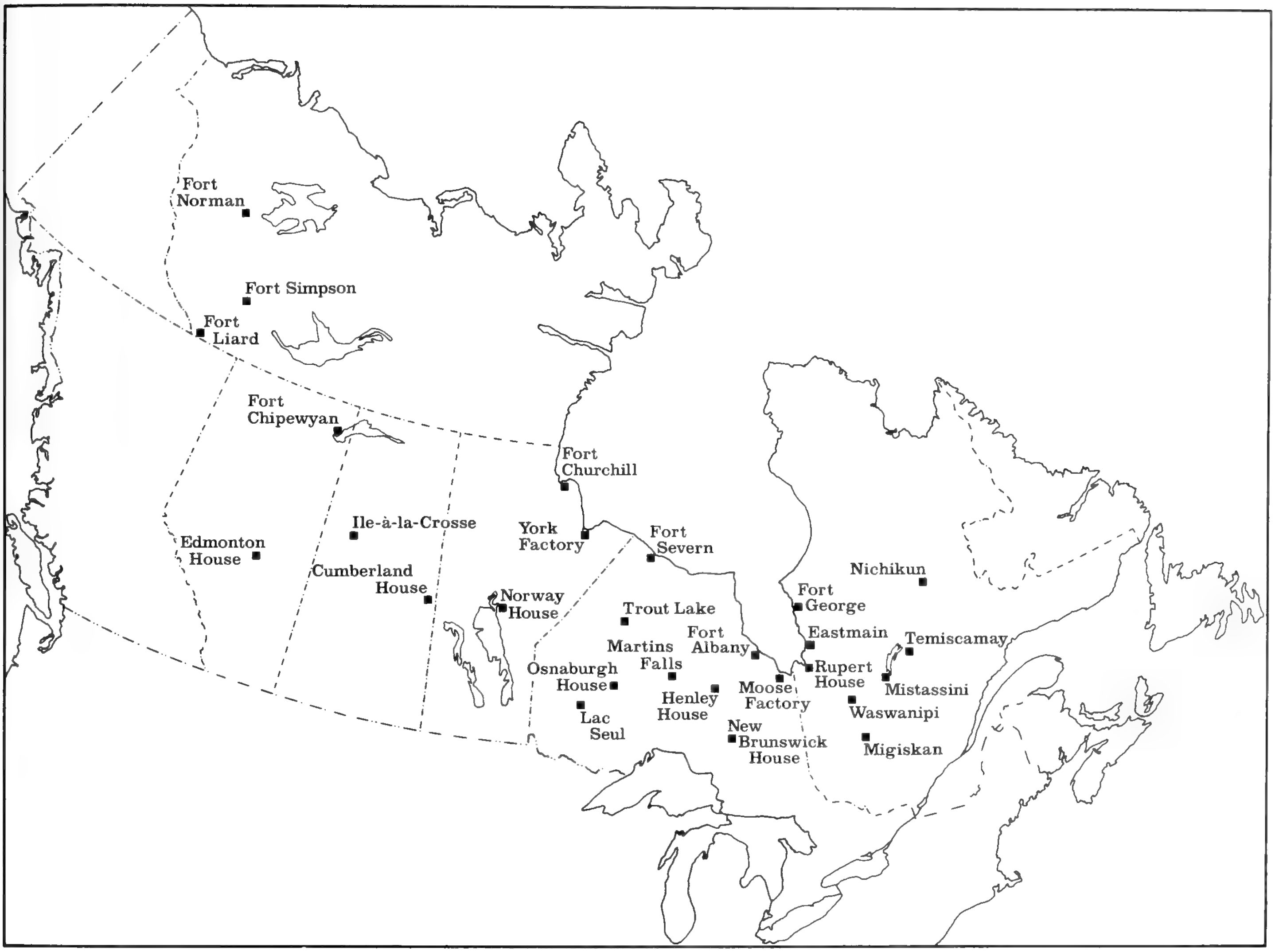

FIGURE 9: *Locations of the Hudson's Bay Company posts shown in Figure 7.*

TABLE 4: *METEOROLOGICAL JOURNALS CONTAINED IN POST JOURNALS IN THE HUDSON'S BAY COMPANY ARCHIVES (EXCEPT WHERE OTHERWISE INDICATED, EACH METEOROLOGICAL JOURNAL IS CONTAINED IN THE POST JOURNAL OF THE SAME NAME).*

Location	Years
Brandon House[1]	1814-1815
Chesterfield House (Bow River)	1800-1801; 1801-1802
Cumberland House	1806-1807; 1815-1816; 1832-1833; 1839-1840
Fort Chipewyan[2]	1840
Fort Churchill	1837-1839; 1838-1839; 1840-1841; 1841-1842; 1842-1843; 1843-1844; 1844-1845
Fort George (Big River)	1816-1817; 1817-1818
Fort Norman	1861-1862
Peel River[3]	1862-1867
York Factory	1771-1772; 1794-1795; 1829-1830; 1831-1832; 1847-1849; 1850-1851; 1851-1852

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[1] The Brandon House meteorological observations are contained in the post journal from Winnipeg, 1814-1815.

[2] The Fort Chipewyan meteorological journal is contained in the post journal from Fort Good Hope, 1840-1841.

[3] The Peel River meteorological journal is contained in the post journal from Fort Norman, 1861-1867.

TABLE 5: *METEOROLOGICAL JOURNALS FROM HUDSON'S BAY COMPANY POSTS, PRESERVED IN THE LIBRARY OF THE ROYAL SOCIETY, LONDON.*

Post	Duration	Post	Duration
Albany	1776 - 1782	Ile à la Cross	1809 - 1811
Athapascow	1790 - 1792	Moose	1795 - 1797
Athapascow Lake	1803 - 1804	Nain	1777 - 1786
Buckingham House	1796 - 1797	Nottingham	1805 - 1806
Carlton House	1795 - 1796	Okkak	1777 - 1784
Chesterfield House	1801 - 1802	Reed Lake House	1794 - 1795
Churchill Factory	1792 - 1793	Swan River	1807 - 1808
Clapham House	1808 - 1809	York Factory	1766 - 1767
Cumberland House	1778 - 1790		1771 - 1772
	1806 - 1807		1774 - 1778
Eastmain	1777 - 1781		1793 - 1797
Gloucester House	1781 - 1782		
Henley House	1784 - 1788		
Hoffenthal	1782 - 1786		

data are preserved in the Society's library. Other early weather journals are preserved in the Company's archives -- usually within the journal of the post where the observations were made.

Not all of the meteorological journals within the post journals have been catalogued and Table 4 contains a list of the meteorological journals that are currently catalogued. The meteorological journals kept only in the library of the Royal Society in London are identified in Table 5.

These records include temperature, wind direction and force, and occasionally pressure readings, but precipitation was not observed except for sporadic references in daily remark columns. In common with all early meteorological records, these data were not observed under standardized circumstances. Usually, readings were made several times per day, but the hours of observation changed from place to place and time to time. Information on site conditions and instrumentation was rarely given.

Climatic Research Using Hudson's Bay Company Archives

I will outline research that has been completed, that which is underway, and the scope for further research. Although completed work has demonstrated the utility of this rich resource, only a small fraction of its potential has been developed.

Completed Research

The published research has utilized only the information in the post journals and is further circumscribed since it focuses only upon the dates of freeze-up and break-up of water bodies. The first of these published works was a study of the dates of freeze-up and break-up of the Churchill River at Churchill and of the Hayes River at York Factory by MacKay and Mackay (1965). This study derived dates from the post journals commencing in 1719 at Churchill and in 1714 at York Factory, and supplemented this information with dates derived from records kept by the Geological Survey of Canada in the nineteenth century. The results were sequences of dates intermittently spanning a period of 250 years.

A second study of freeze-up and break-up using the information in the post journals was conducted by Moodie and Catchpole (1975). A particular feature of this study was the development of a systematic and objective method, using the principles of content analysis, for the derivation of annual dates of freeze-up and break-up from the written sources.

This study also developed methods for testing the reliability of the content analysis when applied by different researchers, and for testing the validity of the dates derived. A preliminary form of this method was first applied to the journals of three inland posts, Edmonton House, Cumberland House and Norway House (Catchpole et al., 1970). Following this, the method was fully developed and then applied to the four longest and most continuous post journals, namely those from Churchill, York Factory, Fort Albany and Moose Factory on the Bayside. The close juxtaposition of, and hydrologic similarities between, the estuaries of the Moose River and the Albany River facilitated validity testing of the data. This test indicated that the historical dates of freeze-up and break-up compare in quality with their modern counterparts observed by the Atmospheric Environment Service (Moodie and Catchpole 1976). The trends within these historical dates were described by Catchpole et al. (1976).

Another work using the Company's records was a study of air mass frequencies over Rupert's Land in the historical period (Minns 1970). This derived measures of the frequencies of wind directions and temperature from the journals of four posts, Edmonton, Winnipeg, Fort William and Fort Simpson, and these were analyzed using the method of partial collectives. This method was developed by Bryson for identifying features in the frequency distributions of air temperatures which might be diagnostic of particular air masses. Minns concluded from this analysis that Arctic air was much commoner in the western interior of Canada in the early nineteenth century than is the case today.

Research in Progress

Several climatic studies based on the Company's archives are underway. While most of these are based on the post journals, use is now being made of the ships' logs.

An intensive, computer-based study of the weather and environmental information in the Churchill and York Factory post journals is being conducted by T. Ball (personal communication, 1977) at the University of Winnipeg. For this purpose a coding system has been devised to enable the daily subjective assertions about each weather element to be coded and then transferred onto punched cards. Each card refers to a particular day at one post and can accommodate coded information on temperature, wind direction, wind speed, pressure (in the unlikely event that this was measured), precipitation type, cloudiness, thunder, melting, freezing, snow drifting and general weather conditions. In the first stages of the analyses, programmes are being run to tabulate the dates of first references to phenological indicators (first day of rain in spring, of snow in fall, of thunder in summer, etc.) and of the frequencies of references to weather conditions. Thus, monthly and annual frequencies of references to rain, snow, thunder, clear skies, cloudy skies, wind directions and weather types are being tabulated.

A study of the utility of the Company's ships' logs as climatic sources is being conducted by the author at the University of Manitoba. This concentrates initially upon the logs written in Hudson Strait and Hudson Bay. The study is developing content analyses of references to sea-ice and weather and these will provide indications of the types of information that can be most readily derived from these sources.

The Climatic Research Unit at the University of East Anglia proposes to undertake a study of the climate of the North Atlantic Ocean from 1500 to 1870 using historical sources (D.J. Underhill, personal communication, 1977). Ships' logs, including those of the Hudson's Bay Company, will compose one of the major categories of evidence used in this study.

Opportunities for Further Research

I conclude discussion of climatic research using the Company's archives with a consideration of the potential for further research. Only a small part of the full potential of these archives has been developed by the completed work and by the work in progress. First, I wish to examine the research potential of the post journals, which will probably remain the most valuable resource. Then I will consider the uses of the correspondence, the account books and the ships' logs.

The post journals continue to offer a broad potential for the description and analysis of long-term trends. Figure 7 indicates that ten journals span a period of at least 100 years. Ball's preliminary findings confirm the impression given by a casual scrutiny of these journals, namely, that they may yield numerical measures of the dates of several phenological indicators and of the occurrence of weather conditions diagnostic of the thermal intensity of the seasons. From several places in Rupert's Land long-trends in the following phenological indicators may be derived:

first day of rain in spring,
first day of snow in fall,
first day of thunder in summer,
first day of ground frost,
first day of freezing of water bodies,
first day of breaking of water bodies,
first day of thawing in spring,
dates of migration of birds,
dates of budding, flowering, ripening of plants

Evaluation of the frequency, intensity and duration of specific weather conditions may yield measures of long-term variations in the severity and duration of winter, and of the mildness and duration of summer.

The post journals also provide a potential for conducting synoptic weather studies of broad areas in Rupert's Land, since in some periods a large number of journals were being written simultaneously (Figures 6 and 8). In the decade 1790 to 1800, approximately 40 journals were being written each year and a similar number were written from 1820 to 1840. These networks may provide a means of studying the spatial characteristics of specific meteorological events such as exceptional spring thaws, cold spells, storms or freezes.

Historical synoptic studies of this nature have been extensively applied to European pressure data by Lamb and Johnson (1966), to European weather data by Oliver and Kington (1970), to nineteenth century data from the great plains in the United States by Lawson (1974), and to Japanese data by Maejima and Koike (1976).

In addition to the scope for the study of climatic temporal and spatial patterns, the post journals also offer considerable potential for methodological research. Le Roy Ladurie (1972, p. 268) has appealed for the development of systematic methods of document interpretation for the purposes of historical environmental research:

> "There are plenty of unpublished texts describing the [weather in historical times]. Such evidence abounds in all the manorial, legal, ecclesiastical, and administrative archives. System is what is needed. These texts should be used to establish valid series, by region, year, season, or even month, by kind of climatic phenomenon (cold, heat, drought, humidity, etc.), and by intensity of climatic phenomenon. All this should be done with the aid of the most up-to-date classifying techniques, including computers".

Existing post journal research uses such techniques but it is highly restricted in scope. Improved content analysis and computer coding methods should be developed not only for retrieving primary data, but also for testing the validity of data and for testing the degree to which the data are influenced by the perceptions and idiosyncracies of individual writers. Methods should also be developed for acquiring data that are representative of broad areas of Rupert's Land rather than point locations within it.

The Company's correspondence constitutes a second category of sources offering potential for research. This is a potential which is almost completely undeveloped. In comparison to the post journals, the correspondence bears all the disadvantages that sporadic sources generally bear to chronicles. There may be sequences of correspondence that were written at such regular time intervals that they thereby acquired the character of a chronicle but, otherwise, the correspondence can only serve to supply scattered fragments of knowledge. These may supply missing information in sequences derived from other sources, or they may serve to verify information from other sources. The first need, however, is for a climatologist to broadly survey the spatial and temporal distributions of the correspondence and to sample and describe its factual contents.

A third source within the Company's archives offers a potential for supplying climatic knowledge that remains entirely unused by climatologists. These are the account books or business records. Fortunately, most of these documents have survived. Indeed, Ray (1975-1976) asserts that the accounting records of the posts are frequently more complete than either the post journals or the correspondence. The account books remain unused not only by climatologists, but also, as Ray has indicated, by historians. Therefore, while it is appropriate to mention them in this context, it should be stressed their potential value as inferential historical evidence is purely speculative and depends upon the degree to which climatic conditions exercised a significant influence on the yield and quality of furs and the flow of provisions.

Other Potential Sources

By virtue of the wealth of their substantive content, the breadth of their distribution in space and time, and the completeness of their preservation, the Hudson's Bay Company records are, as climatic sources, unique in North America and outstanding in global terms. No other Canadian source compares in quality or quantity with these records, therefore, they should be the main focus of attention.

A study of the remaining historical sources is both speculative and incomplete. It is speculative because most of the remaining sources have not yet been used extensively in climatic research and their utility is largely untested. The discussion is incomplete because it refers only to a few selected examples taken from a miscellany of scattered and often poorly catalogued sources.

Figure 2 gives general categories of sources of historical evidence in Canada, and these have been applied in isolated research in the west and north. In a study of long-term variations of freeze-up and break-up dates since 1876 along the Mackenzie River, Mackay (1961) used data from a miscellany of sources including government officers, missionaries, the Royal Canadian Mounted Police (R.C.M.P.), traders and others. Sources of this nature generated a large part of the dates of freeze-up and break-up contained in the first official tabulation of these dates in Canada. "Data were obtained from a wide variety of sources including...newspaper files, power companies, public utility companies, harbour commissions, transportation companies, church missions, R.C.M.P., other governmental agencies, and many private companies and individuals" (Canada, Meteorological Branch, 1959). The Atmospheric Environment Service has recently published a study of the agricultural weather in the Red River Basin of Manitoba since 1800 (Allsop, 1977). It includes historical evidence derived from the various sources identified in Figure 10. Written records have also been used to enhance the detail of weather observation and description in the modern, instrumental period. Hage (1977) derived information on the occurrence of tornadoes in Alberta between 1900 and 1975 from a miscellany of sources including newspapers, diaries, letters, taped interviews, travel accounts, the records of churches, schools, towns and from local histories.

Records of the Royal Canadian Mounted Police*

The predecessor of the R.C.M.P., the North West Mounted Police, was created in 1873 to police the territory from the western border of Manitoba to the Rockies. The recency of this date would, at first sight, appear to disqualify as useful climatic evidence any records that the force might have preserved. It is true that historical records which predate the advent of standardized weather observations by only a few years have no potential for yielding useful long sequences of data. However, the early records do offer a potential in one field of study since they were written in the prairies immediately before and during the advance of the settlement frontier. Climatologists have speculated that agricultural development modified some aspects of the prairie environment and its climate, and the brief records of the R.C.M.P. may be brought to bear on this question.

Perhaps the greatest potential in this context is offered by the prairie fire reports. Information on prairie fires is first available in the R.C.M.P. records of 1886 but this became somewhat standardized after the enactment of the Prairie Fire Ordinance in 1889. This ordinance made the act of setting prairie fires illegal and allowed the R.C.M.P. to appoint Fire Guardians empowered to require settlers to assist in fire control. In this year, each regional division of the force was required to submit a monthly prairie fire report to the Commissioner, indicating where each fire occurred, and the action that the police took to combat and investigate its cause. These reports were systematically kept, but they lack a common format. While some divisions reported on forms, others reported in letters. Table 6 indicates the annual availability of files containing prairie fire reports but it does not identify particular divisions or months in which these occur.

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*Ed. note: R.C.M.P. is used in the broad sense here. The North West Mounted Police was created on August 30, 1873 and lasted until June 24, 1904, when it was replaced by the Royal North-West Mounted Police. The latter force survived until February 1, 1920, when it was replaced by the Royal Canadian Mounted Police (S. Horrall, personal communication, 1979).

TABLE 6: *R.C.M.P. FILES CONTAINING PRAIRIE FIRE REPORTS (FROM CATALOGUE OF RECORDS OF COMMISSIONER'S OFFICE IN RG 18 B, PUBLIC ARCHIVES OF CANADA).*

Year	File Title	Volume and File in RG 18
1886	Prairie Fires	1036/50
1887	Precautions Against Prairie Fires	1060/83 - 1887
1888	Prairie Fires	1104/163 - 1888
1888	Prairie Fires	1105/164 - 1888
1889	Prairie Fires	1136/151 - 1889
1890	Prairie Fires	1171/137 - 1890
1891	Prairie Fires	1201/137 - 1891
1892	Prairie Fires	1234/137 - 1892
1893	Prairie Fires	1262/137 - 1893
1894	Prairie Fires	1292/64 - 1894
1895	Prairie Fires	1327/58 - 1895 (Part 1 and 2)
1896	Prairie Fires, Monthly Reports	1351/58 - 1896 (Part 1)
1896	Prairie Fires, Special Reports	1352/58 - 1896 (Part 2)
1897	Prairie Fires, Monthly Reports	1380/58 - 1897 (Part 1)
1897	Prairie Fires, Special Reports	1380/58 - 1897 (Part 1)
1899	Prairie Fires	1434/58 - 1899

TABLE 7: *WEEKLY REPORTS SUBMITTED BY DIVISIONS OF THE COMMISSIONER FROM 1887 TO 1899 (FROM CATALOGUE OF RECORDS OF COMMISSIONER'S OFFICE IN RG 18 B, PUBLIC ARCHIVES OF CANADA).*

Year	Division									
	A	B	C	D	E	F	G	H	K	Depot
1887	√	χ	√	χ	√	√	√	χ	√	√
1888	√	χ	√	χ	√	√	√	√	√	√
1889	√	χ	√	χ	√	√	√	√	√	χ
1890	√	χ	√	χ	√	√	χ	√	√	χ
1891	√	χ	√	χ	χ	√	√	√	√	√
1892	√	χ	√	χ	√	√	√	√	√	χ
1893	√	χ	√	χ	χ	√	√	√	χ	√
1894	√	χ	√	χ	√	√	√	√	√	χ
1895	√	χ	√	χ	√	√	√	√	√	χ
1896	√	χ	√	√	√	√	√	χ	√	χ
1897	√	χ	√	√	χ	χ	χ	χ	χ	χ
1898	√	χ	√	√	√	√	√	χ	√	χ
1899	√	χ	√	√	√	√	√	χ	√	χ

Note: These divisions are each composed of a large region in the prairies. The divisions were designated by letters. Designations varied from time to time but eventually they were established as follows:

B or Depot = Regina, Saskatchewan
A = Maple Creek, Saskatchewan
C = Battleford, Saskatchewan
D = Fort Macleod, Alberta
E = Calgary, Alberta
F = Prince Albert, Saskatchewan
G = Fort Saskatchewan, Alberta
H = MacLeod, Alberta
K = Lethbridge, Alberta

Ticks (√) and crosses (χ) indicate that reports are present or absent, respectively.

TABLE 8: *MONTHLY REPORTS SUBMITTED BY DIVISIONS TO THE COMMISSIONER FROM 1884 TO 1899 (FROM CATALOGUE OF RECORDS OF COMMISSIONER'S OFFICE IN RG 18 B, PUBLIC ARCHIVES OF CANADA).**

Year	Division									
	A	B	C	D	E	F	G	H	K	Depot	Unspecified
1884	X	X	X	X	X	X	X	X	X	X	✓
1885	✓	X	✓	X	✓	X	X	X	X	X	✓
1886	✓	✓	✓	✓	X	✓	✓	✓	✓	X	X
1887	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
1888	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
1889	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	X
1890	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	X
1891	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	X
1892	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	X
1893	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	X
1894	✓	✓	✓	X	✓	X	✓	✓	✓	✓	X
1895	✓	X	✓	X	✓	✓	✓	✓	✓	✓	X
1896	✓	X	✓	✓	✓	✓	✓	X	✓	✓	X
1897	✓	X	✓	✓	✓	✓	✓	X	✓	✓	X
1898	✓	X	✓	✓	✓	✓	✓	X	✓	✓	X
1899	✓	X	✓	✓	✓	✓	✓	X	✓	✓	X

*For explanation see Table 7.

The prairie fire reports may provide an insight into the problem of the origin of the grasslands and the question concerning the role man played in the development of the grasslands. These reports were used by Raby (1966) in a study of prairie fires in the last two decades of the nineteenth century, while a study of the causes and effects of prairie fires over the last three centuries was conducted by Nelson and England (1971).

In addition to the prairie fire reports, the R.C.M.P. files contain a hierarchy of general reports that were kept at regular intervals. These were the official media of reporting up the chain of command from patrols to detachments, from detachments to divisions and from divisions to the Commissioner. Patrol reports were irregular in occurrence, and the detachment reports were often discontinuous since many detachments operated only in summer. However, the divisional reports were regularly made at weekly, monthly and annual intervals. Tables 7 and 8 indicate the availability of weekly and monthly divisional reports dating from the nineteenth century and preserved in the records of the Commissioner's office.

These reports concentrate on the main duties of the force, namely maintenance of law and order, pacification of the Indians, suppression of the liquor trade and collection of customs dues. The fact that the force functioned in a climatically extreme environment suggests that their reports include evidence of climatic conditions in the period immediately before the agricultural development of the prairies. However, a preliminary survey of the contents of the reports has yet to be undertaken.

No climatic use has been made of the files of the R.C.M.P., other than the prairie fire reports. However, it is noteworthy that the R.C.M.P. is a paramilitary organization and that nineteenth century meteorological records of the U.S. Army kept at military posts in the great plains, have been used as evidence of climatic change (Lawson 1974).

Dominion Land Surveyors' Records

These records have an affinity with those of the R.C.M.P. insofar as they derive from a government agency, are roughly coincident in space and time, and share a similar potential as evidence of climatic change. Thus, the Dominion Land Surveyors' records may indicate environmental conditions in the prairies prior to, and during, the agricultural colonization. They offer no potential for reconstructing long-series of climatic data, however.

The Department of the Interior laid down the township and range system in the Prairie Provinces between 1869 and 1930. This was accomplished by small, independent survey groups. There were two periods of most active surveying, the greatest activity occurring from about 1910 to about 1920. Another period of peak activity took place in the early 1880's.

The Dominion Land Surveyors' records comprise two groups of documents that are descriptive of the prairie environment and weather. The surveyors were required to keep a daily diary and apparently this requirement was well enforced since the diaries were kept

TABLE 9: *ANNUAL NUMBERS OF DOMINION LAND SURVEYORS' DIARIES PRESERVED IN PROVINCIAL ARCHIVES, PRAIRIE PROVINCES, 1869 - 1899.*

YEAR	MANITOBA	SASKATCHEWAN	ALBERTA	TOTAL
1869	4	0	0	4
1870	0	0	0	0
1871	9	0	0	9
1872	9	0	0	9
1873	15	0	0	15
1874	15	0	0	15
1875	16	0	0	16
1876	5	0	0	5
1877	3	0	0	3
1878	1	0	0	1
1879	8	0	0	8
1880	7	2	0	9
1881	7	17	1	25
1882	1	32	12	45
1883	2	14	20	36
1884	0	3	16	19
1885	1	1	4	6
1886	23	6	4	33
1887	4	1	6	11
1888	2	0	4	6
1889	2	5	3	10
1890	2	3	1	6
1891	1	0	1	2
1892	0	2	0	2
1893	1	4	5	10
1894	4	3	4	11
1895	1	1	5	7
1896	2	1	5	8
1897	4	2	2	8
1898	9	2	7	18
1899	13	1	8	22

not only during surveying, but also during periods of travel to and from the field. Table 9 gives the number of diaries kept in each year in the three prairie provinces from 1869 to 1899. In addition, the surveyors kept field note books which described the vegetation and soils of each township at the time of the survey, often with annotated sketch maps. The note books afford a means of reconstructing vegetation and soil patterns of the prairies immediately before colonization. Watts (1960), in a general way, has used the note books for this purpose, but scope exists for detailed studies.

The contents of the diaries as climatic sources have not been examined systematically, but apparently they make frequent references to the weather. Their authors were clearly at pains to identify in their diaries the many problems and difficulties that interfered with their surveying, and adverse weather was a major problem in this context. The diaries focus to a greater or lesser extent on adverse weather conditions. A particular benefit of the land surveyors' papers is that they were written by individuals who were highly conscious of place, so they do not suffer from that common weakness of historical evidence - an uncertainty about the location at which it was written.

Church and Missionary Records

In the vanguard of the exploration and settlement of western and northern Canada were missionaries and church ministers. They were literate with close links to administrative headquarters. These circumstances encouraged a high volume of written correspondence and reporting, together with the keeping of journals and diaries. Efficient archival practices of religious organizations have facilitated the preservation of these documents.

The period of record varies greatly in the different Canadian regions. In western Canada it dates generally from the early and middle decades of the nineteenth century. Most prominent among the religious archives are those of the Church Missionary Society, the Oblates of Mary Immaculate and the Sisters of Charity. The records of the Oblates, for example, comprise an extensive collection that has been centrally organized and contains a near complete collection of mission journals kept throughout northern and western Canada. Although the Oblate codex historicus spans briefer periods than many of the Hudson's Bay Company post journals, it shows many of the attributes of the post journals as a source for historical environmental information.

An example of the spatial and temporal distribution of this category of journals is given in Table 10. This is an alphabetical listing by author of each journal preserved in the archives of the Church Missionary Society and identified as such in the CMS Finding Aid within the Public Archives of Manitoba.

The records of church and missionary organizations, like those of government agencies, do not appear to have been subject to extensive or systematic use by climatologists in Canada. However, several records in this category were among those used by Allsop (1977) in his study of climatic conditions in the Red River Settlement since 1800.

TABLE 10: *LIST OF JOURNALS AND DIARIES OF THE CHURCH MISSIONARY SOCIETY RECORDED IN THE CMS FINDING AID IN THE PUBLIC ARCHIVES OF MANITOBA. (THE AUTHOR, DATES AND LOCATION (IF KNOWN) OF EACH DIARY WRITTEN PRIOR TO 1870, IS GIVEN).*

Author	Dates	Location	Archive Number
Budd, Henry	Dec. 22, 1850 - March 29, 1857	Cumberland House	A83
	April 1, 1857 - Sept. 30, 1867	Nepowewin Station	A84-85
	Oct. 2, 1867 - June 11, 1869	The Pas	A99
Cochran, William	Aug. 12, 1828 - June 1, 1829	Red River	A77
	Sept. 1831 - Aug. 7, 1833	Red River	A77
	Aug. 4, 1826 - June 10, 1846	Red River	A85
Cook, Thomas	Oct. 31, 1861 - June 1, 1862	Cumberland House	A86
Cowley, Abraham	Sept. 28, 1841 - July 15, 1848	Red River	A86
	July 16, 1848 - Aug. 15, 1858	Red River	A84
	Aug. 20, 1859 - Nov. 14, 1866	Red River	A87
Gardiner, Joseph	Aug. 12, 1857 - Aug. 31, 1862	York Factory	A87
	Jan. 1, - Sept. 8, 1863	Fort Churchill	A87
	Nov. 29, 1869 - Dec. 4, 1870	Red River	A98
George, Henry	March 29 - May 19, 1855	Fort Alexander	A87
	Aug. 26, 1856 - June 12, 1857	Cumberland House	A87
Hillyer, Charles	1852	Red River	A88
Horden, John	June 8, 1851 - Dec. 25, 1861	Moose Factory	A88 and A89
Hunt, Robert	July 30, 1850 - July 31, 1851	Lac La Ronge	A89
	July 1, 1851 - Oct. 27, 1861	English River	A89 and A90
Hunter, James	June 1, 1844 - Sept. 15, 1854	Cumberland House	A91
	June 6, 1858 - Aug. 13, 1860	Fort Simpson	A91
	Aug. 18, 1860 - Dec. 15, 1864	Red River	A91 and A92
James, Robert	Oct. 6, 1846 - July 31, 1851	Grand Rapids	A92
Jones, David T.	June 1, 1823 - Oct. 25, 1828	Red River	A77
	Aug. 11, 1832 - June 7, 1833	Red River	A77
	June 22, 1824 - Aug. 21, 1839	Red River	A92
Kirkby, William	June 5, 1852 - Dec. 13, 1853	Red River	A92 and A93
	Aug. 17, 1856 - July 29, 1860	Red River	A92 and A93
	June 21, 1863 - May 14, 1868	Mackenzie River	A93
McKay, J.A.	Sept. 19, 1868 - Dec. 1, 1869	Stanley	A98
Mason, William	June 3, 1855 - Jan. 7, 1869	York Factory	A92 and A95
McDonald, Robert M.	Oct. 6, 1853 - June 17, 1860	Islington	A93
	Aug. 25, 1865 - Oct. 27, 1868	Fort Youcon	A93 and A94
Phair, Robert	Oct. 26, 1864 - Feb. 5, 1869	Fort Alexander	A95
Pratt, Charles	July 31, 1851 - Jan. 31, 1860	Fort Pelly	A95
	Jan. 1 - Dec. 25, 1869	L'Appette	A81 and A98

Roberts, John	Sept. 28, 1841 - July 11, 1842	Red River	A95
Settee, James	June 11, 1852 - Aug. 21, 1852	Lac La Ronge	A95
	July 6, 1854 - June 15, 1856	Shoal River	A95
	July 10, 1856 - June 5, 1857	Red River	A95
	April 6, 1860 - Jan. 20, 1868	Fort Pelly	A95
	Sept. 24, 1867 - March 1, 1869	Scanterbury	A95
Smith, Robert T.	Jan. 1, 1861 - Dec. 30, 1862	English River	A95
Smithurst, John	Dec. 25, 1839 - Feb. 1, 1851	Red River	A96 and A97
Stagg, William,	Feb. 12, 1854 - April 8, 1859	Red River	A97
Vincent, James	Aug. 19, 1865 - Aug. 15, 1866	Albany	A97
Vincent, Thomas	June 16, 1856 - Dec. 30, 1865	Moose Factory	A98
Watkins, E.A.	Sept. 1, 1852 - Aug. 27, 1857	Fort George	A97 and A98
	Aug. 27, 1857 - July 1, 1858	Red River	A98
	July 3, 1858 - June 30, 1863	Cumberland House	A98
West, John,	June 10, 1821 - Oct. 24, 1824	Red River	A77 and A97

TABLE 11: *REFERENCES TO WEATHER PHENOMENA IN THE DIARY OF SAMUEL TAYLOR (THIS DIARY IS IN TWO VOLUMES IDENTIFIED AS 1849-1857, AND 1859-1867. INITIALLY IT WAS WRITTEN AT MOOSE FACTORY, FROM 1849-1857, AND LATER IT WAS WRITTEN AT THE RED RIVER SETTLEMENT, 1859-1867. THE NUMBERS IDENTIFY THE PAGES IN EACH VOLUME ON WHICH THE REFERENCES OCCUR).*

	Moose Factory 1849-1857	Red River 1859-1867	
Subject	(First Volume)	(First Volume)	(Second Volume)
Ice	4, 5, 8, 12, 17, 19, 22, 26, 27, 30, 31, 40.	45, 48, 51, 53, 57, 58, 62, 66, 67, 71, 76, 77, 81.	3, 8, 14, 20, 24, 25, 29, 30, 37, 38, 39, 43.
Snow	5, 7, 9, 12-14, 16-19, 23-25, 28, 30, 33-35, 40-44.	45, 48, 51, 52, 53 57-63, 65-67, 69-71, 76-77, 80-82.	(not indexed)
Rain	16, 17, 22, 23, 28, 36-41.	45-47, 52, 54-58, 62-66, 70-76, 82, 83.	1, 2, 3, 5, 6, 8-14, 17, 19-23, 25, 30, 32-40, 43, 44.
Wind	23, 24, 35, 41, 43, 44.	45-48, 50-66, 68-74, 76, 78, 80-83.	1-13, 15-17, 19, 20, 22, 24-29, 31-36, 39-44.
Other Weather Phenomena	1, 3-6, 8, 9, 12-14, 16-19, 22-24, 26, 28, 30-44.	45-48, 50-78, 80-83.	1-14, 16-44.

(Indexing attributed to H. Bowsfield, former Archivist, Public Archives of Manitoba).

Private Records

The diaries, journals and correspondence of early settlers, explorers and travellers comprise this category of evidence. These records are voluminous, heterogeneous and scattered throughout the archives and libraries of Canada and they have not yet been submitted to any form of general classification or interpretation for climatological purposes.

An indexing of the references to weather phenomena in the diary of Samuel Taylor illustrates the potential of these sources (Table 11). This diary was kept from 1849 to 1867, being written both at Moose Factory (1849-1857) and at the Red River Settlement (1859-1867).

Within the Red River Settlement at least ten surviving private diaries were kept at various times between 1810 and 1870 (Figure 10) and these comprise one of the major categories of evidence used in Allsop's (1977) study of the agricultural weather within the settlement. A glimpse at the role that private correspondence might play in this context is provided by the indexing of references to weather phenomena contained in the letters written by and to Louis Riel (Table 12).

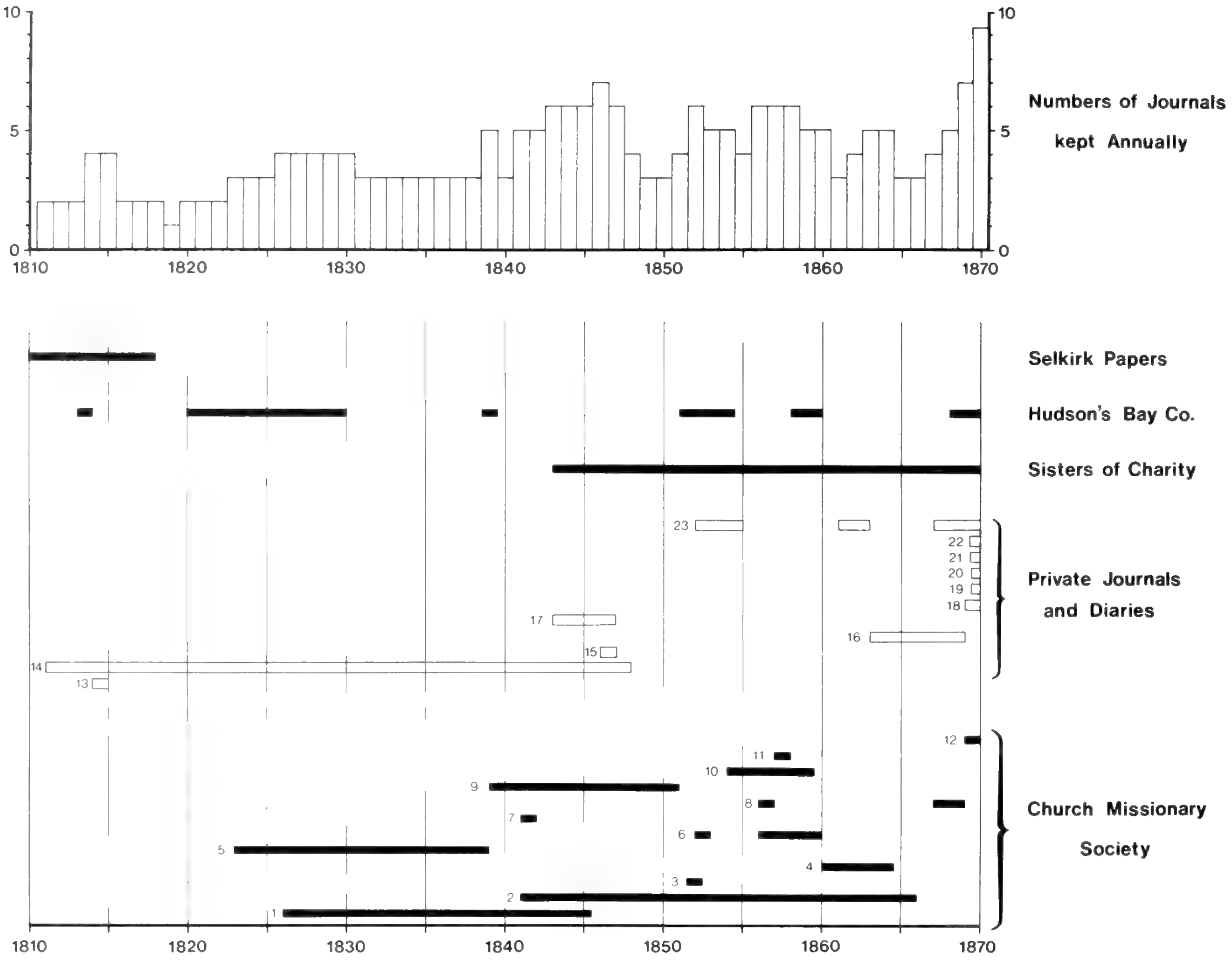

FIGURE 10: *A selection of the general chronicles kept in the Red River Settlement, 1810 to 1870. This is based on the chronicles catalogued in the Inventory of the Public Archives of Manitoba, the Church Missionary Society finding aid, and the Hudson's Bay Company's archival catalogues.*

TABLE 12: *REFERENCES TO WEATHER PHENOMENA CONTAINED IN LOUIS RIEL PAPERS, PUBLIC ARCHIVES OF MANITOBA. (THE NUMBERS ARE THE CATALOGUE NUMBERS OF PARTICULAR ITEMS IN THE PAPERS).*

Year	Locations				
	Assiniboine River	Ile à la Cross	Red River Settlement	Saskatchewan	Winnipeg
1868	____	____	Snow (8)	____	____
1870	____	____	____	____	Weather (189)
1871	Rain (101)	____	Floods (87, 89)	Rain (107)	____
1872	____	____	Ice (147, 154)	____	____
1873	____	Rain (209)	____	____	____
1875	____	Floods (312)	____	____	____
1876	____	Floods (319, 320)	____	____	____
1877	____	Snow (330)	____	____	____
1880	____	Floods (388, 389)	____	____	____

(Indexing attributed to H. Bowsfield - see Table 11).

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HISTORICAL, HYDROLOGICAL AND PHYSICAL EVIDENCE OF CHANGING CLIMATE IN EASTERN CANADA

Claude Hillaire-Marcel, Serge Occhietti and Gilbert Prichonnet*

INTRODUCTION

In its original conception, this research program consisted of using historical data to trace the variations in climate which have occurred in Eastern Canada since colonization. However, we quickly perceived that an empirical approach would be unsatisfactory for two main reasons. The first is that a number of documents contained in archives are onlv of partial interest from our point of view. Analysis of these on an enormous scale would bear little fruit. We therefore decided upon a narrower but more penetrating approach to the historical data. We experimented with two methods of study: one consisted of using various sources to do systematic research on one type of information which is linked to climate (see for example project 2 by Prichonnet), the other of methodically analyzing a particular category of documents which a priori we assumed to be rich in data on climate (see for example project 1 by S. Occhietti).

The other aspect of this program, which we believe is worthy of consideration, is the fact that the collection of data linked to climate is not sufficient in itself. In fact, even though the date of the break up of the ice at Moose Factory (Moodie and Catchpole 1976), or the frequency of spring floods in the valley of the lower St. Lawrence (project 2), seem to be solidly linked to climate, at first glance one would not know how. In other words, these data can reflect numerous effects of climate. Let us examine the local instances: were they the result of the melting of a large amount of snow - and thus greater winter precipitation - or of a more rapid melting of the snow following a sharp increase in temperature or simply of a difficult break up of the ice - and thus perhaps of thicker ice in the river?

Such questions prompted us to add a study of physical data on the climate and the environment of the last few centuries to the two approaches mentioned above. This involves, on one hand, searching for continuous and precise information on the different parameters which define climate and, on the other hand, the study of natural cycles from which variations in climate originate. Thus we have conceived the third project of this program (physical data on the climate and the climatic cycles in Eastern Canada in historical times).

HISTORICAL STUDY OF VARIATIONS IN CLIMATE IN EASTERN CANADA: INVENTORY OF DOCUMENTS (PROJECT 1)

Serge Occhietti

The study of the periodicity of variations in climate is essential to the determination

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of the causes of changes in climate. For the period of history with which we are concerned, the indices which are used for this purpose come under different disciplines, e.g. dendrochronology or coastal morphology (see Hillaire-Marcel's report - project 3), or are obtained by analyzing quantitative and qualitative data contained in different written documents (see for example Landsberg and Kaylor 1976, 1977; Moodie and Catchpole 1976; Lamb 1977).

This project, the first results of which are presented here, consists of reconstructing the variations in climate in Eastern Canada since colonization, with the use of historical documents. In order to avoid a haphazard analysis of the mass of documents available, research on them was provisionally limited to two kinds of material likely to furnish direct paleoclimatic indices: newspapers and periodicals on the one hand, and reports of port and maritime activity on the other. The first phase of the project (December 15, 1977 to March 31, 1978) affirms that the first documents which we have consulted contain significant indices of fluctuations in climate and that numerous other documents, yet to be analyzed, are potential sources of pertinent information.

The inventory of texts is currently being carried out by a document researcher (D. Rochon) whose job consists of finding references to the newspapers and periodicals published in Eastern Canada and selecting those which are likely to contain data on climate. At the same time, a master's student in environmental sciences (L. Marchand) is analyzing the logged periodicals and is doing the inventory of port records. Figure 1 provides a preliminary series of usable periodicals. A few other documents complete this table: the meteorological journal of Captain Vaughan in the Strait of Belle Isle from May 1, 1859 to May 31, 1860; the reports of the Harbourmaster of Montréal from 1879 to 1884; the list of final dates of arrival or departure of ocean-going vessels to and from the Port of Montréal between 1840 and 1949; records of the Port of Québec (1779-1922); meteorological observations at Saint-Modeste (1861-1872), archives of the Seminary of Rimouski; public records of Nova Scotia at Halifax.

For this initial phase of the inventory, the indices of climate fall into three distinct periods. From approximately 1900 until today, meteorological documents have sufficient continuity to permit a direct analysis of climate (Thomas 1975). We have temporarily ignored this third period in our research on documents. The second period begins with the appearance of the first periodicals in Québec around 1780. In spite of the absence of meteorological stations, the indices of climate taken from three periodicals and from the books of the ports will probably permit a reconstruction of one or of several original curves of climatic trends. The first period, before 1780, is the poorest in documentation. It involves a search for periodicals in the Atlantic Provinces (records in Ottawa, Halifax and probably in the United States and England), the analysis of port documents of Québec and the Atlantic Provinces, and possibly the records of religious orders in Québec. The movement of ships coming from Europe may have to be researched in England (at Lloyd's, for example) and in France (National Library, Naval Archives).

The kinds of climatic indices which are recognized to date are the following: measures of temperature, of barometric pressure, of wind direction, descriptions of cloud cover and type of precipitation, and indirect indicators such as movement of vessels, and water

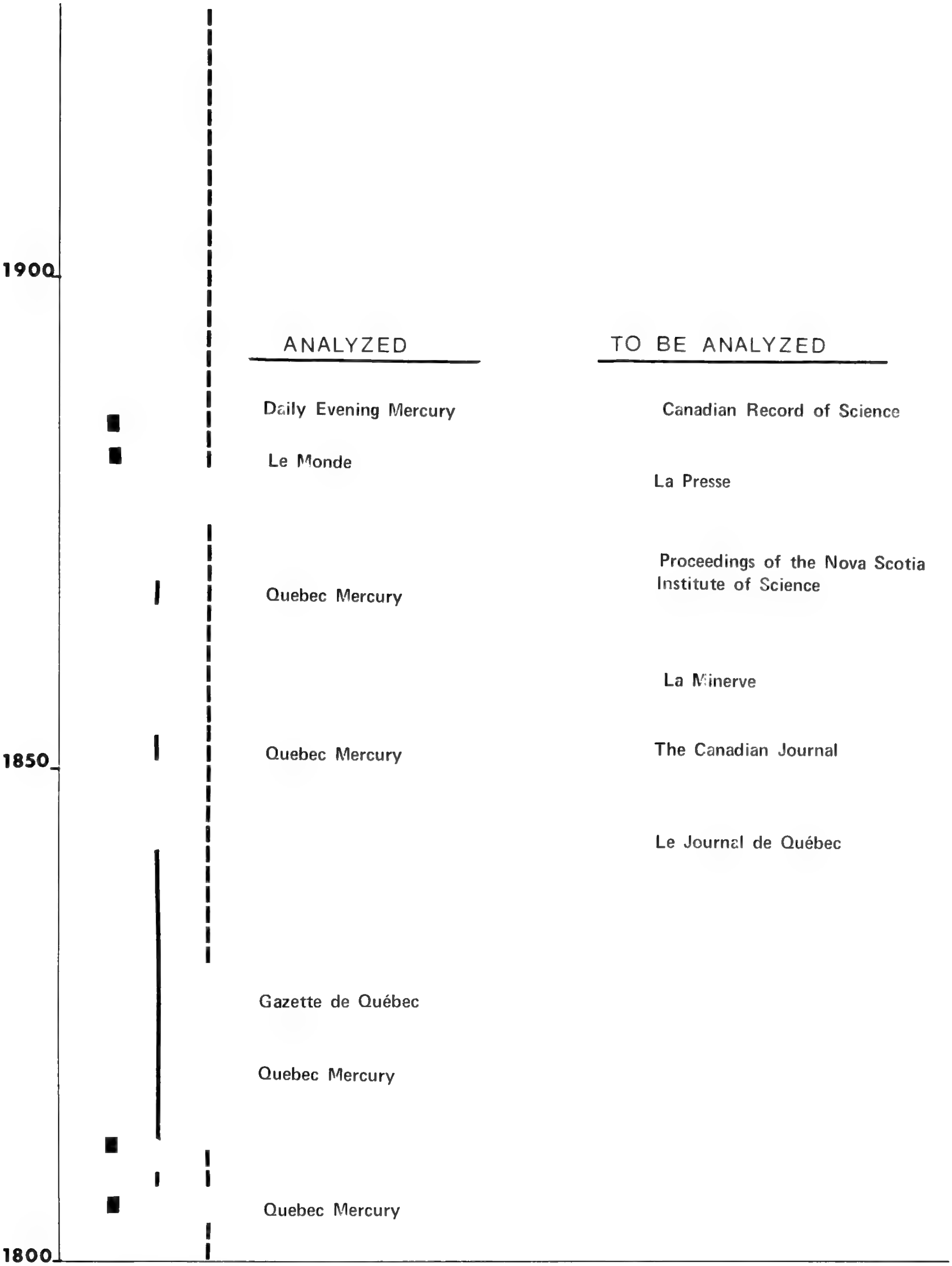

FIGURE 1: *Preliminary review of periodicals containing data of climatic interest for Eastern Canada - 1800 to 1900. Thick line: coverage of daily weather readings; thin line: coverage of ship movements; dashed line: coverage by periodicals containing data on climate to be analyzed.*

levels in the ports. Among these data, two indices are currently being systematically analyzed. They are: temperature readings and apparent or actual opening and closing dates of ports. Temperature readings, once they have been adjusted, provide direct climatic data. Unfortunately, such records are unknown before approximately 1800, and before the establishment of meteorological stations (between 1800 and 1880) they are intermittent. They will be dealt with at the end of the inventory. The activity of the ports reflects the freezing over of the Saint Lawrence waterway. It is a relatively significant index of climate which nevertheless requires prior interpretation. For example, an early closing of the Port of Montréal certainly means the early arrival of winter, but not necessarily a severe winter or an average temperature for that year that is less than normal. A late opening of the port ordinarily indicates a late thaw, but may also reflect a protracted ice jam retarded by spring frosts. The length of time that the port is closed is probably more indicative of winter-related fluctuations (Figure 2). Finally, before 1870, only dates of the first arrivals and the last departures of ships have been found, thus making the climatic index less precise.

In conclusion, preliminary analysis of some of the available data reveals climatic fluctuations and, although fragmentary, these initial results are very promising.

STUDY OF VARIATIONS IN THE FLOW OF RIVERS AND IN THE LEVEL OF SOME OF THE LAKES OF SOUTHERN QUEBEC: ICE JAMS, ICE BREAK UPS, FLOODS, MOVEMENT OF SEDIMENT (PROJECT 2)

G. Prichonnet

THEMES AND DOCUMENTATION

The first stage of this research basically consisted of identifying appropriate documents which were available. Although the purpose of our work is to bring to light the total picture of the evolution of the climate (general cyclicity and periodicity of extreme events), for purposes of analysis it is possible to classify the available documents according to themes:

Ice jams	- Documents of the Coast Guard - National Harbours Board. Port of Montréal. Research Area: navigable channel from Montréal to Trois-Rivières.
Ice break-ups	- Unpublished documents of the Ministry of Natural Resources of Québec (of which we obtained a copy). Research Area: principal rivers flowing into the north shore of the St. Lawrence (Assomption, Nord Rouge,...) and the Richelieu (south shore).
Floods	- The final report of the Committee on the Regulation of Waters, Montréal region (Federal - Provincial agreement) enabled us to identify references relating to these catastrophes.

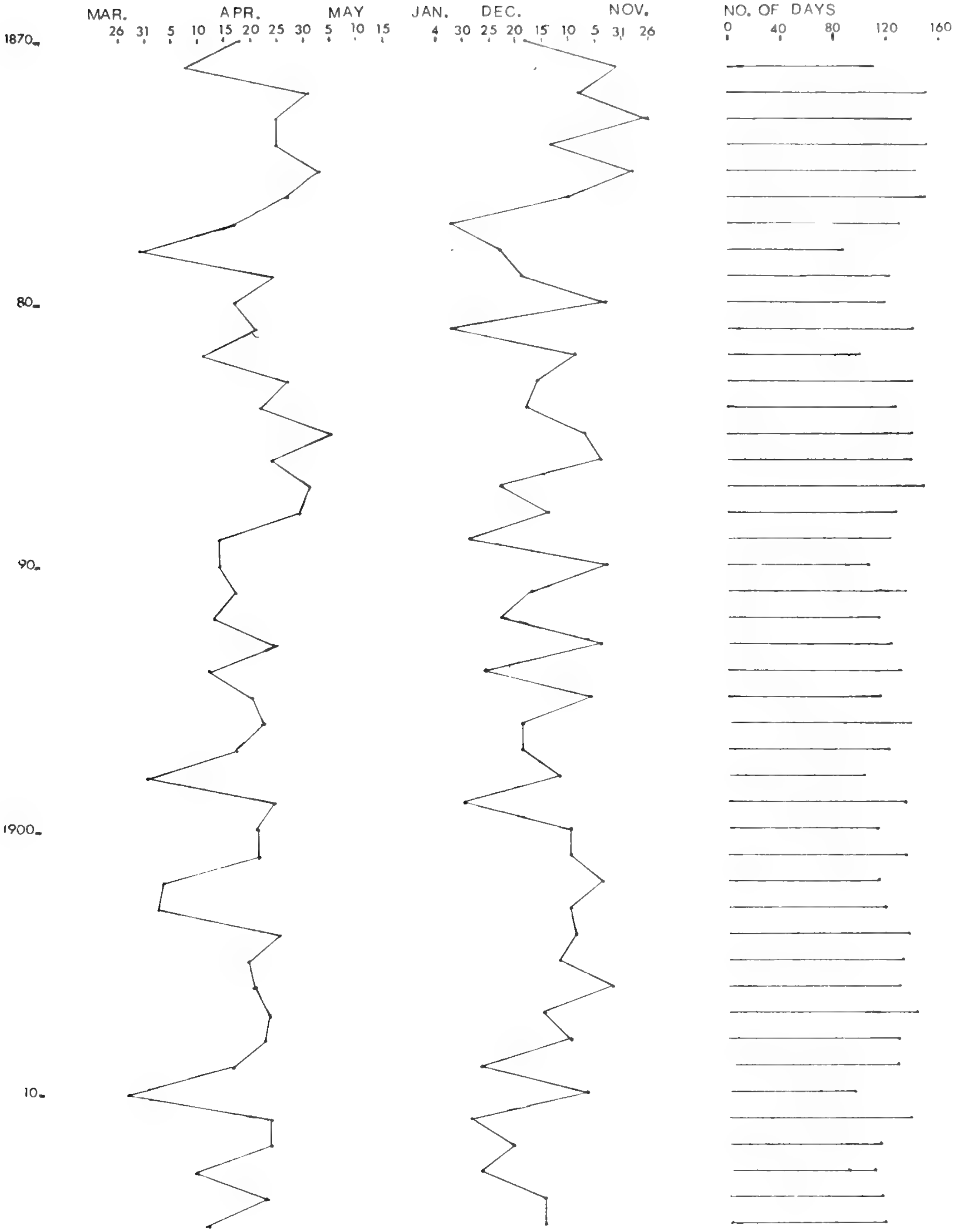

FIGURE 2: *Dates of opening and closing of the Port of Montréal from 1870 to 1915, and number of days Port was closed (right).*

General Aspects - Yearbooks of Hydrology (M.R.N.Q.: 1964 and before; federal documents 1922 to 1964) and the Monthly and Yearly Mean Water Levels (Environment Canada); etc. will be reviewed.

REMARKS AND PROSPECTS

It appears that a few periods of dryness (1930-1936; 1960-1964) or of repeatedly swollen waters accompanied by floods have occurred during the past few decades. A graphic analysis of water levels in rivers and lakes has been undertaken elsewhere (see Figure 3) and it is likely to contribute to an understanding of periodic changes in amount of precipitation.

For 1978-1979 we plan to analyze the available data (reduction in water levels, rising waters, ice jams, ice break-ups) graphically and statistically in order to compare their changes to those of the temperature and precipitation curves. In addition, given the economic importance of floods in densely populated areas of southern Québec, we will try to identify two or three sites on the flood plain suitable for core sampling of recent sediments. A thin layer of deposits might represent a record of events related to climate which are more widespread than those indicated in historical records.

PHYSICAL DATA ON THE CLIMATE AND CLIMATIC CYCLES IN EASTERN CANADA DURING HISTORICAL TIMES (PROJECT 3)

Claude Hillaire-Marcel

PRINCIPLES OF THE STUDY

I believe that the concept of climatic cycles underlies any research about climate and, further, that paleoclimatic studies devoted to the last few millennia of our era are only of real interest in that they permit the eventual projection or extrapolation of such cycles for the future. It is unnecessary to give a detailed account of the importance of weather forecasting in the short and medium term. Today, numerous international bodies devote part of their discussions to this subject. These include: the Sixth Special General Assembly of the United Nations; the World Food Conference (1974); symposia of the World Meteorological Organization, etc. In 1975 during one of the conferences of this latter organization, Professor H.H. Lamb concluded his presentation by saying: "Projects of prediction hang to a large extent on the understanding of... frequency changes and any cycles or quasiperiodicities which can be identified... Impressions so far formed from work in the Climatic Research Unit* are that some significance must be attached to quasi-cyclic recurrences on time-scales of about 2.5 to 6, 12, 19, 22-23, 50, 90, 100 and 200 years, as

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*Ed. note: Climatic Research Unit, University of East Anglia, Norwich, England

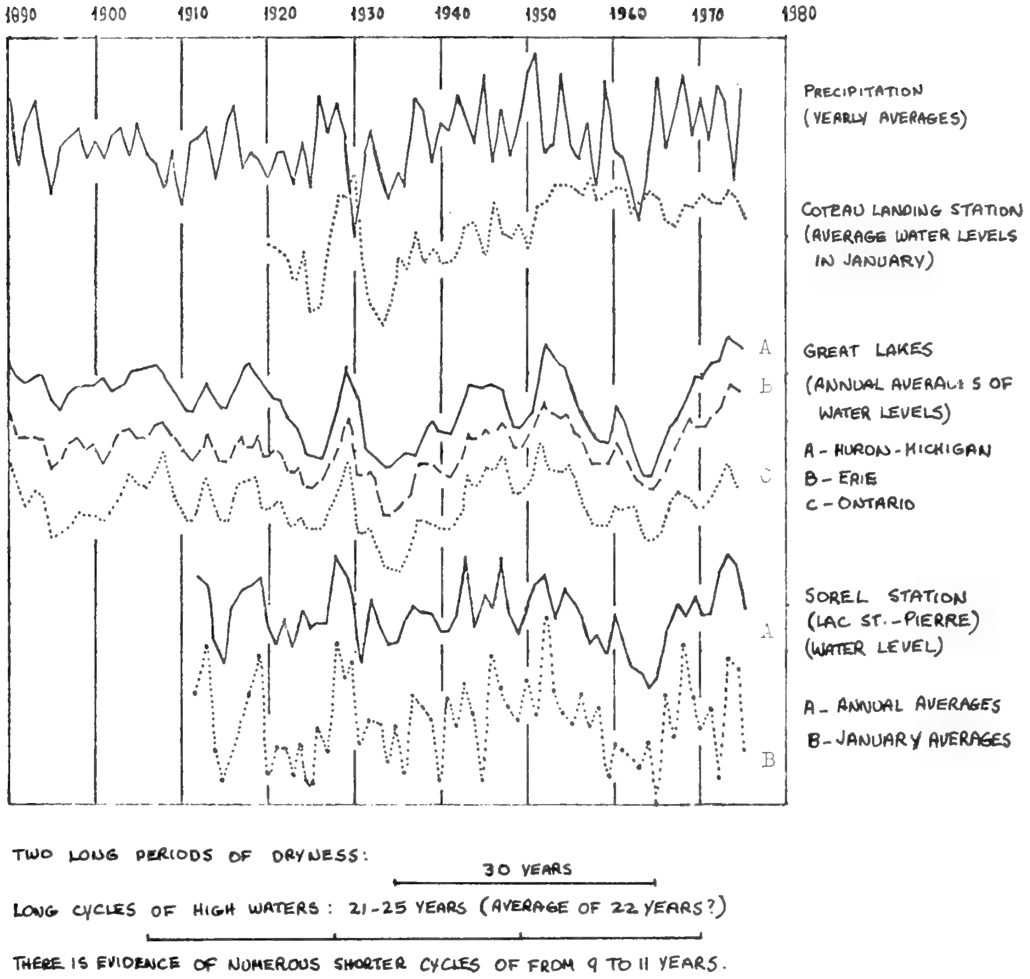

FIGURE 3: *Comparison of some variations in water level in Eastern Canada. (Data from monthly and yearly mean water levels: Environment Canada).*

well as some much longer time-scales. We believe that those of about 5 to 6 years, 22 to 23 years, and especially those of around 50 years and 200 years, have received too little attention".

Work based on this premise had been carried out in collaboration with Professor R.W. Fairbridge (Fairbridge and Hillaire-Marcel 1977) prior to Lamb's suggestion in 1975. During the various stages of that work devoted to the development of chronological series linked to climate, we often encountered skepticism on the part of colleagues concerning these cycles or the importance of studying them. Prof. H.E. Fritts, who has contributed greatly to the study of dendroclimatology, reminded us that in the final analysis a multitude of cycles could be counted. I believe that the answer to the questions one thinks about on climatic rhythmicity lies in this remark. All possible cycles are reflected in natural phenomena; their causes can be found only by trying to understand their spatial distributions and above all their interrelationships.

In this regard, we believed that we were the first to have observed at Hudson Bay the effect of the Double-Hale 45-year solar cycle using data on sea levels. Now, bibliographic searches have shown that Dr. F. Morsetti made a similar observation as early as 1963 by comparing tide-gauge data of Northern Europe with that of the Indian Ocean. Furthermore, he associated this cycle with oscillations in the world's magnetic field. Morsetti also noted an opposition of phase between the cycles of these two regions of the globe. We are convinced that such observations are the kind which will provide the answer we are seeking: the links between geodynamic phenomena, which are internal (geomagnetism) and external (solar cycles, conjunctions of planets), and oscillations in sea level, for example.

These preliminary remarks enable us to describe an approach to the problem. We may begin our study by comparing physical data which have been generally available on an uninterrupted basis for decades. Not only are we familiar with solar activity during this period (see Eddy 1977), but in addition we have data on the following parameters for numerous meteorological and geophysical stations in Eastern Canada: temperature, precipitation, atmospheric pressure, gravimetric variations, magnetic variations, tide-gauge variations, etc.

After selecting a few sites, the study will consist of correlating these data with a view to: (1) revealing similar or opposing tendencies in the fluctuations and (2) noting future cycles.

In dealing with such a brief period, one cannot hope to uncover long cycles, so, in addition, we have undertaken a parallel mathematical analysis of the chronological series available for the last few centuries in dendroclimatology, for example (Wiseman et al. 1976), or the last millennia (curves by Hillaire-Marcel and Occhietti 1977, and Fairbridge and Hillaire-Marcel 1977). In dealing with the last few centuries, we will analyze the data collected in projects 1 and 2 by Gilbert Prichonnet and Serge Occhietti in the same way. Furthermore, we are starting an analysis of oxygen 18 found in tree rings studied by Wiseman et al. (1976). This will enable us to extrapolate the average annual temperatures for the Fort Chimo region during the 18th century (cf Libby et al. 1976; Gray and Thompson 1976).

OBSERVED CYCLICAL TRENDS

We already know of data which indicate: (1) a latitudinal pattern of cycles, and (2) "selective" responses to these cycles. By this we mean that, in a particular region, natural phenomena do not reflect a single cycle, but sometimes multiples or sub-multiples of that cycle. Illustrations of these phenomena follow:

1. Latitudinal Trends

As examples, different phenomena (registered over fairly long periods of time) reveal cycles of different periodicities. Thus the Great Lakes seem to conform to the Hale 22-year cycle - as does Southern James Bay probably - while in Hudson Bay the Double-Hale 45-year cycle appears in the construction of the raised beaches, which are formed by periodic strong littoral activity (storms with high tides). Farther north in Hudson Strait, these same raised beaches, depending on the direction in which they face, reflect either the 45-year cycle or at least a double cycle (80-90 years ?). Further, dendroclimatic variations from Fort Chimo may suggest a similar superimposition of cycles. Finally, to complete the picture, it would be useful to recall the Fourier series analyses of the core samples of ice from Camp Century in Greenland, where a 181-year cycle (either 2 X 90, or 4 X 45, or 8 X 22 years) stands out clearly (Johnsen et al. 1970). It is worth noting that at the lowest latitudes, the most frequent cycles last 11 and 22 years (Schove 1964).

2. Selected Responses and Superimposed Cycles

The preferred location of the beaches on the north side of Ungava Bay already provide an example of a selective response to the 45-year cycle in one case and, notably, to the double cycle (80-90 years) in the other case.

An example from the Great Lakes region also deserves mention here. If the level of the lakes is related to the atmospheric precipitation over the same period of time, it is found that the lakes have a certain inertness and they do not consistently reflect the variations in precipitation. In fact, it would seem that the Great Lakes "filter" the background noise of the oscillations of short periodicity (which show up nevertheless as precipitation) and reveal practically only the 22-year cycle.

If the curve of the secondary fluctuations in sea level at Richmond Gulf in eastern Hudson Bay is examined more closely, many cycles (including one of approximately 1080 years), which were apparently superimposed by an oscillatory damping (Figure 4), are revealed. Finally, we may recall the 78-year cycle superimposed on that of 181 years in the Camp Century data.

3. Causes and Implied Mechanisms

As yet we have only a few examples of the connection between two phenomena which are, as a rule, separate. Let us remember Morsetti's (1963) observations on the relation between the magnetic field and average sea level. In addition, probably a number of phenomena conforming to the same variable can display a certain similarity in their responses. Extrapolating Lutz's (1969) data, it is possible to state that a variation in

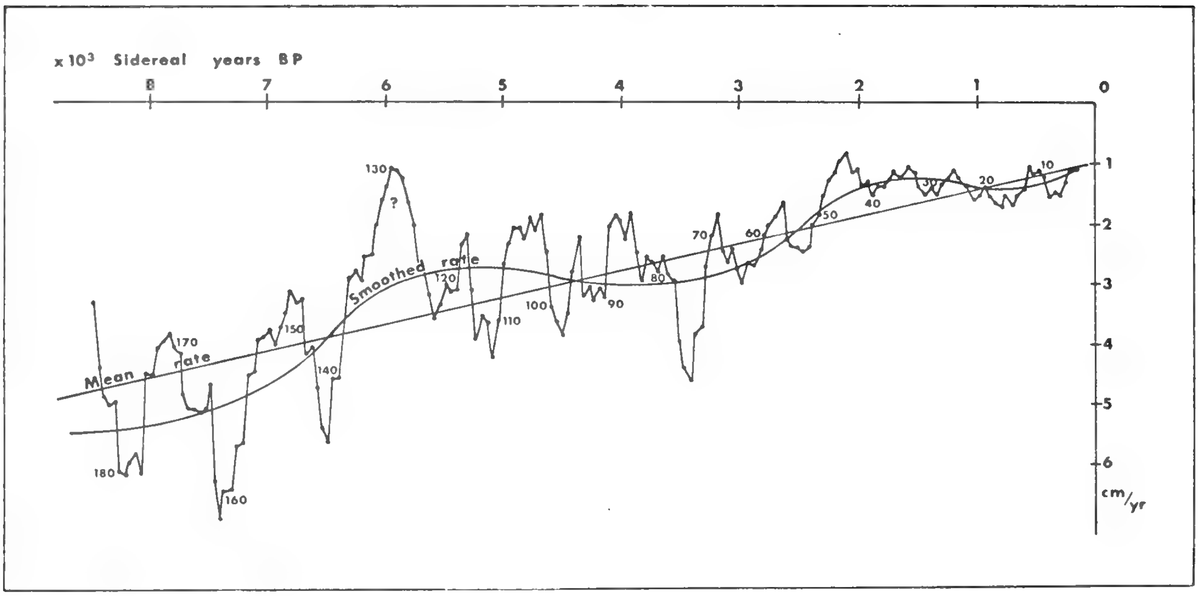

FIGURE 4: *Curve of the postglacial emergence rate in the Richmond Gulf. Fluctuations of the second order are superimposed on an apparent oscillatory damping (century-long oscillations and a 1080-year cycle ? cf. Fairbridge 1978). Each point on the curve represents the rudimentary cycle of 45 years (sliding average). In reality, the construction of the raised beaches seems to correspond to a periodicity of (n × 11) years; 2 ≤ n ≤ 8. (cf. Hillaire-Marcel 1978).*

terrestrial attraction, for example, would entail changes in the usual pattern of precipitation. Furthermore, in the preceding problem, the link between the magnetic field and periods of intense storms affecting coastal regions might be, according to Fairbridge (personal communication, 1978), the beginning of a preferential system of low pressure areas over the magnetic poles. Thus the storm patterns would be altered.

These remarks indicate the paths along which our work will proceed. We plan to complete the mathematical treatment of climatic curves (or curves with climatic connotations) which permit the discovery of natural cycles with correlations of recent trends observed in the physical parameters, such as we have been able to measure in the last few decades. We hope that similarities of these trends will explain the nature and perhaps the origin of the cycles.

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A REVIEW OF PALEOBOTANICAL STUDIES DEALING WITH THE LAST 20,000 YEARS; ALASKA, CANADA AND GREENLAND

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E.V. Sangster*

INTRODUCTION

In 1977 the National Museums of Canada initiated a project "Climatic change in Canada for the last 20,000 years". This paper is part of that program and is designed to provide a resumé of published paleobotanical data. The basic area of study is Canada. However, it is apparent that much useful data can be derived from a knowledge of adjacent areas, thus the review was expanded to include Alaska and Greenland. Although information from the northern conterminous United States is also relevant,it is too voluminous to be included. Attempts were made to make this listing as complete as possible, but omissions undoubtedly occur. We hope future work on this project will provide the opportunity to expand the listing.

Researchers requiring information on specific areas should consult Figure 1, for Alaska; Figure 2, British Columbia to Manitoba; Figure 3, Ontario to the Atlantic Provinces; Figure 4, Yukon and Northwest Territories; Figure 5, Greenland. Figure 6 outlines the total distribution of study sites and gives a visual estimate of areas of concentration and paucity of data. Once a site has been selected, the authors of studies at that site can be obtained from Table 1. Table 2 can then be consulted to obtain a summary as to author, listed alphabetically; date; map location of study; core length (if a palynological study); C^{14} dates and their laboratory numbers; presence of ash layers; zonation; and comments of the author. Where no new data are presented, a précis is provided.

Information on contemporary pollen rain can be obtained from: Anderson and Terasmae, 1966; Bartley, 1967; Bassett, 1959; Birks, 1973, 1977; Birks, Webb and Berti, 1975; Brown, 1962; Cain and Cain, 1953; Collins-Williams and Best, 1955; Crowder and Cuddy, 1973; Davis, 1967; Davis and Webb, 1975; Farley-Wilson, 1975; Ives, 1977; King and Kapp, 1963; LaRush, 1934; Lichti-Federovich, 1975; Lichti-Federovich and Ritchie 1965, 1968; McAndrews, Kroker and Slater, 1977; McAndrews and Power, 1973; Miller, 1973; Mott, 1969, 1974B, 1975B; Potzger, Courtemanche, Sylvio and Hueber, 1956; Richard, 1968, 1976; Ritchie, 1974; Ritchie and Lichti-Federovich, 1963, 1967; Terasmae, 1967D, 1976; Terasmae and Mott, 1964, 1965; Webb and McAndrews, 1976, and Wright, 1967.

Publications on lichenometry and dendrochronology include: Andrews and Webber, 1964; Beschel, 1961; Beschel and Egan, 1965; Beschel and Webb, 1963; Bradley and Miller, 1972; Carrara and Andrews, 1972; Denton and Karlen, 1977; Locke and Locke, 1977; Luckman, 1977; Osborn and Taylor, 1975; Reger and Péwé, 1969; and Wright, 1975.

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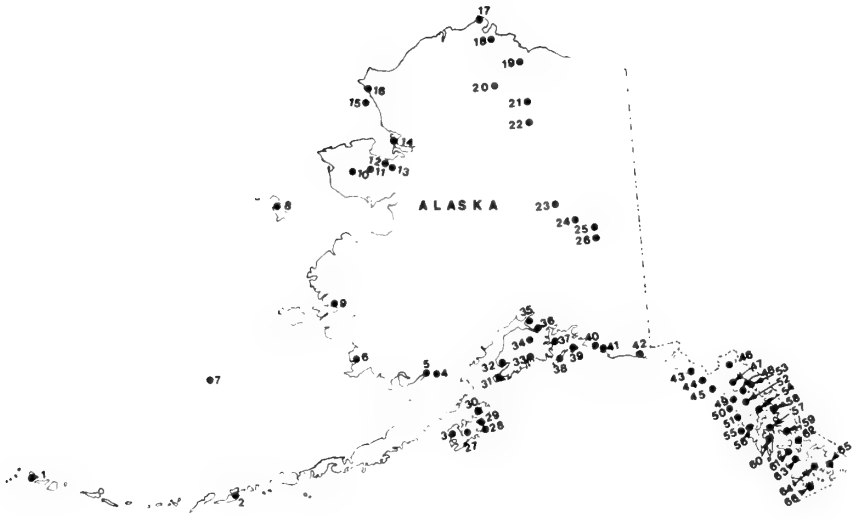

FIGURE 1: *Site locations in Alaska.*

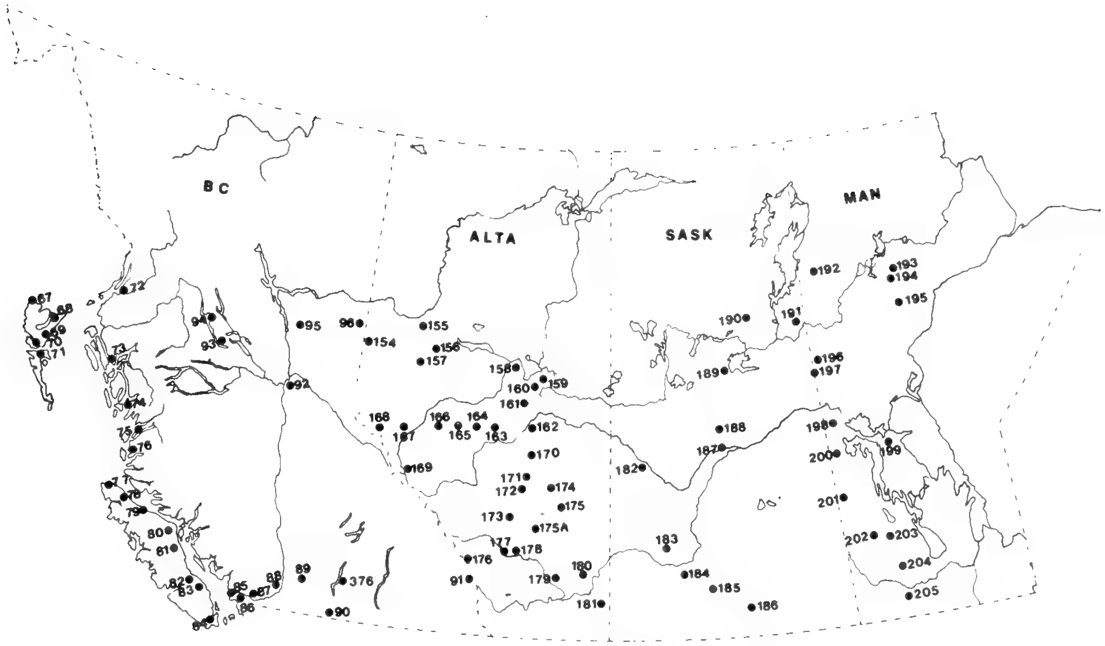

FIGURE 2: *Site locations, British Columbia to Manitoba.*

FIGURE 3: *Site locations, Ontario to the Atlantic Provinces*

FIGURE 4: *Site locations, Yukon and the Northwest Territories.*

FIGURE 5: *Site locations in Greenland.*

FIGURE 6: *Site locations for Canada, Alaska and Greenland, outlining total distribution of sites.*

TABLE 1: *KEY TO PUBLICATIONS NUMERICALLY DESIGNATED ON FIGURES 1 TO 5 (SEE TABLE 2 FOR SITE INFORMATION.*

ALASKA

1. Anderson & Bank 1952
2. Anderson & Bank 1952
3. Heusser 1960
4. Heusser 1963B
5. Heusser 1963B
6. Colinvaux 1967A
7. Colinvaux 1967A
8. Colinvaux 1967B
9. Ager 1977
10. McCullough & Hopkins 1966
11. Colinvaux 1963, 1964B
12. Matthews 1974A
13. McCullough & Hopkins 1966
14. Hopkins, Giterman & Matthews 1976; McCullough & Hopkins 1966
15. Colinvaux 1964B
16. Heusser 1963A, 1966
17. Colinvaux 1964A, 1965
18. Colinvaux 1964A
19. Colinvaux 1964A; Livingstone 1957
20. Colinvaux 1964A
21. Livingstone 1955
22. Livingstone 1955
23. Matthews 1970, 1974B
24. Ager 1975
25. Ager 1975
26. Ager 1975; Anderson 1975
27. Bowman 1934
28. Heusser 1960
29. Heusser 1960
30. Heusser 1960
31. Heusser 1960
32. Heusser 1960
33. Heusser 1955A, 1960
34. Heusser 1960
35. Hansen 1953
36. Heusser 1960
37. Heusser 1960
38. Heusser 1960
39. Heusser 1960
40. Heusser 1955A, 1960
41. Heusser 1960
42. Heusser 1960
43. Heusser 1960
44. Heusser 1960
45. Heusser 1960
46. Heusser 1954A
47. Cooper 1923
48. Heusser 1954A
49. Heusser 1960
50. Heusser 1960
51. Heusser 1960
52. Heusser 1960
53. Heusser 1952, 1954B; Heusser 1960
54. Heusser 1960
55. Heusser 1960
56. Heusser 1952
57. Heusser 1960
58. Heusser 1960
59. Heusser 1952
60. Heusser 1960
61. Heusser 1960
62. Heusser 1952
63. Heusser 1960
64. Heusser 1952
65. Heusser 1960
66. Heusser 1960

BRITISH COLUMBIA

67. Heusser 1955B
68. Heusser 1960
69. Heusser 1955B
70. Heusser 1955B
71. Heusser 1955B
72. Heusser 1960
73. Heusser 1960
74. Heusser 1960

TABLE 1: (cont'd)

75. Heusser 1960
76. Heusser 1960
77. Heusser 1960
78. Heusser 1960
79. Heusser 1960
80. Heusser 1960
81. Hansen 1950B; Heusser 1960
82. Heusser 1960; Terasmae & Fyles 1959
83. Hansen 1950B
84. Hansen 1950B
85. Hansen 1940
86. Mathewes 1976
87. Mathewes 1973A
88. Mathewes, Borden & Rouse 1972; Mathewes & Rouse 1975
89. Hansen 1955
90. Anderson 1973
91. Harrison 1976
92. Hansen 1955
93. Hansen 1955
94. Harington, Tipper & Mott 1974
95. Hansen 1955
96. Hansen 1950A, 1955
376. Alley 1976

YUKON

97. Matthews 1975B
98. Matthews 1975A; Lichti-Federovich 1973
99. Hughes 1969
100. Terasmae & Hughes 1966
101. Terasmae & Hughes 1966; Terasmae 1968B, 1973
102. Rampton 1971
103. Hansen 1953
104. Hansen 1950A, 1953
367. Zoltai & Tarnocai 1975
368. Zoltai & Tarnocai 1975

NORTHWEST TERRITORIES

105. Ritchie 1972B
106. Ritchie 1972B
107. Hyvärinen & Ritchie 1975
108. Yarranton & Ritchie 1972; Ritchie 1972A, B; Ritchie & Hare 1971; Zoltai & Tarnocai 1975
109. Mackay & Terasmae 1963; Porsild 1938; Terasmae 1973
110. Terasmae 1959B
111. Ritchie 1976B; Mackay & Terasmae 1963
112. Hyvärinen & Ritchie 1975
113. Nichols 1972
114. Nichols 1975
115. Nichols 1975
116. Nichols 1975, 1976B
117. Terasmae & Craig 1958
118. Terasmae 1968B
119. Terasmae 1967D
120. Bryson, Irving & Larsen 1965; Hansell, Chant & Weintraub 1971
121. Craig 1959
122. Nichols 1970
123. Bryson, Irving & Larsen 1965
124. Bryson Irving & Larsen 1965; Nichols 1967A, B, 1975
125. Kuc 1970
126. Terasmae 1956
127. Kuc 1974
128. Blake 1972
129. Blake 1972
130. Blake 1972
131. Blake 1972, 1974
132. Blake 1974
133. Blake 1974
134. Blake 1972
135. Blake 1972
136. Blake 1972
137. Hegg 1963; Müller 1963
138. Blake 1972
139. Blake 1972
140. Blake 1972
141. Lyons & Mielke 1973
142. Blake 1974
143. Blake 1972

TABLE 1: (cont'd)

144. Blake 1972
145. Falconer 1966
146. Terasmae, Webber & Andrews 1966
147. Miller 1973
148. Miller 1973
149. Miller 1973
150. Miller 1973
151. Boulton, Dickson, Nichols, Nichols & Short 1976; Nichols 1975; Miller 1973
152. Miller 1973
153. Nichols 1975
369. Zoltai & Tarnocai 1975
370. Zoltai & Tarnocai 1975
371. Zoltai & Tarnocai 1975
372. Rowe, Spittlehouse, Johnson & Jaseniuk 1974-75
373. Zoltai & Tarnocai 1975
374. Rowe, Spittlehouse, Johnson & Jaseniuk 1974-75
375. Jankovska & Bliss 1977

ALBERTA

154. Hansen 1952
155. Westgate, Fritz, Kalas, Delorme, Green, Matthews & Aario 1971
156. Hansen 1952
157. Hansen 1952
158. Hansen 1952
159. Lichti-Federovich 1970
160. Lichti-Federovich 1972
161. Hansen 1949A
162. Hansen 1949A
163. Hansen 1949B; Holloway & Valastro 1977
164. Hansen 1949B; Holloway & Valastro 1977
165. Hansen 1949B; Holloway & Valastro 1977
166. Hansen 1949B; Holloway & Valastro 1977
167. Heusser 1956
168. Heusser 1956
169. Heusser 1956
170. Hansen 1949A
171. Hansen 1949A
172. Strong 1977
173. Strong 1977
174. Strong 1977
175. Strong 1977
175A. Strong 1977
176. Heusser 1956
177. Strong 1977
178. Strong 1977
179. Strong 1977
180. Strong 1977
181. Schweger 1972

SASKATCHEWAN

182. Mott 1967
183. Mott 1973A
184. Kupsch 1960
185. DeVries & Bird 1965; Ritchie & DeVries 1964
186. Terasmae 1973
187. Mott 1973A
188. Mott 1973A
189. Mott 1973A
190. Mott 1971D
191. Ritchie 1976A

MANITOBA

192. Nichols 1967A, B
193. Mott 1973B
194. Mott 1973B
195. Ritchie 1976
196. Mott 1973B
197. Ritchie 1976
198. Nichols 1969
199. Ritchie & Koivo 1975; Ritchie & Hadden 1975
200. Nichols 1969
201. Klassen, Delorme & Mott 1967
202. Ritchie 1967B
203. Ritchie 1964, 1969
204. Terasmae 1970
205. Ritchie & Lichti-Federovich 1968

TABLE 1: (cont'd)

ONTARIO

206. Terasmae 1967C, 1973

207. Terasmae & Hughes 1960B; Terasmae 1968A

208. Terasmae & Hughes 1960B

209. Auer 1927; Penhallow 1896; Terasmae 1958 (Part III); Terasmae & Hughes 1960A, B

210. Auer 1927

211. Auer 1927; Terasmae & Hughes 1960A

212. Terasmae 1970B

213. Terasmae 1970B

214. Terasmae & Hughes 1960A, B

215. Terasmae 1967C

216. McAndrews 1976B

217. Bruland, Koide, Bowser, Maher & Goldberg 1975

218. Bruland, Koide, Bowser, Maher & Goldberg 1975

219. Maher 1977

220. Terasmae 1967C

221. Terasmae & Hughes 1960A

222. Terasmae 1968A

223. Terasmae & Hughes 1960A; Terasmae 1968A

224. Boyko-Diakonow & Terasmae 1975

225. Cwynar 1978

226. Mott & Camfield 1969; Terasmae & Hughes 1960A

227. Penhallow 1896

228. Auer 1930; Mott & Camfield 1969

229. Auer 1930; Potzger & Courtemanche 1956A

230. Terasmae 1965A

231. Auer 1930

232. Terasmae 1968A

233. Terasmae 1968A, 1973

234. Auer 1930

235. McAndrews 1970, 1972, 1973

236. McAndrews 1972, 1976A

237. Berti 1975; Coleman 1895, 1933; Radforth & Terasmae 1960; Terasmae 1960B

238. Byrne & McAndrews 1975; Finlayson, Byrne & McAndrews 1973; McAndrews, Boyko & Byrne 1974; McAndrews 1976A

239. Karrow, Anderson, Clarke, Delorme & Sreenivasa 1975

240. Karrow, Anderson, Clarke, Delorme & Sreenivasa 1975

241. Sigleo & Karrow 1977

242. Berti 1975; Dreimanis, Terasmae & Mackenzie 1966

243. Lewis, Anderson & Berti 1966

244. Hobson & Terasmae 1969; Karrow & Terasmae 1970

245. Auer 1930

QUEBEC

246. Potzger & Courtemanche 1956A

247. Potzger & Courtemanche 1956A

248. Potzger & Courtemanche 1954B

249. Potzger & Courtemanche 1956A

250. Potzger & Courtemanche 1956A

251. Potzger & Courtemanche 1956A

252. Potzger & Courtemanche 1956A

253. Potzger & Courtemanche 1956A

254. Terasmae & Anderson 1970

255. Vincent 1973

256. Potzger 1953

257. Potzger 1953

258. Potzger & Courtemanche 1956B

259. Potzger & Courtemanche 1956A

260. Potzger 1953; Potzger & Courtemanche 1954A, 1956A

261. Potzger & Courtemanche 1956A

262. Potzger 1953

263. Potzger 1953; Potzger & Courtemanche 1956A

264. Potzger 1953

265. Auer 1930

266. LaSalle 1966; Terasmae & LaSalle 1968

267. Potzger 1953

268. Terasmae 1960A

TABLE 1: (cont'd)

269. Terasmae 1958 (Part II), 1960A
270. Potzger 1953
271. Terasmae 1958 (Part II), 1960A
272. Terasmae 1960A
273. Terasmae 1958 (Part I), 1960A
274. Terasmae 1958 (Part II)
275. Richard 1975A
276. Terasmae 1960A
277. Richard 1975A; Terasmae 1958 (Part II)
278. Terasmae 1960A
279. Richard 1973C; Terasmae 1960A
280. Richard 1973C
281. Mott 1977
282. Mott 1977
283. Richard 1975B
284. Mott 1977
285. Mott 1977
286. Auer 1930
287. Richard 1973A
288. Auer 1930
289. Richard 1971
290. Richard 1971
291. Richard & Poulin 1976
292. Auer 1930
293. Richard 1973B
294. LaSalle 1966
295. Richard 1973B
296. Radforth 1945
297. Potzger 1953
298. Potzger 1953
299. Potzger 1953
300. Potzger 1953
301. Potzger 1953
302. Potzger 1953
303. Livingstone 1968
304. Prest, Terasmae, Matthews & Lichti-Federovich 1976
305. Mott 1976
306. Bowman 1931
307. Terasmae, Webber & Andrews 1966
308. Short & Nichols 1977
309. Short & Nichols 1977
310. Bartley & Matthews 1969
312. Bartley & Matthews 1969
313. Bartley & Matthews 1969
314. Bartley & Matthews 1969

NEWFOUNDLAND

315. Short & Nichols 1977
316. Short & Nichols 1977
317. Short & Nichols 1977
318. Short & Nichols 1977
319. Jordan 1975B
320. Wenner 1947
321. Jordan 1975B
322. Jordan 1975B; Wenner 1947
323. Jordan 1975B
324. Wenner 1947
325. Wenner 1947
326. Wenner 1947
327. Morrison 1970
328. Morrison 1970
329. Morrison 1970
330. Morrison 1970
331. Mott 1975A
332. Wenner 1947

NEW BRUNSWICK

333. Mott 1975D
334. Mott 1975D
335. Mott 1975D
336. Mott 1975D
337. Mott 1975C, D
338. Mott 1975C, D
339. Osvald 1970
340. Terasmae 1973
341. Auer 1930
342. Auer 1930

NOVA SCOTIA

343. Mott & Prest 1967

TABLE 1: (cont'd)

344.	Livingstone & Estes 1967
345.	Livingstone 1968; Mott & Prest 1967
346.	Livingstone & Livingstone 1958; Mott 1971C; Schofield & Robinson 1960
347.	Livingstone 1968; Mott & Prest 1967
348.	Terasmae 1974
349.	Auer 1930
350	Osvald 1970
351.	Livingstone 1968
352.	Hadden 1975
353.	Auer 1930; Ogden 1960
354.	Livingstone 1968
355.	Auer 1930
356.	Auer 1930; Livingstone 1968
357.	Auer 1930
358.	Terasmae & Mott 1971
GREENLAND	
359.	Fredskild 1973
360.	Fredskild 1973
361.	Kelly & Funder 1974
362.	Kelly & Funder 1974
363.	Kelly & Funder 1974
364.	Fredskild 1972, 1973; Iversen 1952-3
365.	Fredskild 1967
366.	Fredskild 1969, 1973

TABLE 2: *SUMMARY OF PUBLICATIONS.*

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Ager 1975	24. Birch L., Alaska 64°19'N, 146°40'W (2 cores)	I - 2.9m II - 5.75m	Core I (5568 yr half-life) 244-270mm (10970 ± 513 AU-93) Core II (5730 yr half-life here presented; also lists ages for 5568 yr half life) 80-90mm 4153 ± 135 I-8064 128-142 5897 ± 130 I-8065 233-247 8696 ± 150 I-8066 288-300 9452 ± 325 I-8070 385-400 13388 ± 500 I-8067 510-530 15158 ± 830 I-8068	Core I - zones 2, 3A, 3B. Core II-zones 1, 2, 3A, 3B. Zone 1 (5.1m to base - Core II) - Gramineae-*Artemisia-Salix*-Cyperaceae assemblage. Probably steppe-like vegetation. Zone 2 (2.7m to base - Core I; 3.1m to 5.1m - Core II) - *Betula-Salix*-Gramineae-Cyperaceae assemblage. Shrub tundra. Warmer, moister climate. Zone 3A (2.2m to 2.7m - Core I; 2.4m to 3.1m - Core II) - *Picea-Betula* assemblage. Spruce invasion. Coincides roughly with early Holocene warm interval. Zone 3B (top to 2.2m - Core I; top to 2.4m - Core II) - *Picea-Betula-Alnus* assemblage. Arrival and expansion of alder. Decrease of spruce over 8400-6500 BP. Possibly corresponds to Hypsithermal or may be due to increased forest fires.
	25. Healy L., Alaska	2.9m	.5-.6m 1430 ± 85 I-8071 (1440 BP given in text)	All of profile in Zone 3B. Heavily influenced by local vegetation - bog and deltaic mud flats.
	26. Johnson R. Bog, Alaska	3.1m	base of 7673 ± 193 AU-64 core	All of profile in Zone 3B.
	26. L. George, Alaska 63°47'N, 144°30'W (2 cores)	8.2m (only Core I presented)	Core I (5568 yr half-life) 85-99mm 3170 ± 145 I-8069 185-197 1730 ± 185 I-8024 285-299 2855 ± 255 I-8205 510-525 8410 ± 140 I-8206 685-705 7140 ± 160 I-8207	Zone 1 (7m to base). Zone 2 (5.3m to 7m). Zone 3A (4.5m to 5.3m). Zone 3B (top to 4.5m). Pollen stratigraphy very similar to Birch L. Core II.

Ager 1977	9. Ingakslugwat Hills, Alaska 61°26'N, 164°12'W	5.35m		No pollen diagram given. Zone 1 (basal)-dominated by grass, herbs, some shrubs. Transitional between herbaceous (full-glacial) tundra and shrubby (interglacial) tundra. Zone 2 - high alder, some dwarf birch, grass, sedge, herbs - shrubby tundra. Zone 3 - dominated by grass, sedge, willow, *Artemisia*, herbs. Fellfield type tundra under severe climatic conditions. Zone 4 - similar to Zone 3, but in addition - dwarf birch and ferns. Zone 5 - grass, birch, heath, alder and ferns. Interstadial warming. Zone 6 - abundant birch which decreases upward; increasing grass and herbs. Increasingly severe climate. Zone 7 - high alder; significant birch and grass. Also spruce pollen.
Alley 1976	376. Kelowna Bog Okanagan L. British Columbia 49°56'N, 119°23'W	280cm	*ca.* 260 cm, *Salix* wood 8410 ± 100 GSC 1867 *ca.* 95 cm, *Betula* wood 3640 ± 70 GSC 1868 *ca.* 85 cm, St. Helens Y ash, 3200 BP 125-130 cm Mazama ash 6600 BP	Zone KB1 (280-230 cm) - high *Pinus ponderosa*, *Salix*; increasing Cyperaceae. Forest of *Pinus ponderosa*, *Picea*, *Abies*, *Tsuga heterophylla*, *Pseudotsuga*; some *Betula*, *Acer glabrum*. Similar to modern conditions, but perhaps slightly cooler and/or moister. Zone KB2 (230-125 cm) - decrease in *Pinus*, *Picea*, *Abies*; increase in Cyperaceae, Gramineae, Chenopodiaceae, *Typha*, *Artemisia*. Divided into basal KB2a subzone - high Cyperaceae; and upper KB2b subzone - high Gramineae and *Typha*. *Sarcobatus* occurs in KB2b. Zone KB2 represents a warmer, drier period. Zone KB3 (125 cm to top) - increase in arboreal pollen; decrease in Cyperaceae, Gramineae. Divided into 5 subzones: a) increase in *Betula*, *Alnus*, *Pseudotsuga*; decrease in *Pinus*; moister period; b) decline in

TABLE 2: (cont')

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Alley 1976 continued				*Betula*, *Alnus*, *Pseudotsuga*, *Corylus*; increase in *Pinus*, *Picea*; first drying interval; c) increase in *Betula*, *Alnus*, *Pseudotsuga*; decrease in *Pinus*, *Picea*; moister period; d) decrease in *Betula*, *Alnus*, *Pseudotsuga*; increase in *Pinus*, *Picea*; drier conditions; e) decrease in *Pinus*, *Picea*; increase in *Betula*, *Alnus*, *Corylus*; cooler and moister conditions.
Anderson 1975	26. Hidden L., Alaska 64°00'N, 144°45'W	3 cores		Profiles show no major differences at depth from surface samples. Therefore, no major changes in vegetation occurred with Thermal Maximum and Neoglacial climatic changes. A refugium probably did not exist in the area during the Wisconsin glacial maximum. Lodgepole pine may have migrated into the area from the southeast during the Holocene.
	Hidden L. Middle	56cm	48-55 4505 ± 124	
	Hidden L. North	53cm	47-53 2797 ± 178	
	Hidden L. South	62cm	58-65 4647 ± 241	
	26. Johnson R. Bog, Alaska	128cm	2665 BP estimated from peat accumulation rates	
Anderson and Bank 1952	1. Tanaga I., Alaska	2 samples .85m and 1.83m		Older sample represents *Empetrum* heath (high Ericales and *Lycopodium*). Younger sample similar to *Calamagrostis* meadow existing today at the site.
	2. Unalaska I., Alaska	.74m		Dominated by *Dryopteris* sp. (some Umbelliferae, *Artemisia*).
Anderson 1973	90. Osoyoos L. British Columbia	33cm	Apparently dated but dates not given. Date of 1890 A.D. inferred at *ca.* 26cm.	Total pollen high at base (33 cm). Decreases to minimum at 23 cm and increases toward surface. Spruce, pine, hemlock and grass decrease

			sharply at 28 cm. Poplar, alder, willow and sagebrush increase at 26 cm. Correlated with land use history.
Anderson 1974	Ontario		*Castanea* pollen shows a marked decrease in lakes Ontario and Erie in 1935 (result of Chestnut Blight). This provides a recent time horizon (above the *Ambrosia* boundary) for determining sedimentation trends.
Anrep 1914	Ontario, Québec		Study of 11 peat bogs (locations 229, 265, 270, 292 and 299). Major emphasis on economics and methods of peat industry.
Auer 1927	209. Missinaibi R., Ontario		*Hypnum* detritus; *Picea*, *Pinus*, *Abies*, *Betula*, Polypodiaceae grains. From "interglacial peat".
	210. Soweska R., Ontario		*Hypnum*; *Pinus* wood; *Salix*, *Carex*, *Equisetum*, *Sphagnum*, *Eriophorum* macrofossils. *Picea*, *Pinus* grains. From "interglacial peat".
	211. Opazatika R., Ontario		*Carex*, *Scheuchzeria*, *Hypnum*, *Sphagnum*, *Eriophorum*, *Salix* macrofossils; *Pinus* wood; *Pinus*, *Picea*, *Betula*, *Abies*, Ericaceae, Polypodiaceae grains. From "interglacial peat".
Auer 1928	Canada		Discussion of development of peat bogs, and general pollen record of Canadian peat bogs.
Auer 1930	228. Newington, Mer Bleue, Ontario	.4-6.2m .4-5.4m	General discussion of all diagrams: *Picea* most abundant in oldest layers; decreases in higher layers, in certain cases disappears;
	229. Alfred, Ontario	.4-6.5m	

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Auer 1930 continued	231. Perth, Ontario	.4-4.5m		increases in the highest layers. *Abies* behaves like *Picea*. *Pinus* is very abundant in older layers and gradually decreases in amount upwards. Deciduous tree pollen and *Tsuga* pollen occur abundantly in those layers in which *Picea* is at a minimum. Also includes list of seeds and plant remains from the bogs.
	234. Marsh Hill, Ontario	2.3-5.9m		
	245. Welland, Ontario	.4-4.9m		
	265. Large Tea Field, Québec	.25-1.9m		
	286. Clair, Québec	.4-5.5m		
	288. Sagamité, Québec	.4-6.8m		
	299. L'Ile-verte St. Arsène Cacouna Rivière-du-Loup, Québec	.4-8m .9-8m .4-5.5m .4-6.8m		
	341. Hicks, New Brunswick	.4-3.6m		
	342. Escuminac, New Brunswick	.4-8.7m		
	349. Mulgrave, Nova Scotia	.4-4.5m		
	292. R. Ouelle, Québec	.4-7.7m		

	353. Caribou, Nova Scotia	.3-8m			
	355. Cherryfield, Nova Scotia	.8-4.5m			
	356. Salmon R., Nova Scotia	.3-4m			
	357. Tusket Makoke Heath, Nova Scotia	.3-7m .4-4m .4-7.2m			
Baker 1920	Canada				Review of the Pleistocene of the Great Lakes area. Includes short lists of molluscs, vertebrates, and plants from different intervals of the Pleistocene in Canada (mainly Eastern Canada).
Barry, Arundale, Andrews, Bradley and Nichols 1977	Eastern Canadian Arctic				Discussion of changes in past climate mentioning marine environment, glaciological, palynological, paleosol and lichenological research.
Bartley and Matthews 1969	310. R. Renard Noir, Québec	No diagram given			R.T. 1 - peat layers from base up show Cyperaceae and Ericaceae, then *Salix*, then Cyperaceae and Gramineae and *Betula* as predominant types. Suggests fluctuating vegetation pattern with long snow cover. At 295 cm *Pinus*, *Picea*, *Alnus* and Caryophyllaceae reach maxima. Could be result of forest spread or long-distance transport. Main peat layer (215-295 cm) - first swamp peat (high Gramineae); then *Sphagnum* peat. In *Sphagnum* peat, *Betula* rises gradually, *Picea*, *Pinus*,
	310. R. aux Roches, Québec	5-35cm			
	311. R. Saule, Québec 61°31'N, 74°5'W	1 sample at 30cm	basal peat layer 525 ± 140	NPL-59	
	311. R. aux Poissons, Québec	120-170cm plus 1 sample at 200 cm	200 cm	3990 ± 140 NPL-114	

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Bartley and Matthews 1969 continued	312. R. Tourbe, Québec R.T. 1	Scattered samples from 90-710 cm	280cm 1600 ± 140 FSC-537	*Alnus* are low. In scattered upper samples - increase in Gramineae, Cyperaceae, *Artemisia*. Change to sand-dune vegetation.
	312. R.T. 2	220-350cm plus 2 other samples	270cm 670 ± 120 NPL-125	Other spectra similar. Correlates well with dates from Nichols (1967) in Keewatin. Suggests major peat development followed by cessation is a response to overall climatic change.
	312. R.T. 3	0-100cm		
	312. R. de l'Airelle, Québec	10-75cm	70cm 1625 ± 175 I-727	
	313. Kugluk Cove, Québec	90-150cm		
	314. L. Faucon, Québec	0-35cm		
Bassett and Terasmae 1962	Canada			Descriptions of *Ambrosia artemisiifolia*, *A. trifida* and *A. coronopifolia* and their present distributions. More abundant in lateglacial than in postglacial sediments, but have become abundant again in E. Canada in past 200 years. *Ambrosia* existed further northward in Ontario in the past than at present.
Benninghoff 1954	Central Alaska			Cool-temperate vegetation existed on Seward Peninsula during one of the earlier interglacial stages (*Picea*,

				Pinus, *Abies*, *Tsuga* forest). During Wisconsin stage, vegetation was of modern subarctic species in changing patterns of distribution. (Abstract only).
Bentley and Smith 1956	Nova Scotia			Description of the forests of Cape Breton from observers in the 17th and 18th centuries. Forest was hemlock-white pine-northern hardwood association similar to that currently existing in undisturbed areas. Elm is recorded, supporting the idea that it is a native rather than introduced species. Oak and ash are mentioned frequently - both are comparatively rare today.
Bernabo and Webb 1977	Published cores from Atlantic Provinces, S. Québec, Ontario and S. Manitoba as well as NE U.S. used to map changing Holocene vegetation record.	Abstract: "After 11000 BP, the broad region over which spruce pollen had dominated progressively shrank as the boreal forest zone was compressed between the retreating ice margin and the rapidly westward and northward expanding region where pine was the predominant pollen type. Simultaneously, the oak-pollen dominated deciduous forest moved up from the south and the prairie expanded eastward. By 7000 BP, the prairie had attained its maximum eastward extent with the period of its most rapid expansion evident between 10000 and 9000 BP. Many of the trends of the early Holocene were reversed after 7000 BP with the prairie retreating westward and the boreal and other zones edging southward. In the last 500 years, man's impact on the vegetation is clearly visible, especially in the greatly expanded region dominated by herb pollen."		
Berti 1975	237. Scarborough Bluffs, Ontario middle member - Thorncliffe Fm.	9m		Major types - *Pinus* (long distance transport), *Picea*. Some *Betula*, *Quercus*, Cyperaceae and Gramineae.
	237. Lower member - Thorncliffe Fm.	4 samples analyzed from 30-45 cm	43cm 38000 ± 1300 GSC 271 48800 ± 1400 GSC 534 >53000 (considered most reliable)	*Picea*, *Pinus*, Gramineae and Cyperaceae pollen. *Picea*, *Larix*, *Selaginella selaginoides* macrofossils. Forest-tundra.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Berti 1975 continued	242. Port Talbot-Plum Pt. Ontario. Borehole II	0-12m and 15-15.5m		Zone (PT)-H (basal) - dominated by *Quercus* and *Pinus*. Some *Betula*, *Salix* and *Picea*. NAP high. Oak savanna with some pine and spruce. Zone J - increased *Pinus*, decreased *Quercus*, NAP. Some *Picea*, Cyperaceae. More closed, northern forest. Moist cool climate. Zone K - *Quercus*, *Salix*, *Betula* increase. High NAP. Return to climate of Zone H. Zone L - *Pinus* dominates. Some *Picea*, *Betula*, *Quercus*. Similar to Zone J climate. Zone M - *Pinus* decreases; *Betula* and *Sphagnum* increase. Subzone Ma - ice advance. More boreal type of vegetation. Subzone Mb - slight rise in *Picea*. Beginning of Port Talbot II interval. Also discusses modern vegetation, pollen rain and plant macrofossils.
	242. Port Talbot, Ontario. Boreholes II and III	16m		
Birks 1968				*Betula nana* may be distinguished from *B. tortuosa* on the basis of size alone. *B. nana* may be distinguished from *B. pubescens* on the basis of grain diameter:pore size ratio. Both parameters are necessary to distinguish *B. nana* from tree birch pollen.
Blake 1972	128. Fitzwilliam Owen I., Northwest Territories 77°08'N, 113°48'W		*Larix* or *Picea* 7820 ± 140 GSC 1171	Deglaciation chronology based on dated driftwood. Discussion of currents, ice shelves and identification of driftwood.

129. Melville I. Sherard Bay, Northwest Territories 76°04'N, 108°38'W	*Picea*	7850 ± 140	GSC 1624
130. Ellef Ringnes I., Northwest Territories 77°52'N, 99°37'W	*Larix* or *Picea*	8320 ± 140	GSC 999
131. Bathurst I. Stuart R. Valley, Northwest Territories 76°10.5'N, 99°05'W	*Picea*	8380 ± 160	GSC 1566
134. Ellesmere I. Cape Storm, Northwest Territories 76°24.5'N, 87°33'W	*Populus*	6410 ± 140	GSC 1591
	Picea or *Larix*	6510 ± 280	GSC 1545
		6090 ± 130	GSC 1007
		6060 ± 190	
		5700 ± 140	GSC 1463
		5680 ± 140	GSC 928
		5170 ± 140	GSC 986
		5010 ± 130	GSC 1410
		4750 ± 130	GSC 1512
	Picea	5350 ± 130	GSC 1547
		4600 ± 130	GSC 921
		4580 ± 140	GSC 1537
		4360 ± 130	GSC 839
		8280 ± 140	GSC 845
		6450 ± 140	GSC 833
135. Ellesmere I. South Cape Fiord, Northwest Territories 76°26'N, 85°02'W	*Picea* or *Larix*	8200 ± 150	GSC 1443
136. Axel Heiberg I. Thompson Glacier, Northwest Territories	*Larix*	5690 ± 140	GSC 1138
		5325 ± 270	GX 0144
	Picea or *Larix*	5480 ± 100	B 431
		5920 ± 100	B 432

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Blake 1972 continued	138. Ellesmere I. Yelverton Inlet, Northwest Territories 82°02'N, 81°57'W		*Picea* or *Larix* 8160 ± 140 GSC 1534 6410 ± 250 GSC 1603	
	139. Ellesmere I. Beatrix Bay, Northwest Territories 81°11'N, 70°17'W		*Larix* 5950 ± 140 GSC 1610 *Picea* 6430 ± 150 GSC 1614	
	140. Ellesmere I. Disraeli Fiord, Northwest Territories 83°00'N, 74°13'W		*Larix* 6280 ± 140 SI 568 6120 ± 150 L 254C 5740 ± 200 L 254B 3400 ± 150 L 254A 3000 ± 200 L 254D	
	143. Ellesmere I. Clements Markham Inlet, Northwest Territories 82°38.5'N, 67°30'W		*Picea* 2190 ± 150 L 261B	
	144. Ellesmere I. Cape Sheridan, Northwest Territories 82°28'N, 61°35'W		*Larix* 6050 ± 200 L 261C	
	144. Ellesmere I. Cape Richardson, Northwest Territories 82°33.5'N, 63°01'W		*Picea* 980 ± 100 L 261A	
Blake 1974	131. Bathurst I. Stuart R. Valley, Northwest Territories 76°11.2'N, 99°05'W		Top 2.5 cm of peat >50000 GSC 165-2	Other C^{14} dates from other papers also listed.

	132. Scoresby Hills, Northwest Territories 75°41'N, 98°03'W		Surface peat >38000 GSC 1878	
	133. Goodsir Inlet, Northwest Territories 75°43'N, 98°09'W		Top 5 cm of peat >50000 GSC 165-2 Marine shells >19000 GSC 1879	
	133. Caledonian R., Northwest Territories 75°41'N, 98°48'W		Near top >30000 GSC 1902 *ca.* 1 m lower >43000 GSC 784	
	142. Ellesmere I. Eugene Glacier, Northwest Territories 82°17'N, 66°18'W		Peat layer >43000 GSC 1864	
Boulton, Dickson, Nichols, Nichols and Short 1976	151. Maktak Glacier, Northwest Territories	100 cm peat bed	90-100cm 2500 ± 170 BIRM 380 51-53 2240 ± 90 BIRM 536 24-26 1970 ± 200 BIRM 535 1-5 1480 ± 160 BIRM 370	90-100cm - high Gramineae and Cyperaceae, some *Pinus*, *Salix*, Ericaceae. 85-90 - *Salix* dominates; dwarf willow community. Moister. 70-85 - *Salix* decreases; Cyperaceae increases. Gramineae community. Drier (colder?) climate. 52.5-70 - Gramineae decreases. Cyperaceae, Caryophyllaceae, *Alnus*, *Pinus* increase. Grass dominance over. 27.5-52.5 - Cyperaceae increases to maximum. Ericaceae, *Salix*, *Alnus* increase. Increasing heath cover. Moister. 0-27.5 - Gramineae and Cyperaceae reduced. *Salix*, Ericaceae low. 15 cm - *Pinus* rises to maximum. Grass community, sporadic heath development. Change from moist to dry conditions *ca.* 1500 BP.
Bowman 1931	306. Matamek R., Québec	11.25 ft		Base to 5.5 ft - Cyperaceae and *Betula* most common but decreasing. 5.5 ft - spruce becomes more common.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Bowman 1931 continued				Invasion by forest. 5.5 ft to surface - closed forest. *Abies* peaks at 7 and 9 ft. *Tsuga*, *Acer*, *Lycopodium* and ferns show 3 peaks at the same levels (*ca.* 10.5, 9-9.5 and 7 ft).
Bowman 1934	27. Kodiak I. Alaska 58°N, 153°W. No more precise location given.	2 bogs, 1 7 ft deep, one 13 ft deep, sampled from 3 ft to base.		Present vegetation - spruce, hemlock forest. The peat accumulated at a time when there were few trees in the vicinity. *Alnus* and *Betula* occur at base. Then both decrease - later increasing at the 3 ft level. Ferns common in both bogs.
Boyko-Diakonow and Terasmae 1975	224. Perch L., Ontario 46°02'N, 77°32'30"W	646 cm analyzed	594-600cm 9830 ± 250 GSC 1516	Zone V (575-646cm) - high *Picea*, *Betula*; some *Pinus*, *Artemisia*, Cyperaceae, *Salix*, *Quercus*, *Fraxinus*, *Ulmus*. Cold, moist climate. End of Zone V - 9500 BP. Zone IV (525-575 cm) - low *Picea* and herbs; high *Pinus banksiana/resinosa*. Decrease in *Quercus* and *Betula*. Warmer and drier. End of Zone IV - 8700 BP. Zone III (393-525 cm) - *Pinus strobus* dominates. Increase in *Quercus*; decrease in *Betula*. Climate dry. End of Zone III - 6500 BP. Zone II (65-393 cm)- increase, then decrease, then increase in *Tsuga*. Increase in *Fagus*, *Quercus*, *Acer*, *Alnus*, Cupressineae. *Pinus strobus* decreases but still dominant. Warm and moist. *Tsuga* minimum reflects Hypsithermal. End of Zone II - 1100 B.P. Zone I (top to 65 cm) - decreasing *Tsuga*, *Fagus*; increasing *Betula*. NAP increase at top of

				Zone I reflects European settlement.
Bruland, Koide, Bowser, Maher and Goldberg 1975	217. L. Superior, Ontario 47°28'N, 90°00'W Core 72-247	11.1 cm		Determine rates of sedimentation from ragweed pollen (using 1830 as date for first appearance in the area) and ^{210}Pb dating. Give selected pollen percentages and pollen concentrations for the 2 cores.
	218. 47°02'N, 90°58'W Core 71-1397	29.3 cm		
Bryson, Irving and Larsen 1965	120. Dubawnt L., Northwest Territories 63°01'N, 100°40'W		Charcoal 1475 ± 110 WIS 12	
	123. Dimma L., Northwest Territories		Charcoal 810 ± 90 WIS 17	
	124. Ennadai L., Northwest Territories		Charcoal from S. end Ennadai L. 1070 ± 180 WIS 5 1080 ± 100 WIS 6 Caribou Pt. - Ennadai L. lower layer 1604 ± 116 WIS 18 upper layer 860 ± 135 WIS 27 Aeradio Station - Ennadai L. peat layer 3050 ± 160 WIS 7	Between 1500 and 1000 BP, treeline twice advanced north of its present position. The advances represent the Climatic Optimum and the Little Climatic Optimum. Also use evidence of podzol soils.
Bryson and Wendland 1967	Canada			Mainly a reconstruction of late-glacial climates of the United States. Also includes some discussion of past climates in Canada and the effect of these climates on vegetation.
Byrne and McAndrews 1975	238. Crawford L., Ontario			*Portulaca oleracea* deposited in lake from 1350 to 1539 A.D. but not to the present. Seeds also found. It is suggested that agricultural Indians gathered the plant and washed it in the lake before eating.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Coleman 1895	237. Scarborough Beds, Ontario			Insect, plant and moss macrofossils identified. Climate of the time cool and wet.
	237. Don Beds, Ontario			Shells and plant macrofossils identified. Climate as warm as Toronto at present if not warmer. Discussion of which bed was earlier.
Coleman 1933	237. Don and Scarborough Beds, Ontario			Don Beds: list of plant macrofossils, shellfish. Scarborough Beds: list of plant macrofossils and beetles. Some discussion of climate during formation of the beds.
Coleman 1941	Canada			Pleistocene of Great Lakes area (including Scarborough and Don beds - list given of plants from the Don beds). Pleistocene of the St. Lawrence Valley, Atlantic Coast, Newfoundland and Labrador, James Bay, Hudson Bay regions, Rocky Mountains, Yukon and Arctic Islands. Short lists of fossil plants given for several of the areas.
Colinvaux 1963	11. Imuruk L., Alaska 65°35'N, 163°15'W	8m	.35m 12355 ± 160 Y 1144 .5 13250 ± 700 I 588 1.2 >34500 Y 1142 2.6 >37000 Y 1143 7.25 24060 ± 3000 I 801 7.5 21700 ± 2000 I 415	12 zones: A (basal) to L (surface - similar to modern low-Arctic tundra on Seward Peninsula). Low tree pollen shows forest was never present on the Seward Peninsula during the time covered by the core.
Colinvaux 1964A	17. Point Barrow, Alaska	6 samples	1775 ± 120 I 699	In Zone III
			8715 ± 250 I 1182	In Zone I See Colinvaux 1964B for descriptions of zones.

			9155 ± 300 9550 ± 240	I 1183 I 700	
			10525 ± 280 14000 ± 500	I 701 I 1171	In Zone 0 - extremely frigid tundra. No dwarf birch, some grass, sedge, dwarf willow.
	18. Ikpikpuk, Alaska	1 sample	3840 ± 140	I 1004	In Zone III - on basis of alder content.
	19. Umiat, Alaska	2 samples	9130 ± 240 9325 ± 250	I 356 I 354	In Zone I
	20. Killik, Alaska	1 sample	2310 ± 110	I 1005	In Zone III
Colinvaux 1964B	11. Imuruk L., Alaska	8 m	See Colinvaux 1963		Three types of tundra zones: Zone 1 (pollen zones G and J) - cold, grassy tundras in a climate colder than present-day in the area. Zone II - (pollen zones B, D, F, K) - warming climate. Dwarf birches become numerous, grasses decline, *Eriophorum* tussocks begin to develop. Zone III (pollen zones A, C, E, I, L) - further warming; tussock development reaches maximum. Similar to modern-day vegetation in the area. Zone A (7.5-8m), B(6.5-7.5m), C(6.1-6.5m), D(5.7-6.1m), E (4.8-5.7m), F(4.4-4.8m), G(3.3-4.4m), H(2.9-3.3m), I(1.9-2.9m), J(.6-1.9m), K(2 -.6m), L(0-.2m).
	15. Submarine core, Kotzebue Sound, Alaska 67°30'N, 165°52'W	7 m			Imuruk zones K and L (0-*ca.* .9 m). Grass and tussock tundra with dwarf birches prevailed throughout whole core. In zone L, alder and spruce ranges had advanced close enough so their pollen was adding to the local pollen rain.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS ASH LAYERS	ZONATION AND COMMENTS
Colinvaux 1965	17. Point Barrow, Alaska		Deep drill cores 25300 ± 2300 I 1384 >36000 I 1394	Pollen analysis shows samples belong to coastal pollen zone 0. Climate in northern Alaska has never been warmer than that of present.
Colinvaux 1967A	6. Goodnews Bay, Alaska	3 samples analyzed	Lowest sample 11500 ± 250 I 426	Oldest is herb spectrum, middle a birch spectrum, youngest an alder spectrum.
	7. St. Paul I., Alaska	5.5 m	5.25-5.75m 9570 ± 160 Y 1390 3.0-3.5 3520 ± 100 Y 1389 1.0-1.5 2620 ± 160 Y 1388	Whole spectrum falls into single herb zone. Differs from mainland sites in large amounts Umbelliferae and *Artemisia*. Low amounts of *Betula* and *Alnus* probably wind-blown. Also previously published diagrams from sites in the area and discussion of them.
Colinvaux 1967B	8. Flora L., St. Lawrence I., Alaska	200 cm	50-70 cm 5650 ± 275 I 993	Fern zone (180-200cm) - Polypodiaceae and *Lycopodium*. May be result of differential preservation. Probably tundra. Grass-sedge zone (90-180cm) - cold arctic tundra, dominated by grass and sedge. Little dwarf birch, alder or spruce. 75-90 cm (1 sample) - dwarf birch maximum; low alder and spruce. 0-75cm - high birch; erratic inclusions of alder and spruce. Alder and spruce do not grow on the island at present - result of long-distance transport.
Cooper 1923	47. Glacier Bay Muir Inlet, Alaska			*Picea sitchensis* and *Tsuga heterophylla* or *T. mertensiana* stumps. Dense and large trees (up to 4 ft diam.). Also identified mosses from

				the old forest floor - *Bryum*, *Calliergon giganteum*, *Mnium punctatum*, *Brachythecium rivulare*, *Philonotis americana*, *Rhytidiadelphus loreus*, *R. squarrosus*, *Drepanocladus* sp. Also *Lycopodium annotinum*. Similar to present day forest of SE Alaska.
Cooper 1942	Alaska			Review of palynological studies from U.S. and Alaska. Postglacial climatic sequence is as follows: glacial through boreal to a warm and probably dry middle period, followed by cooler and probably moister conditions of the present.
Craig 1959	121. Thelon Valley, Northwest Territories 64°19'N, 102°41'W		Organic material from *ca.* 45 ft 5500 ± 250 L 428	Organic material is fossil *Ceratophyllum demersum*.
Cwynar 1978	225. Greenleaf L., Ontario 2 cores	100 cm	Spans past 1200 years.	Zone 7 (25-100cm) - dominated by *Pinus*; mostly *P. strobus*, some *P. banksiana* - *P. resinosa* type. Some *Betula*, *Tsuga* and Cupressineae. Low NAP. Zone 8 (0-25cm)- *Ambrosia* zone. Increased NAP. *Rumex* and *Plantago* appear. Concludes that composition of the forest has not altered during the past 1200 years.
Davis 1963				Discussion of vegetational percentages and percentages of pollen in sediments. Where species differ in the amount of pollen contributed to sediments, a correction factor should be used.
Davis 1967	Canada, Alaska			Comparison of late-glacial pollen sequences in New England with contemporary spectra from Canada.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Davis 1967 continued				Also some reference made to published fossil pollen diagrams from Alaska, Keewatin and Labrador.
DeVries and Bird 1965	185. Missouri Coteau, Saskatchewan	5.1 m	See Ritchie and DeVries 1964.	510-450cm - bryophyte and plant macrofossils consistent with modern, youthful *Picea* forest. 450-290cm - 3 habitats suggested by macrofossils: terrestrial, marsh and calcareous aquatic. Suggests present-day *Populus* - *Picea* forest. 290-280cm - no bryophytes found. Other macrofossils suggest climatic deterioration.
Dreimanis, Terasmae and Mackenzie 1966	242. Port Talbot, Ontario, Test Hole I	22 m	10 m 33400 ± 500 GrN-4238	Dominated by *Pinus*, *Picea;* some *Betula*, *Salix*, *Alnus*, *Quercus*. Post-Sangamon age.
	242. Port Talbot Test Hole II	35 cm	Dates from between 8-22 cm 46700 ± 140 GrN 2570 47600 ± 400 GrN 2601	Similar to Port Talbot I, but. *Quercus* not abundant.
	242. Port Talbot Test Holes II and III	18 m		Composite pollen diagram. Pollen rare in glaciolacustrine units.
Faegri and Iversen 1975				Text on Quaternary palynology including techniques, principles of pollen analysis, pollen diagrams and their interpretation, fossil vegetation maps, etc.

Falconer 1966	145. Tiger Ice Cap, Northwest Territories 71°20'N, 78°45'W		Dead moss uncovered between 1961 and 1963 330 ± 75 I 1204	Well preserved tundra polygons revealed by recession of ice body. Dead *Polytrichum juniperinum*, *Rhizocarpon geographicum*, *Alectoria pubescens* and *A. miniscula* exposed.
Finlayson Byrne and McAndrews 1973	238. Crawford L., Ontario	Fill from pits and a midden.		*Rubus* spp. seeds, *Sambucus* spp. seeds, *Juglans* spp. fragments - all carbonized. Probably used as food. Site probably occupied between 1350 and 1400 A.D.
Fredskild 1967	365. 3 profiles from bog at Sermermiut, Greenland 69°12'N, 51°08'W	Profile B "Height m s.m." 4.00 m 3.9-3.95 3.84-3.9 3.65-3.75 3.48-3.61 3.4-3.48 3.36-3.4 3.28-3.36 3.2-3.25 3.1-3.2	 410 ± 100 A.D. Stage 11 10 ± 100 A.D. Stage 10 40 ± 100 A.D.} Stage 9 380 ± 110 B.C. 400 ± 110 B.C. Stage 8 620 ± 110 B.C. Stage 7 880 ± 120 B.C. Stage 6 790 ± 100 B.C. Stages 4&5 1410 ± 120 B.C. Stage 3 1560 ± 120 B.C. Stage 2 (Ed. note: samples dated at the Carbon 14 Dating Laboratory, Danish National Museum).	Stage 1 - emerged beach covered by beach vegetation gradually changes to grass heath. Stage 2 - grass vegetation. Stage 3 - dwarf-shrub heath, first dominated by *Ledum palustre* then by *Betula nana*. Stage 4 - willow scrub. Stage 5 - *Sphagnum* bog with Cyperaceae. Stage 6 - *Empetrum* heath. Stage 7 - similar to Stage 5 (moist community). Stage 8 - grass and dwarf-shrub heath. Stage 9 - moist heath dominated first by *Empetrum*, then by sedges. Stage 10 - heath dominated by grasses with some *Salix*.
Fredskild 1969	366. Klaresö, Greenland 82°10'N, 30°34'W	3.33 to *ca.* 4.8m analyzed.	9 C^{14} dates ranging from 2500 to 7000 years are shown in a figure. Precise dates and laboratory numbers not given.	Herb zone (4.3-4.8m) - dominated by Cyperaceae and Gramineae with some *Oxyria* and *Potentilla*. Later *Saxifraga oppositifolia*, Cruciferae, *Ranunculus* increase. At beginning of this zone, up to 50% of pollen originates from plants not growing in Greenland today. 4.3-3.6m - increase in *Salix arctica*. *Saxifraga*, *Ranunculus*, *Botryococcus* and *Pediastrum* decrease. Cyperaceae, Gramineae constant. 3.6-3.33m - decrease in *Salix*. Increase in Gramineae, *Minuartia rubella*, *Oxyria*, *Botryococcus* and *Pediastrum*.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Fredskild 1972	364. Ujaragssuit, Greenland 65°50'N, 50°08'W	Diagram illegible.		Zone 1 (basal) - *Alnus* zone; some *Salix*; little *Betula nana*. Lowering of summer temperature. Zone 2 - increase in *Betula*. Zone 3 - increase in herbs; decrease in shrubs. Norse settlement. Also diagrams from Isoëtes Sø, Comarum Sø, Comarum Mose, Lake 100m, Lake 8m, Itivnera, Sermermiut and Klaresø. See Fredskild 1969, 1973.
Fredskild 1973	359. Isoëtes Sø, Greenland 59°53'N, 44°21'W	140 cm	137-139cm 9440 ± 140 K 1803 123-125 8700 ± 110 K 1953 99-101 6950 ± 130 K 1804 41-44 3730 ± 100 K 1805 23-26 3140 ± 100 K 1806	Zone A (basal) - small, arctic herbs. Rôche moutonée landscape. Zone B - ericaceous dwarf-shrub heath. Zone C - Cyperaceae, *Sedum*, *Dryopteris*, *Empetrum*, *Lycopodium* dominate. *Angelica* occurs - indicates climatic amelioration. Zone D - *Salix* - *Juniperus* - Gramineae zone; decrease in plants of Zones A and B. Zone E - *Empetrum* - *Salix* zone. Zone F - *Betula glandulosa* - *Empetrum* zone. Zone G - *Empetrum* increases, *Betula* decreases.
	359. Spongila Sø, Greenland 59°58'N, 44°21W	196 cm	191-196cm 9210 ± 140 K 1872 146-151 8720 ± 140 K 1873 116-121 7670 ± 130 K 1874 73-78 3500 ± 100 K 1875 33-38 2110 ± 100 K 1876	
	359. Kløftsø, Greenland 60°03'N, 44°14'W	170 cm	35-38cm 3210 ± 100 K 1899 62-65 3980 ± 100 K 1898 95-98 4870 ± 110 K 1897 128-131 6590 ± 120 K 1896 158-160 8620 ± 140 K 1808	
	359. Drepanocladus Dam, Greenland 60°20'N, 44°16'W	155 cm	150-155cm 2990 ± 100 K 1807 115-120 2240 ± 100 K 1933	
	360. Comarum Sø, Greenland 61°08'N, 45°32'W	345 cm	126-128cm 2590 ± 100 K 1748 204-206 4150 ± 100 K 1747 284-286 6890 ± 120 K 1746 318-320 7940 ± 130 K 1745 338-342 8530 ± 140 K 1744	Zone A - Cyperaceae-Gramineae-*Plantago maritima* zone. Zone B - *Salix*-Gramineae zone. Zone C - *Juniperus*-Gramineae zone. Zone D - *Juniperus*-Gramineae-*Betula glandulosa* zone.

				Zone E - *Betula pubescens-Salix*-Cyperaceae zone. Zone F - *Betula-Salix-Gymnocarpium* zone. Zone G - *Rumex-Sphagnum* zone.
360. Comarum Mose, Greenland 61°08'N, 45°32'W	445 cm	170-175cm	2510 ± 100 K 803	Zone A - *Salix*-Gramineae-Cyperaceae zone. Zone B - *Juniperus*-Gramineae zone. Zone C - *Juniperus*-Gramineae-*Betula glandulosa* zone. Zone D - Cyperaceae-*Betula-Menyanthes* zone. Zone E - Cyperaceae-*Comarum* zone. Zone F - *Rumex acetosella/acetosa* zone.
		435-445	7200 ± 140 K 804	
360. Galium Kaer, Greenland 61°10'N, 45°31'W	200 cm	18-19cm	560 ± 100 K 1648	Zone A - Cyperaceae-Gramineae-*Salix* zone. Zone B - Gramineae-*Dryopteris*-*Juniperus* zone. Zone C - *Juniperus*-Gramineae zone. Zone D - *Juniperus*-*Betula* zone. Zone E - *Betula-Salix*-*Gymnocarpium* zone. Zone F - *Rumex*-Gramineae-herb zone. Zone G - *Juniperus-Salix*-herb zone.
		32-33	1160 ± 100 K 1647	
		68-69	2420 ± 100 K 1646	
		101-102	4390 ± 110 K 1645	
		119-120	5350 ± 120 K 1644	
		160-161	6080 ± 120 K 1643	
		186-187	6800 ± 110 K 1642	
		196-197	7000 ± 130 K 1641	
364. Godthabsfjord area. "Lake 100m", Greenland 64°24'N, 50°12'W	370 cm			Zone C (basal) - *Juniperus-Betula-Lycopodium dubium*. Zone D - *Alnus-Betula*. Zone E_1 - *Betula-Alnus*. Zone E_2 - *Betula*-Ericales-*Lycopodium dubium*. Zone E_3 - *Betula-Rumex acetosella*.
"Lake 8 m" 64°26'N, 50°12'W	290 cm			
364. Itivnera, Greenland 64°23'N, 50°15W	50 cm	41-44cm	3200 ± 120 K 1192	Not zoned. Starts with *Salix glauca*-*Lycopodium dubium* heath. Then grass-*Empetrum* heath. Then after settlement period over - *Empetrum-Betula nanna*. Then ericaceous dwarf-shrub heath; decrease in *Betula nana*. Then more humid conditions - changed from dwarf-shrub heath to moist, bog-like heath. Quite recently, *Salix glauca*, Gramineae dominant - less moist.
		39-41	3140 ± 120 K 1193	
		20.5-22.5	2290 ± 100 K 1194	
		11-13	630 ± 100 K 1195	
366. Klaresø, Greenland 82°10'N, 30°34'W	135 cm	3-6cm	2610 ± 120 K 885	Zone A - Gramineae-Cyperaceae-*Oxyria* zone. Zone B - *Saxifraga oppositifolia*-Gramineae zone. Zone C - *Salix-Saxifraga oppositifolia* zone.
		15-21	4090 ± 140 K 1425	
		27-33	5180 ± 140 K 884	
		39-45	5970 ± 120 K 1424	

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS		ZONATION AND COMMENTS
Fredskild 1973 continued			51-54cm 63-66 75-81 90-93 99-102	5870 ± 140 K 883 6060 ± 130 K 1422 6040 ± 140 K 882 6780 ± 120 K 1423 6850 ± 140 K 868	Zone D - *Salix* zone. Zone E - Gramineae-*Salix* zone.
	366. Sølejren, Greenland 82°13'N, 32°40'W	25-30cm (peat monoliths)	23.5-28cm 18-20 10-12	1520 ± 100 K 1524 760 ± 100 K 1523 770 ± 100 K 1525	Zone A - *Eutrema*-Cyperaceae-*Salix* zone. Zone B - Cyperaceae zone. Zone C - Gramineae-Cyperaceae zone. Zone D - *Salix*-Cyperaceae zone.
Frenzel 1966					Discussion of climatic change over Northern Hemisphere from 3400 BP to present. Uses some evidence from Alaska.
Grayson 1975	North America				1398 references on North American Holocene and immediately pre-Holocene climate. Indexed according to 7 broad geographical regions.
Hadden 1975	352. Shaws Bog, Nova Scotia	6.7m	300-305cm 500-505 600-605 670-675	4415 ± 130 I 7077 6290 ± 140 I 7078 8505 ± 160 I 7079 9180 ± 255 I 7080	Zone A (9180-8505BP) - *Picea* maximum; high *Pinus*, *Betula*, *Salix*, *Myrica*, Cyperaceae. Cool, wet. Zone B (8505-6290 BP) - decrease in *Picea*, NAP. Increase in *Pinus*, *Quercus*. Higher temperature, lower precipitation. Zone C (6290 BP-present). Subzone C1 - increase in *Tsuga* and deciduous trees. Decrease in *Quercus*, *Picea*. Increased temperature, precipitation. Subzone C2 - decrease in *Tsuga*, *Pinus*, NAP. *Betula* dominates. Maximum warmth and dryness. Subzone C3 - increase in *Tsuga*, *Fagus*, *Alnus*, *Abies*,

				Ericaceae. Decrease in *Pinus*, *Tsuga*, *Fagus* in upper levels. Increasing precipitation followed by decreasing temperature.
Hansell, Chant and Weintraub 1971	120. Dubawnt L., Northwest Territories			Spruce has moved closer to Dubawnt Lake since 1893. Treeline may be a response to lake modified climate. History of treeline in Dubawnt area: 7500-7900 to 5500 BP - south arm of Keewatin Glacier left area. 4000 BP - closed forest halfway up east shore leaving fossil podzols. Southward retraction of treeline. Re-extension at 1100 BP (little climatic optimum). Southern retraction. 1870 AD - minor northward extension. 1960 AD - less favourable growth conditions may have begun.
Hansen 1940	85. Bog at New Westminster, British Columbia	4.25 m	2.75-2.25m volcanic ash	First forest to invade area was predominantly lodgepole pine. Cool and damp climate. Then Sitka spruce - pine forest with predominance of spruce; increased moisture and temperature. Then dominated by Douglas fir and hemlock to the present; decreasing moisture and temperature.
	85. Bog on Lulu I., British Columbia	5.0 m	No volcanic ash layer.	
Hansen 1949A	161. Tawatinaw, Alberta; 50 mi North of Edmonton	3.0 m		*Pinus*, *Picea*, *Abies*, *Populus* and Grass-Composites-Chenopods recorded. Forests in the area when earliest sediments deposited consisted of pine, spruce and fir. Pine and spruce fluctuations are converse. *Abies* diminishes upward in all sections. *Populus* is underrepresented. Grass is most abundant in Lacombe section. Jack pine is more abundant in lower half of sections, while lodgepole pine increases upwards. Grass-chenopod-composite pollen increases in
	162. Bog, Alberta 9 mi E of Edmonton	2.3 m		
	162. Bog near Cooking L., Alberta	7.0 m		
	162. Bog 15 mi E of Edmonton, Alberta	2.0 m		

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Hansen 1949A continued	162. Bog 21 mi E of Edmonton, Alberta	2.1 m		middle of most sections indicating a warm, dry maximum during the postglacial. It is followed by increasing spruce in upper levels indicating a cooler, moister climate.
	170. Bog near Kavanaugh, Alberta	1.4 m		
	171. Near Lacombe, Alberta	3.0 m		
Hansen 1949B	163. 4 mi N of Duffield, Alberta	2.2 m		Lodgepole pine, white and black spruce are principal species in the region throughout time of all 4 profiles. In Entwhistle section, pine reaches maximum at 3m (time of volcanic glass) indicating a climatic maximum. Decrease of pine above 3m may reflect increasing moisture. In Edson and Entwhistle sections, fir is best represented at the bottom indicating cooler climate. These profiles may record pre-Late-Wisconsin forests that had migrated southward from Beringia before the Wisconsin glaciations and persisted in ice-free areas close to the ice front.
	164. 4 mi E of Entwhistle, Alberta	6.4 m	0.6 m volcanic glass. 2.8-3.3 volcanic glass.	
	165. near McKay, Alberta	.6 m		
	166. 5 mi W of Edson, Alberta	6.2 m	.1 m volcanic glass. 4.2-4.6 volcanic glass.	
Hansen 1950A	Along Alaska Highway, British Columbia, between 96. and 104.	17 peat sections .5 to 6.6m long.	9 sections have volcanic glass in upper levels.	Diagrams show only *Pinus*, *Picea* and *Abies*. The curves of *Pinus* and *Picea* are nearly perfectly converse to each other because the 2 form nearly 100% of counts. General expansion of spruce to lower or middle third of profiles, then decrease to top. Pine expanded as spruce decreased (warmer and drier climate).

Hansen 1950B	81. Black Ck., British Columbia	7 m	2.8-3.0m	volcanic glass.	Not zoned. General discussion of changes in tree species over time of sections.
	83. Qualicum Beach, British Columbia	6 m	2.2-2.4m	volcanic glass.	
	84. Langford L., British Columbia	8 m	3.2m	volcanic glass.	
Hansen 1952	5 sections between 156. and 158.; 5 between 154. and 157., Alberta	10 peat sections 1 to 2m long			Diagrams show only *Pinus*, *Picea* and *Abies*. Lodgepole pine and alpine fir survived in ice-free areas in W Alberta and NE British Columbia and migrated eastward as Keewatin ice retreated. Jack Pine and balsam fir moved into the area from the south and east.
Hansen 1953	75 peat sections collected between 23. and 104. along Alaska Highway; between 103. and the Alaska Highway along the Haines Highway; and between 35. and the Alaska Highway along the Glenn Highway, Yukon Territory and Alaska.	40 pollen diagrams given.	23 diagrams have at least one volcanic ash layer indicated. 3 C^{14} dates cited from other papers from different sections.		Pine generally increases from bottom to top of sections. Grass declines in upper part of most profiles. In deeper sections, tree pollen is absent or much reduced at the bottom of profiles. Little evidence for climatic trends in the profiles except perhaps a general amelioration.
Hansen 1955	25 peat sections between 89. and 92. along Cariboo Highway; between 92., 95. and 96. along Hart Highway; and between 92. and 93. along highway between Burns L. and Prince George, British Columbia.	Range from 1 to 7.5m	13 of the diagrams have a volcanic ash layer indicated.		Diagrams show *Pinus contorta*, *P. monticola*, *P. ponderosa*, *Picea*, *Pseudotsuga menziesii*, *Abies* and Grass-Chenopods-Composites. In most sections lodgepole pine decreases upward to about the middle third of the sections, then increases to the top. Ponderosa pine recorded in southernmost 9 sections (to Prince George) - therefore it was more abundant during postglacial xerothermic

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Hansen 1955 continued				interval. Inverse fluctuations of spruce and pine probably reflect fire influence.
Hare 1950	Eastern Canada			Study of boreal forest in Eastern Canada. Zonation, vegetation and climatic relations discussed.
Hare 1976				3 major problems in study of Holocene climates: 1) high energy requirements of glacial retreat; 2) retreat of Wisconsin ice in relation to the long-wave structure of westerlies; 3) tundra and boreal forest during maximum glaciation were not in same radiative regime as at present.
Hare and Ritchie 1971	Canada, Alaska			Study of boreal zone in Canada and Alaska. Discussion of zonation, energy climate, annual production, moisture regime, vegetation.
Harington, Tipper and Mott 1974	94. Babine L., British Columbia 55°00'N, 126°14'W	Silty fossiliferous layer from few in. to 20 in. thick.	*Picea* 42900 ± 1860 GSC 1657 *Abies* 43800 ± 1830 GSC 1687 mammoth bone 34000 ± 690 GSC 1754	Birch dominates (probably dwarf birch). Grasses, *Artemisia* and *Salix* abundant. Very little arboreal pollen. Probably a pond environment - sedge, *Sphagnum* pollen and macroscopic *Drepanocladus exannulatus*.
Harrison 1976	91. Elk Valley, British Columbia		Two samples from the same thin organic layer 1 m below Mazama tephra: 11900 ± 100 GSC 2142 12200 ± 160 GSC 2275	

Hegg 1963	86. Expedition Fiord, Axel Heiberg I., Northwest Territories 79°25'N, 90°03'W	4 overlapping peat profiles 220cm 210-270 255-275 270-300.	80 cm 130 260	1070 ± 120 900 ± 120 2210 ± 100	2500 B.C. - large shallow basin - swamp vegetation. Climate fairly mild. Slopes with *Salix arctica* and *Saxifraga oppositifolia*. Later basin separated from river; climate still fairly favourable. 1000 B.C. - basin flooded. Later groundwater lowered; swamp edges dried. *Pinus* and *Alnus* grains found - long-distance transport.	
Heusser 1952	53. Lemon Ck., Alaska	4.8 m	1.1 m	volcanic glass.	Periods II-V	For description of Periods, see below.
	53. Mendenhall R., Alaska	2.9 m			Periods III-V	
	53. Auke Bay, Alaska	2.6 m	1.3 m	volcanic glass.	Periods III-V	
	53. Lena Beach, Alaska	5.0 m			Periods II-V	
	53. Eagle Harbour, Alaska	5.0 m	1.1 m	volcanic glass.	Periods II-V	
	53. Herbert R. Tributary, Alaska	.4 m		No ash found	Period V	
	53. Upper Montana Ck., Alaska	3.8 m	.2 m	volcanic glass.	Periods I-V	
	53. Lower Montana Ck., Alaska	5.9 m	1.3 m	volcanic glass.	Periods II-V	
	56. Halibut Point Rd., Alaska	5.0 m	.9 m	volcanic glass.	Periods II-V	
	56. Silver Bay Rd., Alaska	3.7 m	3.6 m	volcanic glass.	Periods III-V	
	59. Mitkof Highway, Alaska	3.0 m			Periods II-V	
	59. Petersburg, Alaska	2.8 m			Periods I-V	

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Heusser 1952 continued	62. Ski Trail, Alaska	1.2 m		Periods IV, V
	62. North Wrangell, Alaska	3.9 m		Periods II-V
	64. Upper Ward Ck., Alaska	3.8 m	.6 m volcanic glass.	Periods I-V
	64. Point Higgins, Alaska	4.3 m	.7 m volcanic glass.	Periods I-V
				Period I (8000-6000 BP) - cool moist climate. Period II (6000-5000 BP) - amelioration of climate. Period III (5000-2000 BP) - warm and dry. Period IV (2000-1750 BP) - cooler and wetter; glaciers in region advanced. Period V (1750-present) - warming and/or drying - recession of ice of Period IV. Period I - lodgepole pine dominated. Period II - lodgepole pine replaced by Sitka spruce, then by western hemlock-spruce, climax. Period III - western hemlock and spruce composed the forest with hemlock increasing. Period IV - predominance of hemlock. Increase in spruce and pine during late Period IV. Period V - modern-day vegetation.
Heusser 1954A	46. Chilkat Peninsula, Alaska	.7 m		Zone IV (.7-.2m) - pine predominates; spruce high at base, then decreases. Zone V (.2m-top) - pine decreases; spruce, *Tsuga* increase.
	48. Excursion Inlet, Alaska	3.1 m		Zone I (3.1-3.0m) - lodgepole pine predominates. Zone II (2.6-3.0m) - Sitka spruce predominates. Zone III

	(Diagram also given for Icy Point, Alaska see Heusser, 1960)			(2.3-2.6m) - *Tsuga heterophylla* reaches maximum. Zone IV (.2-2.3m) - increase in lodgepole pine; decrease in spruce and *Tsuga heterophylla*. Zone V (0-.2m) - spruce, *Tsuga heterophylla* increase; pine decreases.
Heusser 1954B	53. Taku Glacier, Alaska	Pollen diagrams from 6 pits in glacier. Range from 1 to 7 m.		Deepest pit covers pollen rain from 1950-52. Levels of seasonal snow (i.e. autumn, winter, spring and summer) elucidated on basis of pollen variation. Atmospheric pollen rain also sampled over the flowering period.
Heusser 1955A	33. Seward, Alaska 40. Cordova, Alaska	See Heusser 1960.	Two main ash layers. Upper is in Period III, lower in Period II. Correlated between the 2 sections. Layer in Period III is from Aleutian Is. (possibly Mt. Katmai). Layer in Period II is from Wrangell Mountains to the northeast.	Periods I, II and III in both sections. Period I - cold and moist. Possibly drier at Cordova (more *Tsuga mertensiana*, NAP). Period II - warmer and drier climate. Increase in *Picea sitchensis*; decrease in *Tsuga mertensiana* and NAP. Period III - cooler and wetter (but warmer and wetter than Period I) - *Picea sitchensis*, *Tsuga heterophylla*, *T. mertensiana* co-dominant. Decrease in NAP. Plants survived glaciation in nunataks in Prince William Sound area.
Heusser 1955B	67. Langara I., British Columbia	6.6 m		Period I (5.2m to base) - pine predominated; spruce became more important toward top of Period I. Cool, moist climate. Period II (4.1-5.2m) - increase in spruce, alder, *Tsuga mertensiana*. Warmer, drier climate. Period III (2.7-4.1m) - increase in *Tsuga heterophylla*, spruce co-dominant. Maximum warmth and dryness. Period IV (0-2.7m) - increase in lodgepole pine, *Sphagnum*. Cooler, wetter climate.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Heusser 1955B continued	68. Masset Bog, British Columbia	2.5 m		Period IV
	69. Tlell-Port Clemens, British Columbia	2.4 m		Period IV
	70. Queen Charlotte City, British Columbia	6.0 m		Periods II, III, IV
	71. Sandspit, British Columbia	2.3 m		Period IV
Heusser 1956	167. Jasper, Alberta	4.0 m	3.0 m volcanic ash.	First forest - lodgepole pine with some spruce and fir (slightly colder environment). Decrease of fir from 2-3m (slightly warmer). Increase of Douglas fir at same time (warmer and drier). Succeeded by pine-spruce-fir forest (cooler).
	168. Moose L., Alberta	1.6 m	No ash.	Late postglacial section. Increase in pine, decrease in spruce to top.
	169. Sunwapta Falls, Alberta	1.5 m	.6 m volcanic ash.	Gradual succession of lodgepole pine to spruce interrupted at *ca.* .2m .
	176. Moraine L. Rd., Alberta	1.9 m	Volcanic ash at base.	Originated about the time of xerothermic maximum.
Heusser 1958	Alaska			Abstract: Alexander Archipelago sections begin at 10800 ± 600 (park tundra - alder, willow, lodgepole pine). Late glacial-postglacial boundary 10300 ± 400 (cool, moist climate - pine, alder, fern). Hypsithermal from 7800 ± 300 to 3500 ± 250 - succession from Sitka spruce, alder, fern to hemlock-spruce-*Lysichitum*. Followed by cooler, moister climate - muskeg

				growth. Icy Cape section dated at 10820 ± 420; Prince William Sound section at 9440 ± 530; Katalla section at 9510 ± 475; Kenai Peninsula section at 9000 BP; Kodiak section at 9000 BP.
Heusser 1960	3. Karluk, Alaska 57°34'N, 154°28'W	1.1 m	All samples are basal. 3470 ± 180 I(AGS)-1	Heath, fern, *Sphagnum* increase upward, while alder and grass decrease. LP - late-postglacial.
	28. Cape Chiniak, Alaska 57°35'N, 152°11'W	1 m	Ash layers present near surface from Mt. Katmai.	LP
	28. Cape Greville, Alaska (2 sites) 57°35'N, 152°11'W	1.5 m 2.5 m	Ash layers present near surface from 1912 Mt. Katmai eruption.	HTL - Hypsithermal, and LP
	29. Kodiak 1, Alaska 57°46'N, 152°30'W	2.5 m	Ash layers present near surface from 1912 Mt. Katmai eruption in all 3 sections.	(EP) - Early postglacial, HTL and LP. Cool, moist, early postglacial environment dominated by fern, sedge and Umbelliferae.
	29. Kodiak 2, Alaska 57°49'N, 152°22'W	2 m		
	29. Kodiak 3, Alaska 57°49'N, 152°21'W	2.25 m	8870 ± 300 I(AGS)-2	
	30. Afognak, Alaska 58°01'N, 152°21W	2.5 m	9350 ± 320 I(AGS)-3 3 ash layers present.	(EP), HTL and LP. Similar to Kodiak, but more sedge suggests cooler and drier.
	31. Windy Bay, Alaska 59°14'N, 151°34'W	2 m	2 ash layers present.	(HTL) and LP
	31. Port Chatham, Alaska 59°13'N, 151°41'W	1.5 m	2 ash layers present.	LP
	32. Homer 1, Alaska 59°40'N, 151°39'W	5.5 m	Several ash layers present in all 3 sections. Not dated or precisely indicated on log.	(LG-3) - Late-Glacial 3, EP, HTL and LP.
	32. Homer 2, Alaska 59°39'N, 151°28'W	3 m		HTL and LP

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Heusser 1960 continued	32. Homer 3, Alaska 59°41'N, 151°28'W	3.8 m		HTL and LP
	33. Seward, Alaska 60°17'N, 149°20'W	3.6 m	2 ash layers present.	(LG-3), EP, HTL, LP
	34. Moose Pass, Alaska 60°31'N, 149°26'W	1.5 m		LP
	34. Saxton, Alaska 60°41'N, 149°08'W	2 m		(HTL) and LP
	36. Girdwood, Alaska 60°58'N, 149°08'W	1.5 m		LP
	37. Perry I., Alaska 60°14'N, 147°54'W	4 m	9440 ± 350 I(AGS)-4	(LG-3), EP, HTL, LP. Relatively cool, dry conditions as shown by low willow and birch; high alder.
	38. Montague I., Alaska 60°14N, 147°15'W	1.1 m		LP
	39. Hinchinbrook I., Alaska 60°22'N, 146°35'W	1.2 m		LP
	40. Cordova, Alaska 60°34'N, 145°40'W	3.0 m		HTL and LP
	40. Alaganik 1, Alaska 60°27'N, 145°17'W	2 m	10390 ± 350 I(AGS)-5	(LG-3), EP, HTL, LP. Relatively dry cold climate.
	40. Alaganik 2, Alaska 60°27'N, 145°15'W	2 m		LP

41. Upper Katalla, Alaska 60°12'N, 144°32'W	2.4 m	7650 ± 330 I(AGS)-6 Ash layers present.	(EP), HTL, LP.
41. Lower Katalla, Alaska 60°12'N, 144°32'W	2 m	3770 ± 200 I(AGS)-7 Ash layers present.	LP
41. Martin L., Alaska 60°21'N, 144°34'W	1.3 m	6810 ± 375 I(AGS)-8 Ash layers present.	(HTL) and LP. Alder predominates.
41. Bering L., Alaska 60°19'N, 144°20'W	3.3 m	9510 ± 475 I(AGS)-9 Ash layers present.	(LG-3), EP, HTL, LP.
42. Munday Ck., Alaska 60°01'N, 141°57'W	7.1 m	10820 ± 420 I(AGS)-10	(LG-3), EP, HTL, LP. Predominantly sedge, some heath, willow and Umbelliferae.
43. Grand Plateau Glacier, Alaska 58°57'N, 138°00'W	2 m	1210 ± 200 I(AGS)-11	LP
44. Upper Northwest Lituya Bay, Alaska 58°43'N, 137°45'W	3.1 m	8140 ± 390 I(AGS)-12	HTL, LP. Fern spores predominate.
44. Lower Northwest Lituya Bay, Alaska 58°43'N, 137°45'W	2.2 m	6890 ± 350 I(AGS)-13	(HTL), LP
44. Southeast Lituya Bay, Alaska 58°36'N, 137°34'W	1 m	2790 ± 250 I(AGS)-14	LP
45. Icy Point, Alaska 58°26'N, 137°10'W	1.5 m		LP
49. Gull Cove, Alaska 58°12'N, 136°09'W	2.5 m		HTL, LP

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS ASH LAYERS	ZONATION AND COMMENTS
Heusser 1960 continued	50. Mite Cove, Alaska 58°04'N, 136°27'W	1.5 m		LP
	51. Suloia L., Alaska 57°26'N, 135°42'W	1.6 m		LP
	52. Whitestone Harbor, Alaska 58°04'N, 135°05'W	3.6 m		(EP), HTL, LP
	53. Upper Montana Ck., Alaska 58°27'N, 134°40'W	3.8 m	10300 ± 400 L 297D	(LG-3), HTL, LP.
	53. Lower Montana Ck., Alaska 58°25'N, 134°37'W	5.9 m	7800 ± 300 L 297G	HTL, LP.
	53. Lemon Ck., Alaska 58°22'N, 134°32'W	4.8 m	Basal 6100 ± 300 L 297B wood at 3500 ± 250 L 106B 3.4 m	HTL, LP.
	54. Hasselborg L., Alaska 57°39'N, 134°15'W	7.2 m		(LG-3), EP, HTL, LP
	55. Port Krestof, Alaska 57°09'N, 135°35'W	1.4 m		LP
	57. Hamilton Bay, Alaska 56°54'N, 133°46'W	2.6 m		(HTL), LP.
	58. Hobart Bay, Alaska 57°26'N, 133°23'W	7.3 m		HTL, LP.

60. Threemile Arm, Alaska 56°36'N, 133°54'W	3.7 m	(EP), HTL, LP.
61. Salmon Bay, Alaska 56°18'N, 133°09'W	3 m	(EP), HTL, LP.
61. Sarker L., Alaska 55°57'N, 133°13'W	3.5 m	HTL, LP.
63. Hollis, Alaska 55°30'N, 132°43'W	6.1 m	HTL, LP.
65. Southeast Gokachin Lakes, Alaska 55°23'N, 131°06'W	4.4 m	HTL, LP.
66. Kendrick Bay, Alaska 54°51'N, 132°07'W	4 m	HTL, LP.
68. Masset, British Columbia 54°00'N, 132°07'W	8 m	(EP), HTL, LP.
72. Summit, British Columbia 54°15'N, 130°02'W	2.8 m	HTL, LP.
72. Rainbow L., British Columbia 54°14'N, 130°05'W	4 m	(LG-3), EP, HTL, LP.
72. Prince Rupert, British Columbia 54°19'N, 130°18'W	5.6 m	HTL, LP.
73. Pitt I., British Columbia 53°27'N, 129°29'W	1 m	LP

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Heusser 1960 continued	74. Susan I., British Columbia 52°29'N, 128°17'W	1.8 m		LP
	75. Fitzhugh Sound, British Columbia 51°42'N, 127°52'W	1.6 m		LP
	76. Cape Caution, British Columbia 51°13'N, 127°35'W	1.5 m		LP
	77. Upper Hope I., British Columbia 50°56'N, 127°55'W	3.5 m		(LG-3), EP, HTL, LP.
	77. Lower Hope I., British Columbia 50°56'N, 127°55'W	1.5 m		LP
	78. Port Hardy, British Columbia 50°44'N, 127°25'W	2 m		HTL, LP.
	79. Harbledown I., British Columbia 50°35'N, 126°34'W	3.9 m		(EP), HTL, LP.
	80. Menzies Bay, British Columbia 50°10'N, 125°37'W	4.7 m		EP, HTL, LP.
	81. Malahat, British Columbia 48°34'N, 123°35'W	7 m	2 ash layers present	(EP), HTL, LP.
	82. Little Qualicum Falls, British Columbia 49°19'N, 124°33'W	1.6 m		(HTL), LP.

Heusser 1963A	16. Ogotoruk Ck., Alaska Section 1	5-140 cm		Description of zones below. Zones I, IIa, IIb, IIc.
	Section 2	10-80 cm		Zones I, IIa, IIb.
	Section 2A	75-150 cm		Zones I, IIa.
				Zone I (basal) - high Cyperaceae, Gramineae, *Salix*. Similar to modern *Eriophorum-Carex* solifluction slope vegetation. Zone IIa - increase in *Betula*; decrease in Cyperaceae, Gramineae, *Salix*. Zone IIb - decrease in *Betula*; increase in Cyperaceae, Gramineae, *Salix*. Zone IIc - increase in *Betula* and *Empetrum*-Ericaceae. Zone II - climatic amelioration.
Heusser 1963B	4. Brooks R., Alaska Core BRH	2.8 m	1.5 m 4800 ± 175 I 528 2.5 m 5570 ± 200 I 529 Volcanic ash at 1.6-1.7 m and 2.5-2.8 m.	HTL (basal) - birch minimum; alder maximum. Some ferns, sedges. LP_1 - increase in birch. LP_2 - peak in birch. LP_3 - decrease in birch.
	Core BRB	2.2 m	Ash at 0-.5 m, .9m, 2.3 m	HTL, LP_1, LP_2, LP_3.
	Core BRD	2 m	1.2 m 3860 ± 90 Y-931 Ash at .5, 1.2, 2 m	LP_1, LP_2, LP_3.
	BR5-archaeological section	1.7 m	Dated ash falls: .2m - 450-500 BP; .5 m - 700-900 BP; .8 m - 1700-3000 BP; 1.25 m - 3800 BP.	
	5. Naknek R., Alaska Core SMC 1	1.5 m		LP_{2a} (basal) - high birch; increasing alder. LP_{2b} - high birch; decreasing alder. LP_3 - decreasing birch.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Heusser 1963B continued	Core NK 1	1.5 m	Base 3450 ± 200 I 506	$\underline{LP_2}$ (basal) - high birch. $\underline{LP_3}$ - decreasing birch.
Heusser 1965	Alaska		Several dates given from other papers.	Pleistocene phytogeography of Washington, Oregon and Alaska. Pollen diagrams from Ward Creek, Montana Creek, Munday Creek, Homer and Afognak (from previous work). EP - early appearance of lodgepole pine. LP - late-postglacial profusion of western hemlock. HTL - warmer, drier hypsithermal. Prominences of alder, Sitka spruce, hemlock. There is general uniformity of C^{14} dates for beginning of Alaska pollen diagrams - does not support theory of progressive postglacial migration. Nunataks probable centres of postglacial migration.
Heusser 1966	16. Ogotoruk Ck., Alaska			See Heusser 1963A
Heusser 1967A	Alaska, British Columbia			Correlation of climate, vegetation and pollen zonation between Pacific Northwest (Queen Charlotte Islands and SE Alaska) and Chile. Concludes that there was harmonious climatic fluctuation.
Heusser 1967B	Alaska, Yukon Territory			Lists and briefly discusses previous work in Alaska and the Yukon. Fairly long discussion of postglacial vegetational history of the area.

Hobson and Terasmae 1969	244. St. David's buried gorge, Ontario	106-183 ft	Wood at 150 ft 22800 ± 450 GSC 816	Pre-Pleistocene pollen occurred in most samples. Dominated by *Picea* and *Pinus banksiana*; some *Abies* and *Betula*. Also some *Artemisia*, *Ambrosia*, *Shepherdia canadensis*, Cyperaceae and Chenopods. Forested conditions around site. Climate much colder than at present.
Holloway and Valastro 1977	163. L. Wabamun, Alberta 2 cores combined	16 m	Extends back to 16180 ± 980 BP. Volcanic ash at 13 m - bracketed by C^{14} dates 10300 ± 3720 and 10400 ± 390.	Upper section of record is parkland of *Picea* and *Pinus* with *Corylus* understory. 5280 BP - Hypsithermal Interval. At time of volcanic ash level - dominated by boreal forest (*Picea*, *Betula*, *Abies*, *Pinus*). Lower 3 m - cool, moist climate.
Hopkins, Giterman and Matthews 1976	14. Baldwin Peninsula, Alaska	Sample from lacustrine silt 7.5 m below surface.	Peat 15 cm below bone horizon. 26900 ± 2300-3400 AU 90	Pollen assemblage dominated by dwarf birch, sedges and grasses. Shrub tundra, no spruce or alder in area. Differs from modern or interglacial spectra which represent forest-tundra ecotone and from full-glacial spectra which show xeric steppe-tundra. Suggest a late Wisconsin interstadial equivalent to Plum Point Interstade is represented.
Hughes 1969	99. Porcupine R., Yukon Territory		2 C^{14} dates - see Lichti-Federovich 1974	Stratigraphy of the area.
Hustich 1966	Canada, Alaska			Maps and discussion of northern ranges of many coniferous and deciduous trees in North America, Europe, Russia, and Siberia. Short discussion of refugia in Alaska and Canada; as well as effects of bedrock, permafrost, fire and people on tree ranges.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Hyvärinen and Ritchie 1975	107. Hendrickson I. pingo, Northwest Territories 69°32'N, 133°35'W	180 cm	45-50cm 3160 ± 60 GSC 1905 85-90 3180 ± 60 GSC 1970 125-130 6810 ± 80 GSC 1960 175-180 9350 ± 80 GSC 1896-2 175-180 9010 ± 100 GSC 1896	Zone I (base to 155 cm) - *Betula glandulosa*, *Salix*, *Artemisia*, *Shepherdia canadensis*, grass and sedge. Zone II (155-125 cm) - tree birch, spruce. Zone III (125-55 cm) - alder peak at base; tree birch, spruce, Ericaceae present. Zone IV (55 cm to top) - *Betula glandulosa*.
	112. Eskimo Lakes pingo, Northwest Territories 69°24'30"N, 30°40'W	280 cm	15-20cm 2920 ± 130 GSC 1669 70-75 4530 ± 140 GSC 1724 80-85 6770 ± 140 GSC 1737 100-105 9500 ± 170 GSC 1717 185-190 9690 ± 250 GSC 1671	Zone I (base to 110 cm); Zone II (110-85 cm); Zone III (85 cm to top). Zones the same as previous site.
Iversen 1952-53	364. Lake at Kapisilik, Greenland	3 m		Zones III, IV, $V_{a,b,c}$
	364. Another diagram from a lake 100 m above sea level is given, but without precise location. Greenland	300-650 cm		Zones I-IV Zone descriptions for both sites: Zone I - rich herbaceous and dwarf shrub flora. Some thermophilous herbs (e.g. *Atriplex*) show climate about the same as present. Zone II - *Salix glauca* becomes common; some *Alnus viridis*. Zone III - *Betula nana* appears and dominates; *Juniperus* arrives at same time. Zone IV - alder becomes very abundant. *Myriophyllum alterniflorum* blooms in lakes - warm period. Zone V - alder scrub recedes; *Empetrum-Vaccinium* heath advances. *Myriophyllum alterniflorum* becomes sterile - climatic deterioration.

Ives, Nichols and Short 1976	Québec, Newfoundland			Progress report of work done. No pollen diagrams or C^{14} dates.
Jankovska and Bliss 1977	375. Truelove Lowland, Devon I., Northwest Territories 1 km south of base camp	170 cm	165-170 cm 2450 ± 90 Basal peat Truelove Valley 6900 ± 115 Basal peat Beschel Ck 4300 ± 98	Macrofossils: *Polytrichum*, *Mnium*, *Meesia* cf. *uliginosa*, *Tomenthypnum nitens*, *Bryum*, *Calliergon*, *Drepanocladus*. *Salix arctica* and *Dryas integrifolia* leaves. Decomposed *Nostoc*. Pollen analysis: very low production. 85-105 cm - increase in *Salix;* decrease in Gramineaceae - may coincide with a thermal maximum. Cold, dry climate has prevailed for the last 1000+ years.
Jordan 1975B	319. Sandy Cove Pond; Groswater Bay, Newfoundland 54°24'N, 57°43'W	260 cm	220-250 cm 4555 ± 145 SI 1333 165-185 4495 ± 165 SI 1523 80-120 2225 ± 230 SI 1738 25-50 modern SI 1522	Zone V (258-260 cm); Zone IV (250-258); Zone III (240-250); Zone II (230-240). Zones compressed but similar to those at Alexander Lake (see below). Following forest immigration: Zone Ie (180-230) - spruce peak. Zone Id (160-180) - increased alder and birch (forest retreat). Zone Ic (100-160) - increased spruce (forest re-establishment). Zone Ib (70-100) - increased alder, sedge, *Lycopodium* (less severe reversal). Zone Ia (0-70) increase in spruce. At top - birch increases and spruce decreases as result of logging and fire.
	319. Aliuk Pond, Newfoundland 54°34'N, 57°22'W	90 cm	50-70 cm 7170 ± 180 SI 1531-A 0-20 2255 ± 510 SI 1741	Zone IV (70-90); Zone III (50-70); Zone Ie (30-50); Zone Id (20-30); Zone Ic (0-20). Zones similar to above but no birch-fir zone and spruce probably never dominated the landscape.
	321. Saint John I. Pond, L. Melville, Newfoundland 53°57'N, 58°55'W	220 cm	155-175 cm 10240 ± 1240 SI 1737 (anomalous early date) 105-125 5480 ± 470 SI 1736	Zone V (185-220); Zone IV (175-185); Zone III (160-175); Zone II (110-160); Zone I (1-110). See Alexander Lake zones (below).

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Jordan 1975B continued	322. Northwest R. Pond, Newfoundland 53°31'N, 60°10'W	374 cm	340-355 cm 4805 ± 55 SI 1332	Zone Ic (365-374) - decrease in spruce, increase in alder, sedges. Zone Ib (355-365) - increase in alder; decrease in spruce. Zones Ic and Ib are local vegetation changes associated with uplift. Zone Ia (0-355) - increase in spruce; other curves stabilized. Spruce able to colonize once island became large enough to become drier.
	323. Alexander L., Newfoundland 53°20'N, 60°35'W	260 cm	220-240 cm 5985 ± 140 SI 1331 150-170 5945 ± 120 SI 1521 40-60 4055 ± 120 SI 1520	Zone V (260 cm) - no flowering vegetation present locally. Zone IV (250-260) - peaks in *Salix*, *Artemisia*, Ericaceae, Gramineae, Cyperaceae. Sedge-shrub tundra. Zone III (235-250) - peak in alder; birch increases then decreases; *Lycopodium* increases. Alder thickets with some willow and dwarf birch. Zone II (180-235) peak in *Abies*; increase in birch; decrease in alder and *Lycopodium*. Open or closed birch-fir forest; dwarf birch shrub tundra on exposed sites. Zone I (0-180) - increase in spruce. Closed crown forest or lichen woodland.
Karrow and Anderson 1975	New Brunswick			Discussion of C^{14} dates from southwestern New Brunswick (Mott 1975) and reliability of C^{14} dates from various materials (e.g. peat, marl).

Karrow, Anderson Clarke, Delorme and Sreenivasa 1975	239. Nicolson Cut, Ontario	2-2.5 m analyzed		Zone 2C at base - high *Picea;* low *Pinus.* Zone 2D - decrease in *Picea;* increase in *Pinus*, *Dryopteris.* Zone 3 - decrease in *Picea;* increase in *Pinus.* The sequence represents a warming climatic trend.
	239. Cookstown Bog, Ontario	0-700 cm	150 cm 10200 ± 150 GSC 1111	Zone 2B at base - lower spruce than 2C. High pine, birch, *Quercus*, *Carpinus-Ostrya*, *Artemisia*, *Salix*, Cyperaceae - open spruce forest. Zone 2C - dominated by spruce. Peak in birch (probably *Betula papyrifera*). Zone 2D - transition between spruce and pine maxima. Increasing dryness. Base of 2D 10200 ± 150 B.P. Draining of Lake Algonquin from area. Sedge-swamp environment established. Zone 3 - pine maximum. Zones 4-7 - pine decreases. Increase in *Tsuga*, *Acer.* Hemlock-maple upland forest dominated to the present.
	240. Eighteen Mile R., Ontario Section 1	3.2-4.4 m analyzed	Woody peat layer 3.8-3.9 m 10600 ± 160 GSC 1127	Whole sequence assigned to Zone 2C. High spruce, all other pollen low. Most plants have boreal or tundra distribution today.
	Section 2	no diagram given	Woody peat layer 10500 ± 150 GSC 1126	
	240. Kincardine Bog, Ontario	5 m	4-4.2 m 11200 ± 170 GSC 1374 Plant fibres at 305-320 cm 10600 ± 150 GSC 1366 Molluscs at 305-320 cm 10300 ± 200 GSC 1644 206.5-208.5 cm 7620 ± 70 GSC 1816	Base in Zone 2B - low spruce, high *Juniperus-Thuja*, *Quercus*, *Carpinus-Ostrya*, *Salix*, *Artemisia*, Gramineae, Cyperaceae. Zone 2C - maximum spruce. Other pollen low. Zone 2D - spruce-pine transition. Birch peak. Increase in *Quercus*, *Carpinus-Ostrya*, *Ulmus.* Zone 3 - pine maximum. Zones 4-7 - increase in hemlock, oak, elm, maple, ash.
				Also detailed studies of molluscs, diatoms and plant macrofossils.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Karrow and Terasmae 1970	244. St. David's buried gorge, Ontario	6 samples produced small amounts of pollen.	Lacustrine sediments from the deep boring. 22800 ± 450 GSC 816	Samples showed mostly spruce and pine pollen with small amounts of other trees, NAP and spores. All had significant amounts of pre-Quaternary spores.
Kelly and Funder 1974	361. Neria, Greenland 61°39'N, 49°00'W	270 cm		Zones 1, 2, 3, 4, 5, 6. Zone descriptions below.
	362. Kvanefjord, Greenland 62°08'N, 48°50'W	170 cm	165-170 cm 9620 ± 130	Zones 1-2, 3, 4, 5, 6.
	363. Qaqarssuaq, Greenland 62°06'N, 49°37'W	170 cm	170 cm 9840 ± 170	Zones 1, 2-3, 4, 5, 6.
	363. Nigerdleq, Greenland 62°04'N, 49°20'W	190 cm	190 cm 9580 ± 210 160-170 8950 ± 130 130-140 8860 ± 130 110-115 7790 ± 110 75-85 5730 ± 100 40-45 3530 ± 100	Zones 1, 2, 3a, 3b, 3c, 4, 5, and 6.
				Zone 1 (pre-9600) - pioneer herb vegetation. Zone 2 (9600-8950) - decrease in *Oxyria*, increase in Cyperaceae, Gramineae, *Empetrum*. Zone 3 (8950-7600) - increase in *Salix*. Zone 3 subdivisions based on *Salix* curve. Zone 3c - decrease in pioneer species. Zone 4 (7600-5750) - increase in *Alnus*, *Juniperus*, *Selaginella selaginoides*, *Lycopodium*. Warmer climate. Zone 5 (5750-3200) - increase in *Betula glandulosa*. Period of optimum temperature. Zone 6 (3200-present) - decrease in *Alnus*, *Juniperus*,

				Gramineae and lycopods. Climatic deterioration.
Kemp, Anderson, Thomas and Mudrochova 1974	Ontario			14 cores in lakes Huron, Erie and Ontario. Changes in sedimentation rates estimated from changes in *Ambrosia* (increase at 1850) and *Castanea* (decrease at 1930 or 1935) concentrations. Also measure changes in concentration of organic C, N, P and Hg.
Kind 1972			Many C^{14} dates for Siberia.	Correlation of Late Quaternary climatic changes and glacial events in Europe, Siberia and North America.
Klassen, Delorme and Mott 1967	201. Roaring R., Manitoba 51°51'N. 101°08'W	82-92 ft		Zone I (basal) - high *Picea glauca*, some *P. mariana*. Closed spruce forest. Zone II - sharp decrease in *Picea*, abundant NAP. Treeless vegetation. Zone III - NAP remains high. *Quercus* abundant. Oak savannah. Zone IV - NAP and *Quercus* drop at beginning; increase in *Picea mariana*, *P. glauca*. Coniferous boreal forest. Zone V - *P. mariana* decreases; *Betula*, *Equisetum*, NAP increase - tundra vegetation.
Kuc 1970	125. Masik R., Banks I., Northwest Territories 71°34'N, 123°30'W		Areas of older peat. 10660 ± 170 GSC 240	Thick peat deposits dominated by willow (especially *Salix alaxensis*) and mosses. Product of shrub-tundra.
Kuc 1974	127. Worth Point, Banks I., Northwest Territories 72°15'N, 125°37'W	498 cm	378 cm >54000 GSC 1236 148 >43000 GSC 1239	List of fossil lichens, mosses, ferns and vascular palnts. Chronology from forest to mire forest to *Salix-Sphagnum* bog to tundra.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Kupsch 1960	184. Herbert, Saskatchewan	58 ft	11 ft 10050 ± 300 S 41	7 pollen samples from 7.5 to 11 ft. 10-12 ft - deposition in quiet pond or small lake surrounded by black and white spruce, pine, birch and willow. Higher sediments - abundant *Artemisia*, *Shepherdia*, *Elaeagnus*, Chenopods - indicative of present-day grassland. This has been predominant vegetation since Hypsithermal.
LaSalle 1966	266. L. Hertel Bog, Québec	0-800 cm	775-790 cm 10880 ± 260 GSC 482	Zone A_{1-2} (780-800) - high NAP, *Salix*, *Pinus*, *Picea*. Zone A_3 (745-780) - decrease in NAP; increase in thermophilous trees, pine and birch. Zone A_4 (710-745) - decrease in *Quercus*, *Fraxinus*; increase in *Abies*; slight increase in NAP. Zone B (675-710) - large increase in pine. Zone C_1 (590-675) - birch, *Quercus*, *Tsuga* fairly high. Zone C_2 (430-590) - decrease in *Tsuga*; increase in *Fagus*; birch and pine remain high. Zone C_{3a} (95-430) - *Tsuga* regains high values; *Fagus* remains high. Zone C_{3b} (0-95) - increase in pine; decrease in *Tsuga* and *Fagus*. At top of zone - increase in NAP.
	266. St. Hilaire Bog, Québec	540-950 cm analyzed	940 cm 12570 ± 220 GSC 419 (Ed. note: dated sample from "29 ft below surface of bog" (Lowdon and Blake 1968), therefore it would be 884 cm deep rather than 940 cm).	Zone T (910-950) - high herbs and shrubs (including *Salix*, *Alnus*). Zone A_{1-2-3} (850-910) - pine and oak maxima in upper part of zone; birch maximum before this. Zone A_{4a} (835-850) - increase in *Shepherdia canadensis*, Cyperaceae, Gramineae; decrease in oak. Zone A_{4b} (815-835) - increase in spruce; decrease in herbs.

					Zone B (705-815) - increase in pine, oak, birch, thermophilous trees. Zone C_1 (540-705) - peak in *Tsuga*.
	266. St. Bruno Bog, Québec	600-680 cm			Zone A_4 (660-680) - low NAP peak. Zone B_1 (605-660) - increase in birch, oak; decrease in spruce. Zone B_2 (600-605) - recovery of pine to its postglacial peak.
	266. St. Antoine, Québec 48°48'N, 73°18'W	2-28 m			Zone A_{1-2-3} (12-28 m) - dominated by spruce and pine. Zone A_{4a} (7-12 m) - large NAP peak due to abundance of *Glaux maritima* var. *obtusifolia* (indicates lowering of sea level). Also increase in *Artemisia*. Zone A_{4b} (2-7 m) - pine and spruce maxima; decrease in herbs; increase in thermophilous trees.
	294. L. Kénogami, Québec	660-700 cm			Zone K_1 (686-700) - high birch; some pine and spruce; herbs rather low. Zone K_2 (668-686) - increase in pine, *Abies*; some spruce, birch. Zone K_3 (660-668) - increase in pine; appearance of *Tsuga* at top of zone.
Lee 1957	221. Sheguiandah Site, Ontario	8 m (5.9 m in diagram)			Diagram prepared by Terasmae. Peat formation begins about 5 m. Climate was already fairly warm. From about 3.5 to 4.5 m - decrease in pine; increase in spruce, NAP. Cold period (may be Cochrane Ice advance) followed by warmer period. Abrupt changes in pine and spruce above 3.5 m may be due to forest fires.
Lewis, Anderson and Berti 1966	243. L. Erie, Ontario Core 1240	18 ft	12.9 ft	11300 ± 160 GSC 382	Pollen scarce in lowermost section. Zone I - high spruce; pine increases toward top of zone with *Larix*, *Tsuga*. Cold, moist climate.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS ASH LAYERS	ZONATION AND COMMENTS
Lewis, Anderson and Berti 1966 continued				Zone II - decreasing spruce and *Abies;* increasing *Pinus banksiana* to maximum. Pine-oak-elm-hickory forest. Climate cool and dry. Zone III - not represented (*Tsuga* and *Fagus* maxima). Zone IV - high birch, *Carpinus*, *Ostrya*, *Quercus*, *Ulmus*, *Carya*, *Acer*, *Fraxinus*, *Tilia*, *Juglans*. Warmer and drier than Zone II. Zone V - slight increase in *Pinus*, *Tsuga*, *Betula*, *Fagus*, *Fraxinus*, Cyperaceae; decrease in *Quercus*, *Tilia*, *Juglans*. Climate moister and not so warm as Zone IV.
Lichti-Federovich 1970	159. Lofty L., Alberta 54°44'N, 112°29'W	5.5 m	156-164 cm 3440 ± 140 GSC 1201 290-298 5200 ± 140 GSC 1202 436-444 7480 ± 150 GSC 1234 512-518 9180 ± 150 GSC 1240 559-554 11400 ± 190 GSC 1049	Zone L-1 (555-542) - dominated by *Populus*, *Salix*, *Shepherdia canadensis*. Also *Artemisia*, Cyperaceae. Zone L-2 (542-512) - dominated by spruce. Significant amounts of *Populus*. Some *Shepherdia canadensis*, Cyperaceae. Zone L-3 (512-440) - dominated by tree birch. Increase in *Corylus*. Disappearance of *Shepherdia*. Decrease of *Artemisia*, Cyperaceae. Zone L-4 (440-180) - prevalence of *Betula*, *Alnus*, Gramineae, Chenopods and *Artemisia*. Increase in spruce and pine. Zone L-5 (180-0) - dominated by spruce, birch, alder. Small but consistent numbers of *Abies* and *Larix*.
Lighti-Federovich 1972	160. Alpen Siding L., Alberta 54°27'N, 113°00'W	0-390 cm	380-358 cm 10700 ± 170 GSC 1093	Stratigraphy very similar to Lofty Lake section. 390-380 cm - *Populus-Salix-Shepherdia-Artemisia* assemblage. 378-353 cm - dominated by spruce; high *Populus*, *Artemisia*, Gramineae, Cyperaceae. Low

						Shepherdia canadensis. 325-348 cm - increase in pine, spruce, alder; decrease in birch. 125-0 cm - dominated by spruce, pine, birch; decrease in NAP.
Lichti-Federovich 1973	98. Old Crow R., area, Yukon Territory Old Crow Section 1	23-54 ft (above river level)				Zone 1A (24-26) - dominated by Gramineae and Cyperaceae; some spruce, birch. Zone 1B (27-43) - higher spruce, birch; lower Cyperaceae, Gramineae. Zone 1C (44-51) - less spruce, birch; increase in Gramineae, Cyperaceae, NAP.
	98. Old Crow Section 2	Scattered samples from 0-57 ft (above river level)	82 ft 12	8270 ± 140 >44000	GSC 1329 GSC 1593	Zone 2A (0-5) - dominated by dwarf birch; low spruce, alder, willow, herb. Zone 2B (5-33) - decrease in birch; increase in spruce, willow, grass, sedge. Zone 2C (33-57) - high grass; low birch, spruce; increase in sedges, herbs.
	98. Old Crow Section 3	0-73 ft (above river level)	45 ft	>42000	GSC 1589	Zone 3A (0-22) - dominated by birch; some grass, sedge, spruce, alder. Zone 3B (22-60) - increase in spruce and grass; decrease in birch; richer herb flora. Zone 3C (60-73) - decrease in spruce and birch; increase in grass and sedge.
	98. Old Crow Section 4	13 samples from 52-61 ft; 99-105 ft (above river level)	99 ft 87 79 61	6430 ± 140 7650 ± 150 8100 ± 160 31300 ± 640	GSC 372 GSC 1175 GSC 1243 GSC 1191	Zone 4A (52-61) dominated by Gramineae; some spruce and birch. Zone 4B (single sample at 88) - low alder, abundant birch; high grass, sedge. Zone 4C (99-105) - high alder; large variable percentages of spruce and birch.
	98. Old Crow Section 5	Samples from 5-71 ft; one at 103 ft (above river level)	103 ft	7620 ± 160	GSC 1252	Zone 5A (5-12) - less spruce than 5B. Zone 5B (12-33) - high spruce; lower Glumiflorae. Zone 5C (33-71) - high Glumiflorae; low spruce and birch; rich herb flora. Zone 5D - (single sample at 103) - dominated

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Lichti-Federovich 1973 continued				by birch; associated with Glumiflorae.
	98. Old Crow Section 6	5-72 ft (above river level)	81 ft >42000 GSC 1297	Zone 6A (5-27) - dominated by birch; some spruce, Glumiflorae, herbs. Zone 6B (27-72) - decreased birch; increased spruce; less rich in herbs.
Lichti-Federovich 1974	99. Porcupine R., Yukon Territory Section 1	Scattered samples from 2-198 ft (above river level)	173.5 ft 10740 ± 180 GSC 121 142 (shells) 32400 ± 770 GSC 952 142 (wood) >37000 GSC 958 112 >41300 GSC 199	Zone A (0-41) - distinguished by presence of pine, *Corylus*. Dominated by birch. Low shrubs, Cyperaceae, Gramineae. Zone B (47-105) - distinguished by absence or only trace of *Corylus*; rich in herbs. Pine, spruce, birch fairly common. Zone C (105-148) - Glumiflorae-herb assemblage. Dominated by grasses, sedges. Zone D (149-161) - pine-birch-Glumiflorae-herb assemblage. Zone E (162-167) - Glumiflorae-herb assemblage. Zone F (192-194) - birch-herb assemblage. Dominated by dwarf birch, low grass, sedge, willow. Zone G (194-198) - spruce-birch-Glumiflorae-herb assemblage.
	99. Porcupine R. Section 2	Samples from 45-160 ft (above river level)		Zone A (45-60). Zone B (80-106). Zone C (130 and 138 samples). Zone D (samples at 150 and 160). Similar to above zones.
Livingstone 1955	21. Chandler L., Alaska 68°15'N, 152°42'W	5 m		Zones IA, IB, II, IIIA, IIIB. Zones described below.

	21. Eight L., Alaska 68°08'N, 152°59'W	2 m			Zones II, IIIA, IIIB.
	21. Lake A, Alaska 67°10'N, 151°25'W	5.5 m			Zones II, IIIA, IIIB.
	22. Death Valley, Alaska 67°10'N, 151°25'W	4.8 m			Zones II, IIIA, IIIB, IIIC.
					Zone I - herbaceous zone. Subzone IA - sedge predominates. Zone II - birch maximum. Probably cotton-grass tussock tundra with much dwarf birch. Zone III - alder pollen zone. Alder pollen probably result of moderate-distance transport. Subzone IIIB - represents postglacial thermal maximum.
Livingstone 1957	19. Umiat, Alaska	30 ft; pollen studied to 26.5 ft	4 ft 20-22 23-25	5900 ± 200 7500 ± 250 8125 ± 250	Zone I (22.5-26.5) - tundra; many open ground indicators. Zone II (3.5-22.5) - tundra with less open ground, more dwarf birch. Zone III (0-3.5) - tundra where alder is more important. Profile similar to Chandler Lake.
Livingstone 1968	303. Harriman L., Québec 48°14'20"N, 65°50'15"W	7.5 m			Zone L (6.7-7.5) - abundant sedge; significant *Salix*, *Shepherdia canadensis*, *Epilobium*, *Artemisia*, Ranunculaceae, Caryophyllaceae. Tundra with fingers of forest along river valleys. Zone A (6.35-6.7) - decrease in NAP; increase in spruce. Some pine, birch. Spruce forest. Zone C - high birch; significant oak. Subzone C-1 (5.5-6.35m) - up to appearance of maple in record - similar to present-day vegetation of N. Maine. Subzones C-1 and C-2

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Livingstone 1968 continued				- climate warmer. Subzone C-3 (0-1m) - increase in spruce and fir - climate cooler.
	345. Upper Gillies L., Nova Scotia 46°04'N, 60°23'30"N	6.2 m		Zone L-2 (6.0-6.2) - more birch, less sedge. Zone L-3 (5.2-6.0) - less birch, more sedge. Zone A (4.7-5.2) - pine, spruce and fir high. Zone B (4.4-4.7) - increase in pine. Zone C-1 (3.7-4.4) - increase in *Tsuga*. Zone C-2 (3.0-3.7) - hemlock peak. Zone C-3 (0-3.0) - high maple and birch in upper metre. Decrease in birch and increase in spruce at top.
	345. McDougal L., Nova Scotia 46°03'10"N, 60°25'50"W	5.7 m		Zone L (5.4-5.7). Zone A (4.6-5.4). Zone B (4.2-4.6). Zone C-1 (3.6-4.2). Zone C-2 (2.9-3.6). Zone C-3 (0-2.9). Zones very similar to Upper Gillies Lake.
	347. Hillsborough Interstadial deposit, Nova Scotia 46°04'15"N, 61°22'15"W	.5-2.5 m		Zone I (base to 2.1 m) - more alder, less spruce. Zone II - more spruce, less alder, more Cyperaceae. Initially a low-arctic tundra changing to hemiarctic vegetation, then to boreal forest dominated by spruce.
	351. Folly Bog, Nova Scotia 45°33'N, 63°33'W	6.1 m		Zone A (5-6.1) - high spruce; some willow, *Lycopodium*. Zone B (4.3-5) - pine increases. Zone C-1 (3.8-4.3) - oak increases. Zone C-2 (2.6-3.8) - high hemlock. Zone C-3 (0-2.6) - lower hemlock; high birch; low pine.

	354. Silver L., Nova Scotia 44°33'48"N, 63°38'34"W	6.8 m	2.5 m 3.5 4.5	4540 ± 140 7140 ± 140 9650 ± 150	Zone G (5.8-6.8) - much birch, conifers, oak. Zone L (4.6-5.8) - abundant willow and sedge. Zone A (4.4-4.6) - low sedge and willow; fairly high spruce. Zone C-1 (3.5-4.4) - oak increases; low hemlock. Zone C-2 (2.5-3.5) - hemlock peak. Zone C-3 (0-2.5) - beech increases.
	354. Bluff L., Nova Scotia 44°33'15"N, 63°38'45"W	4.4 m			Zone G (3.8-4.4) - birch, pine, spruce, oak. Zone L (3.2-3.8) - high sedge, willow, grass, *Shepherdia canadensis*. Zone A 3.0-3.2) - no pine or spruce peak. Zone C-1 (2.3-3.0) - oak high. Zone C-2 (1.2-2.3) - hemlock high. Zone C-3 (top -1.2) - decrease in spruce; increase in beech, maple.
	356. Salmon R., Nova Scotia 45°38'40"N, 60°46'30"W	4.7 m	3.75 m 2.75	8770 ± 150 5540 ± 140 GSC 791	Zone L (4.5-4.7) - high sedge, willow, significant *Artemisia*. Zone A (3.75-4.5) - increase in birch, pine, spruce. Zone B (3.5-3.75) - increase in pine. Zone C-1 (3.0-3.5) - oak high. Zone C-2 (2.4-3.0) - increase in *Tsuga*. Zone C-3 (top -2.4) - decrease in birch, increase in pine.
Livingstone and Estes 1967	344. Wreck Cove L., Nova Scotia 46°32'25"N, 60°26'50"W	4 m	310-330 cm	9030 ± 170 GSC 335	Zone L - high Cyperaceae; some Gramineae, *Salix*, *Artemisia*. Open vegetation; spruce, *Abies*, *Populus* in sheltered areas. Zone A - low Cyperaceae. Spruce, pine high. *Betula* dominates. Zone B - pine important; some birch. Zone C-1 - less hemlock than C-2. Zone C-2 - hemlock peak. Zone C-3a - less spruce, more oak. Zone C has more oak, hemlock, ash, maple, beech and elm than previous zones.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Livingstone and Livingstone 1958	346. Gillis L., Nova Scotia 45°39'30"N, 60°46'30"W	7 m	4.3-4.5 m 10340 ± 220 Y-524	Zone L1 (5.9-7) - high Cyperaceae, Ericaceae, *Salix*, *Artemisia*, *Abies*, pine, spruce. Open tundra vegetation with scattered conifers. Zone L2 (5-5.9) - increase in birch; decrease in sedges, conifers and willow. Birch and heath shrub vegetation. Increased temperature, decreased moisture. Zone L3 (4.5-5) - similar to L1, but birch not so low and conifers not so high. Zone A1 (4-4.5) - high spruce and birch. Closed boreal forest. Zone A2 (3.7-4) - increased *Abies*, some *Quercus*. Warmer climate. Zone B (3.3-3.7) - high pine (uncertain of species). Zone C1 (2.8-3.3) - high oak; significant amounts of other hardwoods. Warm climate. Zone C2 (2.2-2.8) - high *Tsuga*. Moister than C1, warmer than present. Zone C3c (1.8-2.2) - decrease in *Tsuga* and other conifers. Birch dominates. Cooling. Zone C3b (.4-1.8) - *Abies*, then spruce increases. Zone C3a (0-.4) - decreased birch, increased spruce, grasses; *Rumex* present. Reflects settlement.
Löve 1959	Manitoba		Abstract: "The ice was at first followed by a cold (marsh) grassland, covering the bottom of the drained Lake Agassiz I, and a riverine spruce (-pine) parkland of western origin, which persisted throughout the Valders period and the damming up of Lake Agassiz II. Around 9000 BP a deciduous forest flora started to fill in around the edges of Lake Agassiz II, and a pine-oak savanna occupied the drier portions of the upland. This flora reached its maximum north- and westwards distribution towards the peak of the Hypsithermal. Also during the Hypsithermal it is suggested that a western (-southwestern) prairie flora covered the bottom of the draining Lake Agassiz II, reaching its farthest	

extension towards the north and east. During the same time, the Arctic flora expanded over the Hudson's Bay Lowland. The last part to be covered by vegetation seems to have been the zone now called taiga, probably as late as 3000-4000 years ago. The spruce forest and its undervegetation seems to have arrived both from the west and from the east, and in recent times (from 2000 to 3000 BP) is in a stage of expansion, forcing itself into the deciduous zone, which in turn is expanding over the prairie, save for the checking activities of Man (fire and cultivation)."

Lyons and Mielke 1973	141. Ward Hunt area, Ellesmere I., Northwest Territories		In basement ice: Shells 3645 ± 120 SI 638 6815 ± 190 SI 721 3390 ± 130 SI 772 3680 ± 100 SI 727 4775 ± 120 SI 723 Raised beach; Shells 7755 ± 150 SI 718 5950 ± 155 SI 720 Sponges in ice: 13200 ± 440 SI 719A Organic material in sponge debris: 3400 ± 140 SI 719B Camp Creek Ice Rise: Shells 5735 ± 110 SI 724 7045 ± 190 SI 725	Discussion of postglacial rebound and climatic oscillations of northern Ellesmere Island.
Mackay and Terasmae 1963	109. Eskimo Lakes, Northwest Territories	12 ft	12 ft 8000 ± 300 GSC 25	Zonation for both sites: Basal levels (8200-7500 BP) - high spruce, birch, willow, Cyperaceae. Followed by high Ericaceae (at 7000 BP). Then high *Myrica* followed by high alder (3000-2000 BP). 12000 BP - deglaciation. 8500-7500 - cool, dry climate. Then increased moisture (increase in Ericaceae), followed by cooler climate (*Myrica* maximum), then increased moisture (increase in alder).
	111. Twin Lakes near Inuvik, Northwest Territories	7.5 ft	7.2 ft 7400 ± 200 GSC 16	
Maher 1964	Ontario			*Ephedra* and *Sarcobatus* are transported long distances from their present distributional ranges today. Reports of *Ephedra* as part

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Maher 1964 continued				of the periglacial flora of the Great Lakes region are concluded to be a result of long-distance transport.
Maher 1977	219. L. Superior, Ontario Core 72-1 47°09'N, 91°20'W Duplicate cores taken from map locations 217 and 218.	150 cm		Event A - the present. Event B - start of tailing accumulation - 6 years BP. Event C (9.5) - ragweed pollen rise - 60 years BP. Event D (40-50) - midpostglacial herb pollen maximum - 46 cm - 7200 years BP. Event E (53) - rise of white pine - 8500 years BP. Event F (61.5) - elm pollen maximum - 9000 years BP. Event G (base of core 72-1) - 9100 years BP. Discussion of differences in pollen record since settlement and sedimentation rates.
Mathewes 1973A	87. Marion L., British Columbia	8.9 m	20-25 cm 520 ± 115 I 6833 47.5-52.5 890 ± 90 I 5961 180-185 2140 ± 125 I 6832 330-335 4035 ± 105 I 6823 450-455 4860 ± 105 I 6822 700-705 7645 ± 340 I 6821 810-867 12350 ± 190 I 5960 600 Mazama ash	Zone ML-1 (8.9-8.7) - increasing *Pinus contorta;* high *Salix*, *Alnus*, *Artemisia*, Polypodiaceae. Zone ML-2 (8.7-8.2) - decrease in *P. contorta;* increase in *Abies*, *Picea*, *Tsuga mertensiana*, *Alnus* and ferns. Zone ML-3 (8.2-6) - abundant *Pseudotsuga* at base; increasing *Tsuga heterophylla;* decreasing *Pinus contorta*, *Abies*, *Picea* and *Tsuga mertensiana*. *Alnus*, monolete fern and *Pteridium aquilinum* reach peak. First appearance of *Corylus*, *Quercus* and *Arceuthobium*. Zone ML-4 (6-.2) - increase in Cupressaceae. *Tsuga heterophylla* increases in lower half, decreases in upper half of zone. *Thuja-Chamaecyparis* increases in upper half of zone. Zone ML-5 (.2 to top) - *Alnus*,

						Betula, Pteridium, Rosaceae increase; *Tsuga heterophylla, Thuja-Chamaecyparis* decrease.
	87. Surprise L., British Columbia	5.2 m	55-60 cm 130-140 305-315 455-465 515-520	1555 ± 130 4715 ± 100 8275 ± 135 10340 ± 155 11230 ± 230	I 6964 I 6965 I 6966 I 6967 I 5816	Zone SL-1 (5.2-4.7) - *Pinus contorta* abundant at base, declines to top; alder common (Zone =ML-2). Zone SL-2 (4.7-2.9) - increase in *Pseudotsuga. Abies, Picea, Tsuga mertensiana, Pinus contorta* decrease. Alder high; *Pteridium* increases. Zone SL-3 (2.9-0) - increase in *Thuja-Chamaecyparis. Pinus contorta* and *P. monticola* low. *Betula, Acer macrophyllum, Quercus, Lysichitum americanum* common.
Mathewes 1976	86. Glenrose Cannery Site, British Columbia 49°08'N, 122°56'W	8 samples				Low pollen content. One sample predominantly fern spores. One predominantly *Lysichitum americanum.* Some *Epilobium angustifolium, Polygonum* sp., western hemlock, pine and *Abies.*
Mathewes, Borden and Rouse 1972	88. Pinecrest L., British Columbia 2 samples		450-460 cm 386-388	11000 ± 170 Mazama ash	I 5346	
			665-675 436-438	11430 ± 150 Mazama ash	I 6057	
	88. Squeah L., British Columbia		655-665 cm 430.5 408-410.5	11140 ± 260 6930 ± 135 Mazama ash	I 6058 I 5347	
Mathewes and Rouse 1975	88. Pinecrest L., British Columbia	4.5 m	See Mathewes, Borden and Rouse 1972			Zone PL-1 (4.4-4.5) - high *Pinus contorta, Picea, Alnus, Abies* and *Artemisia.* Zone PL-2 (4.5-3.85) - abundant *Pseudotsuga* and *Selaginella wallacei* at bottom. *Tsuga heterophylla* low. *Selaginella, Salix, Pteridium, Alnus* and Gramineae high. Birch increases. Zone PL-3 (3.85-top) - abundant

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Mathewes and Rouse 1975 continued				*Tsuga heterophylla*, *Pseudotsuga*, *Alnus* and *Betula*. *Thuja-Chamaecyparis* increases.
	88. Squeah L., British Columbia	6.7 m	See Mathewes, Borden and Rouse 1972	Zone SqL-1 (6.7-6.3) - *Pinus contorta*, *Abies*, *Alnus* predominate. High spruce and *Artemisia* (Zone = PL-1). Zone SqL-2 (6.3 to top) - declining *Pinus contorta*, low *Tsuga heterophylla*. Increasing birch. High Gramineae, *Artemisia*, *Pteridium* and *Selaginella wallacei*.
Matthews 1970	23. Eva Ck. Near Fairbanks, Alaska 7 samples - bar diagram for each.		5 samples dated 3-3D <24400 3-3C 24400 ± 600 I 2116 3-3B >24400 3-2 >24400 3-1A >56900 Hr 1328	All spectra except McGee C. and Lost Chicken 1 imply treeless conditions. Eva 3-3B, 3-3C and 3-3D referable to Livingstone's Herb Zone due to low *Betula* and *Alnus*. High *Artemisia* - evidence of paleoclimate with mean annual temperature of -10 or -12°C. Also present surface pollen spectra.
	23. McGee Cut, Alaska 2 samples		C 7280 ± 140 I 2240 D >39900 I 2248	
	3 other single sample diagrams given from sites NW of Fairbanks, Alaska			
Matthews 1974A	12. Cape Deceit, Alaska Many pollen diagrams given (bar diagrams) from small units in the area		3 C^{14} dates given - should be seen in conjunction with pollen diagrams.	Surface pollen samples, plant, invertebrate, and animal macrofossils studied. Gives table correlating environmental history and glacial periods. The latest part of this table states: Early Wisconsin? - herbaceous tundra; locally grassy with crucifers. Climate colder than present. Late Wisconsin (12-13000 BP) - steppe-

						tundra. *Poa, Artemisia, Potentilla* locally abundant. Climate arid, colder, but not too cold for growth of dwarf birch. Early Holocene (*ca.* 9000 BP) - tundra. Birches (dwarf?) abundant; spruce treeline perhaps closer to Deering than now. Climate slightly warmer than present. Late Holocene - tundra like present. Dwarf birches widespread; alders in valleys or other protected sites. Climate like present.
Matthews 1974B	23. Isabella Ck., Alaska	27 m	1.55 m (Core II) 2.02 (Core I) 2.82 3.64 7.25 9.95 18.0 25.1	4510 ± 120 6910 ± 140 7810 ± 160 9200 ± 160 7840 ± 280 11500 ± 190 >31900 34900 ± 2950	I 3627 I 3624 I 3625 I 3006 I 4774 I 3007 I 4775 I 3083	Zone A. Subzone Aa - high Cyperaceae, lower birch, alder, spruce and *Sphagnum* than Subzone Ab. Open sedge-dominated environment with scattered spruce. Subzone Ab - change to more taiga-like conditions - tree cover greater, more alder. Zone B - low alder and spruce. High Cyperaceae and *Artemisia*. Cold temperatures and aridity possibly involved in suppression of alder, birch and spruce (colder than Zone A). In Upper Zone B (12000 BP) - dwarf birch became more common - climate amelioration. Zone C - high spruce and birch. Low Cyperaceae and *Artemisia*. High *Sphagnum* and Polypodiaceae. Base of Zone C - 7800-9200 BP. Change from steppe-tundra to taiga. Possibly records a mid-Holocene warm interval. Paper also lists plant and animal macrofossils from core.
Matthews 1975A	98. Old Crow R., Yukon Territory 68°12.6'N, 140°00'W		Wood	>44000 BP	GSC 1593	Lists insect and plant macrofossils found at the two sites. Both sites associated with Assemblage Zone II pollen spectra (Lichti-Federovich 1973) - forest-tundra. *Alnus incana* (= *tenuifolia*) and
	98. Porcupine R., Yukon Territory		Shells Wood	32400 ± 770 >37000 BP	GSC 952 GSC 958	

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Matthews 1975A continued				*Najas flexilis* found at Old Crow site - neither occur in the area today.
Matthews 1975B	97. Northern coast, Yukon Territory 69°36'14"N, 140°36'12"W		*Betula* wood 10900 ± 80 GSC 1853	Animal, insect and plant macrofossils listed (*Equisetum*, *Carex* sp., *Salix* sp., *Betula glandulosa*, *Dryas integrifolia*). List of pollen given for the sample. Dominated by Cyperaceae. *Betula* pollen very low (puzzling since it was growing at the site, as evidenced by macrofossils).
McAndrews 1970	Ontario			Popular summary on palynology with examples from Van Nostrand Lake and Lake Ontario (sites 235 and 236). For more detail on these sites see McAndrews 1972, 1973, 1976A.
McAndrews 1972	235. L. Ontario, Ontario 43°33.4'N, 78°09'W	14 m		Zone 1 (basal) - dominated by spruce and pine with Cyperaceae. Zone 2 and 3 - dominated by pine (species can not be distinguished). Zone 4 - decrease in pine; increase in oak, *Acer*, *Tsuga*. Zone 5 - hemlock minimum. Zone 6 - increase in hemlock. Zone 7 - increase in pine. Zone 8 - dominated by *Ambrosia*.
McAndrews 1973	235. L. Ontario, Ontario	14 m		See McAndrews 1972
	236. Van Nostrand L., Ontario	10 m	4.8 m 5110 ± 135 I 5785 9 9750 ± 135 I 5786	Zone 1 (basal)- late glacial spruce zone. Zone 2 - dominated by *Pinus banksiana/resinosa*. Zone 3 (9750 BP) - decrease in *P. banksiana/*

				resinosa; increase in *Pinus strobus*, *Fagus*, *Tsuga*. Zone 4 - decrease in pine; increase in *Tsuga*, *Fagus*. Zone 5 (5710 BP) - *Tsuga* minimum. Zone 6 - increase in *Tsuga*. Zone 7 - increased pine. Zone 8 - *Ambrosia* dominant.
McAndrews 1976A	236. Van Nostrand L., Ontario			Zones 6, 7, 8 as below.
	238. Crawford L., Ontario			Zone 6 - dominated by maple and beech with lesser amounts of cedar and hemlock. Zone 7 - *Fagus* and *Acer* decline. Succeeded first by oak, then by pine. Reflects forest succession following impact of Indian agriculture from *ca.* 1500-1850. Zone 8 - decrease in pine. Increase in birch, *Ulmus* and *Thuja*. Dominated by *Ambrosia* and Gramineae. Bottom of Zone 8 is beginning of European impact.
McAndrews 1976B	216. Pass L., Ontario	450 cm		Bottom "zone" - herbs, Gramineae, Cyperaceae, *Artemisia*, *Ambrosia*. Succeeded by a spruce zone lacking birch - may represent "northern" part of boreal forest. Succeeded by birch zone - represents the type of boreal forest occurring just north of the area today. Succeeded by white spruce zone - represents a period of Great Lakes forest. Succeeded by spruce zone - a result of climatic cooling over the past 3000 years.
McAndrews 1976C	A lake in northern Québec. 56°N, 64°W Not mapped.	270 cm	4 dates obtained	Abstract only: succession from sedge-willow tundra to birch-alder tundra then to spruce dominated forest-tundra.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
McAndrews, Boyko and Byrne 1974	238. Crawford L., Ontario 43°28.1'N, 79°56.9'W	4 m		Zones 6, 7, 8 (See McAndrews 1972)
	238. Crawford Bog, Ontario	15 m		Zone 1 (Pleistocene) - dominated by spruce with substantial shrub and herb pollen. Suggests forest-tundra. Zone 2 - dominated by jack pine. Lacks abundant shrub and herb pollen. Suggests boreal forest. Upper boundary 9750 ± 135 (see McAndrews 1972). Zone 3 - jack pine replaced by white pine and oak with small amounts of beech, maple and hemlock. Vegetation similar to southern Great Lakes Forest. Zones 4, 5 and 6 are similar. Dominated by beech, maple, birch and elm and varying amounts hemlock. Zone 5 is a hemlock minimum. Zone 4/5 boundary 5710 ± 135 (see McAndrews 1972). Zone 7 - rise in white pine, oak and bracken. Varve dated at 580 years BP. Zone 8 - dominated by ragweed and other weeds. Represents European agriculture. Zone 7/8 boundary - 120 years BP by varves.
McAndrews and King 1976	North America			Review of 60 Holocene sections across North America. The distribution of the 20 most important taxa are used to describe 6 floristic provinces.
McCullough and Hopkins 1966	10. Seward Peninsula, Alaska. Coffee Ck., Black Gulch - 4 sites		Wood 10 ft below surface 10200 ± 800 L 137G Wood 8 ft below surface 8350 ± 200 L 117C	At Coffee Creek, at 10200 BP, vegetation and climate were much as at present. 8300 BP - poplar and beaver present; willow more

		Wood and peat 3 ft below surface 450 ± 100 L 117D Peat 8 ft below surface 2750 ± 350 L 137F	abundant, summers warmer. 2700 and 450 BP - climate and vegetation again similar to present.
	13. Seward Peninsula, Alaska. Candle Cr., Mud Ck.	Wood from beaver dam 9400 ± 750 L 137N 3600 ± 500 L 117E	Evidence for Early Recent warm interval: large fossil beaver dams; birch, willow, alder wood.
	14. Baldwin Peninsula, Alaska. - 4 sites	Woody zone 5-15 ft below surface: 9020 ± 400 W 1255 8550 ± 400 W 1249 7270 ± 350 W 1250 Wood from a beaver dam 9480 ± 160 Y 1351 Twigs filling ice wedge casts 11340 ± 400 W 1254	Evidence for "Early Recent" warm interval: Site A: many large logs including birch; beaver-chewed wood fragments (outside present range of beaver). Site B: fossil beaver dam including poplar, spruce and birch wood. Site C: large logs including alder, poplar, birch and spruce.
Miller 1973	147. Baffin I., Northwest Territories	Bone 680 ± 80 Gak 3722	Also uses lichenometry to set out and date glacial and climatic history of the area.
	148. Baffin I., Northwest Territories	Thin organic horizon under glacial outwash: 1010 ± 100 Gak 3725 450 ± 130 Gak 3726 Marine shells, Okoa Bay: 4810 ± 110 Gak 3724 Marine shells, Nedlukseak Fiord: 5200 ± 100 Gak 3723 8410 ± 340 GSC 1638	
	149. Baffin I., Northwest Territories	Marine shells 7100 ± 140 Gak 3365 7950 ± 170 Gak 2566 8290 ± 170 Gak 3092 8760 ± 350 St 3816 Buried soil: 1260 ± 150 Gak 3160	
	150. Island in mouth of Quajon Fiord, Baffin I., Northwest Territories	Peat 1205 ± 120 GX 1812 Organic debris at bottom of ice wedge: 350 ± 100 Gak 2983	

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Miller 1973 continued	151. Maktak Fiord, Baffin I., Northwest Territories		Top of peat from Broughton I. 160 ± 80 Gak 3097 Basal peat from Broughton I. 680 ± 130 Gak 3098 Basal organic muck 1480 ± 110 Gak 3687 1170 ± 330 Gak 3686 Marine shells 5330 ± 450 Gx 1824 6350 ± 100 Gak 3385	
	152. Heads of Narpaing and Quajon Fiords, Baffin I., Northwest Territories		Top of peat - Quajon head 730 ± 70 Gak 2792 Basal peat - Quajon head 1670 ± 90 Gak 2575 Moss fronting Boas Glacier 330 ± 90 Gak 3099 430 ± 90 Gak 3357 850 ± 110 Gak 3094 Moss 3570 ± 140 GSC 1507	
Miller 1976	North America			Review paper of Quaternary fossil bryophytes in North America. Contains published records and phytogeography.
Morrison 1970	327. Landing L., Newfoundland 53°37'N, 63°22'W	140 cm		Zones 1 and 2, 3a Zones described below.
	327. Pole L., Newfoundland 53°30'N, 63°20'W	160 cm		Zones 1, 2
	328. Sona L. West, Newfoundland 53°35'N, 63°57'W	300 cm	275 cm 5575 ± 250	Zones 1, 2, 3a, 3b, 4, 5

	329. Churchill Falls North, Newfoundland 53°36'N, 64°19'W	290 cm	220 cm	5255 ± 200	Zones 1, 2, 3a, 4, 5, 6
	329. Churchill Falls South, Newfoundland 53°35'N, 64°18'W	420 cm	380 cm	5450 ± 200	Zones 1, 2, 3a, 3b, 4
	329. Churchill Falls East, Newfoundland 53°36'N, 64°18'W	180 cm			Zones 1 and 2, 3a, 3b, 4
					Zone 6 (basal) - percentage of pine and exotics high, therefore probably mainly bare ground. Zone 5 - pine, spruce, fir, larch and birch decrease. Willow and alder increase. Willow-alder thickets with sedge-shrub vegetation. Zone 4 - decrease in alder and willow. Increase in birch. Migration of dwarf birch into area. Zone 3 - increase in spruce, fir, larch. Zone 3b - still mainly treeless. Zone 3a - birch peak - coniferous forest. Zone 2 - increase in fir - coniferous forest giving way to lichen woodland. Zone 1 - differences between open and closed lichen woodland, coniferous and mixed forest.
Mott 1966	Saskatchewan				Short progress report on palynological studies in central Saskatchewan. No C^{14} dates or pollen diagrams.
Mott 1967	182. Site 4 near Battleford, Saskatchewan		Basal sediments	11090 ± 160 GSC 642	4 basal C^{14} dates reported. For other 3 see Mott 1973.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Mott 1971A	Saskatchewan			Short progress report on palynological studies in central Saskatchewan.
Mott 1971B	Alberta, Saskatchewan, Québec			Short progress report mentioning a palynological reconnaissance survey of Cypress Hills area, and coring in Québec.
Mott 1971C	346. R. Inhabitants, Nova Scotia 45°40.57'N, 61°19.58'W	15 ft (not all analyzed for pollen)	1/3 of way down section >39000 GSC 1406 Shell fragment 32100 ± 900 GSC 1408	Sequence dominated by spruce and alder with some pine and small amounts birch and *Abies*. Boreal forest assemblage. Environment of deposition - alder swamp. Surrounding area - closed spruce forest. Early Wisconsin interstade.
Mott 1971D	190. Site 5, Saskatchewan 55°23'20"N, 104°04'30"W		Basal sediment 8640 ± 240 GSC 1446	Both dates provide minimum ages for deglaciation.
	190. Site 6, Saskatchewan 56°07'30"N, 104°24'20"W		Basal sediment 8230 ± 250 GSC 1466	
Mott 1972	Ontario, Québec			Description of cores collected. No C^{14} dates or pollen diagrams.
Mott 1973A	183. Clearwater L., Saskatchewan	1270 cm	1250-1260cm 7590 ± 220 GSC 1506 9310 ± 150 GSC 1506-2 60-70 1120 ± 190 GSC 1563-1 1260 ± 190 GSC 1563-2	Dominated by herbs. *Pinus* (probably *contorta*) only abundant tree. Zone CIII (1270-1200) - *Ambrosia*-Chenopod zone. Zone CII (1200-60) - *Artemisia*-Gramineae zone. Zone CI (60-0) - Chenopodiineae-*Selaginella densa* zone.

(Ed. note: Lowden and Blake 1975:15-16 give the following data on the "Clearwater Lake series": Mott comments that the basal sediments "are probably no older than 6500 years".)		60-70 cm (inorganic) 1300 ± 190 GSC 1563 60-70 (organic) 1170 ± 190 GSC 1563-2 1250-1260 (inorganic) 9310 ± 150 GSC 1506 1250-1260 (organic) 7580 ± 220 GSC 1506-2	
187. Lake A, near Prince Albert, Saskatchewan 53°14'15"N, 105°43'30"W	600 cm	590-620cm 11560 ± 640 GSC 648	Zone A-V (560-600) - spruce-Cyperaceae. Zone A-IV (510-560) - decrease in spruce and Cyperaceae; increase in birch, grass, Chenopods, *Artemisia*. Zone A-III (510-350) - decrease in birch, spruce, sedge; increase in Gramineae, *Artemisia*. Zone A-II (350-140) - decrease in herbs; increase in birch, alder and *Pinus banksiana*. Zone A-I (140-0) - *Pinus banksiana* predominates; decreased birch, alder and herbs.
188. Lake B, Saskatchewan 53°48'N, 106°04'45"	510 cm	496-504cm 10260 ± 170 GSC 647	Zone B-V (460-510)- spruce assemblage; Zone B-IV (460-420) - higher *Artemisia*, Gramineae, sedges, chenopods; slight decrease in spruce; increase in birch. Spruce-herb assemblage. Zone B-III (420-270) - decrease in spruce; increase then decrease in *Pinus banksiana*; increase in birch, alder. *Pinus banksiana*-herb assemblage. Zone B-II (270-220) - increase in *Pinus banksiana*, birch; decrease in herbs. *Pinus banksiana*-*Betula* assemblage. Zone B-I (220-0) - decrease in birch. *Pinus banksiana* assemblage.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Mott 1973A continued	189. Cycloid L., Saskatchewan 55°16'N, 105°16'W	340 cm	323-328cm 8520 ± 170 GSC 643 257-262 6000 ± 170 GSC 1335	Zone Cy-V (330-340) - *Picea-Salix* assemblage. Abundant herbs, spruce, willow. Zone Cy-IV (315-330) - increase in spruce; slight decrease in herbs and shrubs. Spruce assemblage. Zone Cy-III (255-315) - decrease in spruce, herbs. Increase in birch, alder. Birch-alder assemblage. Zone Cy-II (170-255) - increase in *Pinus banksiana*; decrease in birch, alder. *Pinus banksiana-Betula* assemblage. Zone Cy-I (0-170)- *Pinus banksiana* assemblage. Boundary of I and II is where pine reaches minimum values before increasing again.
Mott 1973B	193. N. Manitoba 56°28.6'N, 97°44'W	Moss remains sampled. Base of organic layer not reached.	423-428cm 5430 ± 210 GSC 1782	Mosses (identified by Kuc) - *Drepanocladus exannulatus* and *Calliergon trifarium*.
	194. N. Manitoba 56°18.7'N, 97°57.5'W		172-175cm 6920 ± 150 GSC 1818	A minimum for deglaciation.
	196. N. Manitoba 54°44.5'N, 101°40.8'W		371-376cm 8080 ± 150 GSC 1825	Much younger than would be expected for deglaciation.
Mott 1974A	Alberta, Québec			Description of coring work done in 1973 and 1974.

Mott 1975A	331. L'Anse aux Meadows Norse Site, Newfoundland	80 cm (monolith 2)	60cm 640 ± 50 GSC 2051 80 2150 ± 60 GSC 2076	Spruce, fir only tree pollen in significant amounts. Birch common, but most of dwarf species. *Alnus*, *Salix*, *Myrica*, Ericaceae most abundant shrubs. Gramineae especially abundant at base of monolith 8. Chenopods abundant in rhizome peat of monolith 8 and disappear in sedge peat. *Sanguisorba canadensis* relatively abundant in top half of both profiles. Over last 1800-2000 years, no drastic changes in vegetation of the area.
		60 cm (monolith 8)	51cm 1700(prelim) GSC 2069	
Mott 1975C	337. Basswood Road L., New Brunswick 45°15'15"N, 67°19'50"W	660 cm	160-167cm 3000 ± 150 GSC 1693 260-265 5170 ± 220 GSC 1595 347-352 6580 ± 240 GSC 1513 507-512 9500 ± 220 GSC 1643 621-626 11400 ± 180 GSC 1645 639-644 12600 ± 270 GSC 1067	Zones 9 - 1 Zones described below.
	338. Little L., New Brunswick 45°08'40"N, 66°43'W	650 cm	230-235cm 6440 ± 300 GSC 1604 392-397 9140 ± 230 GSC 1447 588-593 14300 ± 270 GSC 1272 622-629 16500 ± 370 GSC 1063	Zones 9 - 1
				Zone 9 - Gramineae, Cyperaceae, *Salix*, *Artemisia* dominant. Tundra vegetation. Zone 8 - *Populus*, *Betula* increase; herb and shrub pollen except for Cyperaceae decrease. Transition from tundra to coniferous forest (began at 12680 BP). Zone 7 - increase in spruce; decrease in birch, *Populus*. Open spruce forest (maximum at 11300 BP). Zone 6 - spruce decreases. Birch, *Carpinus/Ostrya*, Cyperaceae, Polypodiaceae increase. Toward top of zone, *Abies balsamea*, *Populus*, *Quercus*, *Myrica* and *Lycopodium* increase. (11000-9500 BP). Zone 5 - *Pinus strobus* and *Quercus* increase. Influx rates increase. *Fraxinus*, *Ulmus* and

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Mott 1975C continued				*Tsuga canadensis* present. Decrease in spruce, *Abies*, *Populus*, *Myrica*, *Lycopodium* and Polypodiaceae. (9500-6500 BP). Zone 4 - sharp increase, then decrease in *Tsuga canadensis*. Decrease in oak, pine. Increase in *Fagus*, *Acer*, *Fraxinus*. Mixed hardwood forest. (6580-5120 BP). Zone 3 - decrease in *Tsuga canadensis*. Increase in birch, *Fagus*, *Acer*. (5100-3000 BP). Zone 2 - increase in *Tsuga canadensis*, *Fagus*. *Betula*, *Quercus*, *Acer*, *Fraxinus* decrease slightly. Zone 1 - spruce increases. Gradual decrease in *Tsuga* and some other hardwoods.
Mott 1975D	333. Grand Falls, New Brunswick Bog	30 ft	17 ft 9800 ± 160 GSC 56	Localities 333 to 336 show same zonation as 337 and 338.
	334. Upper Kent, New Brunswick Marl Mine	500 cm		
	335. Hartland Bog, New Brunswick	750 cm		
	336. Fredericton Bog, New Brunswick	500 cm		
	337. Basswood Road L., New Brunswick			See Mott 1975C
	338. Little L., New Brunswick			See Mott 1975C

Mott 1976	305. "LD" L., Québec 50°08'25"N, 67°07'55"W	345 cm	335-345cm	6960 ± 300	GSC 1811	Zone LD-5 (345 to base) - *Alnus rugosa* abundant. Birch, spruce, *Abies balsamea* common. *Carpinus/Ostrya, Lycopodium annotinum*, Polypodiaceae present. Zone LD-4 (345-320) - increase in *Abies balsamea*. *Populus* consistently present. Zone LD-3 (320-245) - high birch and spruce. Clubmoss, fern and fir low. Zone LD-2 (245-170) - influx rates for spruce, birch and alder high, but rates for *Pinus strobus* and *Abies balsamea* higher. Zone LD-1 (170-top) - influx rates lower. Spruce increases slightly toward top. Alder decreases slightly.
			168-172	3390 ± 110	GSC 2032	
Mott 1977	281. L. Colin, Québec 46°43'N, 70°17.5'W	887 cm	688-694cm	11100 ± 180	GSC 2282	Zone 8 (basal) - dominated by Cyperaceae; abundant *Betula glandulosa, Alnus crispa, Salix*. Tundra conditions. Zone 7 - increase in spruce; decrease in birch, alder, willow. Spruce forest. Zone 6 - decrease in spruce, alder. Increase in *Abies balsamea, Betula* (probably *B. papyrifera*), *Quercus* and *Pinus strobus*. Closed balsam fir, white birch association. Zone 5 - Balsam fir less abundant. White pine increases; jack pine decreases. White birch abundant. Maple common. Zone 4 - decrease in pine. Increase in *Tsuga canadensis, Alnus rugosa, Betula* (probably *B. alleghaniensis*). *Quercus, Acer* decrease. *Fagus* present. Zone 3 - *Betula alleghaniensis* and *B. papyrifera* abundant. Increase in *Fagus, Acer*. Zone 2 - dominated by birch; increase in *Fagus*. Zone 1 - spruce increases. Birch still abundant, but other hardwoods decrease.
			664-668	9020 ± 100	GSC 2325	
			468-472	6360 ± 110	GSC 2329	
			296-300	4900 ± 90	GSC 2333	
			147.5-152.5	3360 ± 100	GSC 2337	
	281. Petit L. Terrien, Québec 46°35'N, 70°36.5'W	574 cm	626-638cm	12640 ± 190	GSC 312	
			Zones 8 - 1			
	282. Barnstorm L., Quúbec 45°06.7'N, 71°53'W	Top m and 450-550cm	485-495cm	11020 ± 330	GSC 420	
			Zones 8, 7, 6			
	284. Unknown Pond, Maine 45°36'N, 70°38'W	678 cm	695-700cm	14900 ± 220	GSC 1339	
			685-688	12700 ± 280	GSC 1404	
			512-518	4990 ± 140	GSC 1907	
			117.5-122.5	2780 ± 180	GSC 1929	
			Zones 8 - 1			
	284. Boundary Pond, Québec 45°34'N, 70°40.5'W	380 cm	389-392cm	11200 ± 200	GSC 1248	
			341-344	7750 ± 150	GSC 1932	
			257.5-262.5	5730 ± 130	GSC 1895	

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Mott 1977 continued			167.5-172.5 3080 ± 120 GSC 1934 82.5-88.5 1420 ± 80 GSC 1954 Zones 7 - 1	
	285. L. Dufresne, Québec 45°51'N, 70°21'W	362 cm	357-363cm 11200 ± 160 GSC 1294 345-349 9660 ± 140 GSC 2345 Zones 8 - 1	
Mott and Camfield 1969	226. Site 2 Dows L. Bog, Ontario 45°23.5'N, 75°42'W	700 cm	Zones I-IV	Zone IV (basal) - high jack pine, some white pine, birch, oak. Low spruce, NAP. Warming trend, drier conditions. Zone III - jack pine decreases; white pine dominates. Increased oak and birch. Climate similar to IV. Zone II - increased hemlock, beech, oak, elm. Decrease in white pine. Warm climate, increased moisture. Zone I - decreased hemlock, beech, white pine; increased spruce, birch. NAP increases near top. Colder, moister climate. Logging and agriculture shown near top by decrease in white pine and increase in NAP.
	226. Site 3 45°24.3'N, 75°42.5'W	4.5 ft	Basal organic material 3.9-3.95 ft 8830 ± 190 GSC 546 Zones II, III, IV	
	226. Site 4 45°24.5'N, 75°42'W	5.2-7 ft	6.8-7 ft NaOH soluble 7590 ± 140 GSC 628IP NaOH insoluble 7870 ± 160 GSC 628OP Zones II, III, IV	
	228. Mer Bleue, Ontario 45°24'N, 75°30.4'W	0-530 cm	Basal organic material 7650 ± 210 GSC 681 Zones I-IV	
Mott and Prest 1967	343. Bay St. Lawrence, Nova Scotia 47°01'N, 60°27'W	12 ft	*Larix* >38270 GSC 283	Alder high throughout the samples. Birch increases in uppermost sample.
	345. Benacadie, Nova Scotia 45°54'N, 60°42'W	Sub-till silts sampled.		Only one sample had enough pollen to be reliable. High pine, Gramineae and Cyperaceae. Smaller amounts of birch, alder and spruce.

	347. Hillsborough, Nova Scotia (2 sections) 46°04'N, 61°22'W	25-31 ft 11	*Abies* from base of 4 ft peat layer (section 2) >51000 GSC 570	5 zones. Lowest zone - in silty clay. Abundant alder, high Gramineae, low conifers. Next zone - high *Abies balsamea*. Next zone - high *Pinus banksiana*, *Picea*, *Larix laricina*. Some *Betula*, *Alnus*. Cyperaceae abundant. Next zone - spruce decreases; alder and birch increase. Top zone - willow and birch increase. Alder decreases.
	347. Whycocomagh, Nova Scotia 45°58'N, 61°07'W	4 ft	*Larix* >44000 GSC 290	Base - high *Abies*; some alder, birch, spruce. Middle - high spruce; some *Abies*; less alder, birch. Top - increase in alder, birch.
Müller 1963	137. Expedition area, Axel Heiberg I., Northwest Territories		Organic material at interface between the recent moraine and outwash gravels 240 ± 100 B 464 2.5m depth in outwash fan 2219 ± 205 GX 0140 Lowest layer of peat (see Hegg 1963) 4210 ± 100 (Bern) Driftwood from beneath Thompson Glacier 5480 ± 100 B 431 5920 ± 100 B 432 Driftwood on push-moraine 5325 ± 270 GX 0144 Shells on raised marine beaches 5330 ± 195 GX 0143 6840 ± 120 B 434 7100 ± 100 L 647E 9000 ± 200 L 647F	
Nichols 1967A	124. Ennadai L., Northwest Territories			See Nichols 1967B
	192. Lynn L., Manitoba			

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Nichols 1967B	124. Ennadai L., Northwest Territories 61°10'N 100°55'W	150 cm	10cm 630 ± 70 WIS 133 20 1510 ± 80 WIS 88 33-36 1530 ± 80 1250 ± 75 1280 ± 75 55 2670 ± 105 WIS 93 73 3140 ± 105 WIS 139 90 3650 ± 100 WIS 80 110 4800 ± 90 WIS 166 130 5570 ± 100 WIS 85 130 5720 ± 110 WIS 85 150 5780 ± 110 WIS 67	8000-5700 BP - relatively warm climate (high alder and spruce at base). Wet climate at Ennadai (high *Sphagnum*). Low NAP at both. Rapid expansion of spruce forest. 5700-3600 BP - low *Sphagnum*; high alder, spruce. Warmer period. 5100 (Lynn Lake), 4800 (Ennadai Lake) - decrease in spruce. Opening up of spruce forest. 3600-2600 - Lynn Lake - alder decreases. Pine then birch increases. Ennadai Lake - spruce variable. Cooler period. 2600-1500 - Ennadai Lake - low *Sphagnum*; increase in Ericaceae; irregular spruce. Drier, colder climate. 1500-present - Ennadai Lake - begins with peak of spruce and *Sphagnum*. Then decline in spruce and *Sphagnum* and rise in NAP. Colder, drier. Retreat of forest south; tundra vegetation at north end of lake.
	192. Lynn L., Manitoba	140 cm	35cm 2170 ± 80 68 5130 ± 100 WIS 112 68 5140 ± 100 WIS 112 120 5970 ± 110 120 6060 ± 110 134-140 6530 ± 130 WIS 72	
Nichols 1967C	124. Ennadai L., Northwest Territories			See Nichols 1967B
	192. Lynn L., Manitoba			
Nichols 1968	Northwest Territories			Short note on paleoclimatic reconstruction based on pollen analysis for Ennadai Lake.
Nichols 1969	198. Clearwater Bog, Manitoba 53°59'N, 101°12'W	80 cm	26-30cm 250 BP WIS 170 62-63 250 BP WIS 153 71 410 ± 60 79 940 ± 60 WIS 173	Base - spruce low but rising. Pine, *Sphagnum*, NAP low. 65cm - decrease in spruce and pine - probably a result of fire. Subsequent pine

		80cm	1280 ± 75	WIS 146	peak due to recolonization. 50cm - spruce recovers - dominates through rest of diagram. 30cm - low peaks of alder and birch; rise in Chenopods and *Ambrosia* - drier conditions. Top of diagram - *Sphagnum* increases. Wetter climate.
200. Porcupine Mountain, Manitoba 52°31'N, 101°15'W	220 cm	30cm	250 BP	WIS 301	Base to 6670 BP - high spruce, willow; some Cyperaceae, *Artemisia*, *Ambrosia*. Probably spruce forest with local open disturbed areas. Relatively cool, moist climate. Then increase in Gramineae, birch, *Artemisia* - warmer drier summers. 6670-5140 BP - low spruce; increasing birch, pine, Gramineae, Cyperaceae, *Artemisia* - establishment of prairie. Warm, dry summers. 5140-4180 BP - pine decreases; spruce increases slightly. Some birch, Gramineae, *Artemisia*. High Cyperaceae. Spruce increase due to southward shift of Boreal Forest. Still warm dry summers, but less so than in previous zone. 4180-2450 BP - spruce increases. Pine very low, rising late in zone. NAP low. *Sphagnum* high. Closed spruce forest - cooler, wetter summers. Change to *Sphagnum* peat bog. 2450-2000 BP - spruce high and irregular; pine increasing after 2270 BP. NAP low; *Sphagnum* increases. Spruce forest. Pine perhaps encouraged by fire. Cool, moist summers. 2000-1170 BP - spruce low, pine high - reverses after 65cm. *Sphagnum* first falls, then increases again. At first, mixed pine-spruce forest, then changed to spruce forest (wetter climate). 1170-present - spruce high until 25cm, then falls. Pine
		50	1170 ± 60	WIS 287	
		79	2000 ± 55	WIS 289	
		100	2270 ± 60	WIS 303	
		118	2450 ± 60		
		143	4180 ± 75		
		172	5140 ± 75	WIS 308	
		200	6670 ± 70	WIS 271	

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Nichols 1969 continued				high. NAP low to 25cm, then rises. Closed spruce forest with some pine. At 20cm, spruce forest partially destroyed. First appearance of *Cerealia* pollen. Herbs increase. Result of logging and agriculture.
Nichols 1970	122. Pelly L., Northwest Territories 66°05'N, 101°04'W	35 cm	6-10cm 900 ± 75 WIS 245 26-28 2080 ± 60 WIS 292 33-36 3360 ± 70 WIS 216	Pine and spruce - moderate at 35cm, decline, then rise to maxima at 10cm, fall toward top. Thought to be result of variations in air currents. Compatible with climate changes suggested by Fredskild 1969 in Greenland.
	122. Drainage L., Northwest Territories 66°08'N, 101°04'W	30 cm	13-14cm 900 ± 60 WIS 278 26-28 1060 ± 55 WIS 263	Pine and spruce percentages similar to Pelly Lake. High Cyperaceae and Ericaceae at base - colonization because of wetter ground. 25cm - Ericaceae peak. 15cm - Cyperaceae peak - perhaps drier conditions.
				Deposition at these sites began at the end of a period of warm-dry summers. Then came a severe cold episode. This was followed by an amelioration, then a return to cold.
Nichols 1972	113. Colville L., Northwest Territories 67°06'N, 125°47'W	215 cm	215cm 6790 ± 75 WIS 275 175 6630 ± 85 WIS 299 125 5730 ± 75 WIS 296 90 4130 ± 55 WIS 294 70 3980 ± 65 WIS 295 45 3180 ± 65 WIS 314 35 1810 ± 60 WIS 297	Base - open spruce-birch forest. 6790-6630 BP - spruce forest denser, birch decreases. 4130-3180 BP - cooler, wetter summers. Just after 3180 BP - spruce and *Sphagnum* decrease - cold, dry summers. Tundra. Lasted until 1810 BP when slow Ericaceae peat growth began. Spruce percentages did not recover. Paper also includes many other

						previously published diagrams from central and eastern Canadian Arctic. Correlations of climatic trends over time in the area.
Nichols 1974	Alaska, Canada Greenland					Many previously published diagrams from central and eastern Arctic; some discussion of previous work from Greenland and Arctic Alaska. Correlations of climate over time in the area.
Nichols 1975	114. Port Radium, Northwest Territories Site A 66°06'N, 117°58'W	120 cm	113-117cm 115-135 37-41	5600 ± 140 4800 ± 110 2500 ± 90	GSC 1783 Gak 5054 Gak 5044	Basal sample - low counts. Then high birch, fairly high spruce. Low pine, willow. At *ca.* 5000 BP - spruce peak; short pine peak; decrease in birch. At 4800 BP - decrease in spruce, alder. 4250 BP - increase in pine, spruce, alder, *Sphagnum*. Sawtooth falls in spruce, pine. 3000 BP - spruce, pine, birch low. 2500 BP - decrease in *Sphagnum*, alder; increase in Ericaceae. 1900-950 BP - modest recovery of spruce and pine. 750 BP to top - decrease in spruce and pine and *Sphagnum*. 200 BP - increase in Ericaceae
	114. Port Radium, Northwest Territories Site C 66°05'N, 118°01'W	55 cm	52-56cm 33.5-36.5 4-6.5	1560 ± 70 950 ± 60 130 ± 70	GSC 1839 Gak 5047 Gak 5058	Basal sample - low to moderate spruce; high *Sphagnum*. 950 BP - peak in spruce followed by its immediate decrease. Increase in *Artemisia*. 400 BP - recovery of spruce. 130 BP to top - dominated by alder; high Ericaceae.
	115. Thompson Landing, Northwest Territories 63°04'N, 110°47'30"W	160 cm	157-159cm 74-76 23-25 4-6	6170 ± 130 4300 ± 100 3380 ± 105 130 ± 70	GSC 1840 Gak 5044 Gak 5050 Gak 5055	6170-4900 BP - moderate spruce, alder, other taxa low. 4900-4500 BP - decrease in alder, spruce. 4500 BP - increase in alder, spruce, *Myrica*. 4500-3800 BP - spruce increases and decreases. 3800-3350 BP - increase in spruce, pine, alder, birch.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Nichols 1975 continued				3350 BP to top - pine, spruce, alder birch decrease; Ericaceae increase. Topmost sample - high alder, birch, spruce, pine.
	116. Coppermine Beach. Northwest Territories 67°50'N, 115°19'W	62.5 cm	4-6 cm 230 ± 50 Gak 5063 21.5-24 1430 ± 80 Gak 5064 35-37.5 1920 ± 85 Gak 5065 52-54.5 2180 ± 90 Gak 5066 60-62.5 2500 ± 140 GSC 1517	Base - low alder, spruce, pine. 2150 BP - temporary recovery of alder, spruce, pine. 1700-1600 BP-decrease in alder, spruce, pine. 1500 BP - high occurrences of the 3 genera. 1275 BP - reduction of the 3. 770 BP - gain of the 3. 230 BP - reduction of the 3. *Betula glandulosa* low after 2500 BP; moderate after 2000 BP; high after 1430 BP; decreases from 230 to the top. Willow - low until 1000 BP; peaked then decreased after 800 BP. Grasses - low until 1000 BP; reached maximum, then moderate to the surface.
	116. Saddleback Hill, Northwest Territories	110 cm	102-104cm 3715 ± 120 GX 1813 99-99.5 2920 ± 100 Gak 5052 85-89 3100 ± 110 Gak 5053 27-29 2120 ± 100 Gak 5054 8-10 130 ± 70 Gak 5055	Spruce, pine, fir low until 3250 BP. They increase, then decrease from 3100-2800 BP. Spruce variable until 2120 BP. 1300 BP - decrease in spruce. *Betula glandulosa* dominates until 2150 BP, then becomes low to the surface. Willow is more or less stable with a decrease at 3400 BP and peaks at 600 and 130 BP. Grass increases after 1100 BP.
	124. Ennadai L., Northwest Territories 61°14'40"N, 100°57'05"W	290 cm	286-289cm 4690 ± 140 GSC 1781 264-267 970 ± 70 Gak 5056 224-227 4520 ± 110 Gak 5057 142-144 4520 ± 100 Gak 5048 102-104 3340 ± 120 Gak 5059 61-63 2960 ± 100 Gak 5060 3-6 870 ± 60 Gak 5062	4690-4000 BP - high spruce. In lowest metre - high alder, some birch, pine. 4000-2960 BP - decrease in spruce, alder, birch, pine, *Rubus*; increase in *Sphagnum*. 2960-870 BP - low spruce, pine, alder, birch; high *Sphagnum*. Increase in Ericaceae.

	151. Maktak Fiord, Northwest Territories	100 cm	92-95cm 51-53 24-26 1-5	2500 ± 170 2240 ± 190 1970 ± 200 1480 ± 160	Birm 380 Birm 536 Birm 535 Birm 370	90-100cm - high Gramineae and Cyperaceae. 85-90cm - willow dominates. 70-85cm - decrease in willow; increase in Gramineae, Cyperaceae, *Potentilla*. 52.5-70cm - decrease in Gramineae; increase in Cyperaceae, alder, spruce. 27.5-52.5cm - increase in Cyperaceae; later increase in Gramineae, Ericaceae, willow. 15-27.5cm - decrease in Cyperaceae, Gramineae, willow, Ericaceae. 15cm to top - decrease in Gramineae; increase in pine.
	153. Windy L., Northwest Territories 66°31N, 65°29'W	120 cm	115-118cm 68-70 2.5-5	3840 ± 55 2060 ± 85 850 ± 65	DIC 328 Gak 5412 DIC 3277	Base to 2060 BP - high Gramineae; fairly high Ericaceae; some Caryophyllaceae. 3250-3100 BP - willow peak. 2060 BP - *Sphagnum* peak. Upper half of diagram - dominated by Gramineae; some alder, spruce, pine.
Nichols 1976A	Arctic Canada					Abstract only: uniform treeline response to summer climatic parameters. 6500-4800 BP - warmer summers than present. 4800-4600 BP - cold. 4600-3600 BP - warm. 3600-3000 BP - cold, then warm. 3000-2000 BP - cold. 2000-800 BP - minor warming. 800-0 BP - cold with recent warming.
Nichols 1976B	116. Coppermine, Northwest Territories		*Picea*	3715 ± 120	GX 1813	Fossil pollen diagrams have been prepared from the Coppermine core but are not published in this paper. Discusses 2 possible historical explanations for present-day northern tree-line. Mentions 6 unpublished fossil pollen diagrams from northern Labrador by S.K. Short.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr. B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Ogden 1960	353. Caribou Bog, Nova Scotia 45°02'N, 64°46'W	650 cm		Zone A (610-650) - pre-pine spruce maximum. Zone B (480-610) - dominated by *Pinus banksiana*. Zone C1 (340-480) - increase in beech, hemlock, oak; decrease in pine. Red pine replaces white pine. Increase in ericads. First recurrence horizon. Climate warmer than Zone B. Zone C2 (305-340) - Recurrence horizon. Gap in pollen stratigraphy. Zone C3a (220-305) - increase in hemlock beech, spruce, birch. Climate warmer than Zone C1, but cooling. Recurrence horizon - brief interval of decreased moisture. Zone C3b (0-220) - increase in spruce, beech, sedges; decrease in ericads, birch. Cooler climate. Recurrence horizon.
Ogden 1965	E. North America			Review paper on pollen records from eastern North America. Also mentions modern pollen spectra, plant macrofossils and pollen analysis as it relates to mammal remains, archaeology and sea-level rise and fall.
Ogden 1971				General discussion of postglacial vegetational history using Silver L. in New England as example.
Ogden 1977A	N.E. North America			Review paper discussing the Wisconsin Ice retreat and revegetation of northeastern North America based on pollen spectra and C^{14} dates from many previous papers.

Osvald 1970	339. Spruce L., Bog, New Brunswick	5 m		4-5m - *Tsuga* high; fir, spruce low. Pine and birch dominant over almost whole diagram. Just above 3m, pine decreases - change in climate from Sub-boreal to Sub-atlantic.
	350. Glasgow Head Bog, Nova Scotia	5.7 m		Pollen flora fairly uniform. Just below 4m (transition from dry to wet period) - decrease in *Tsuga*, *Abies*, *Quercus*, *Corylus*.
				Descriptions of vegetation and peat stratigraphy of many bogs from the U.S., Nova Scotia and New Brunswick, near Edmonton, Alberta and along the Pacific Coast, B.C. A few of the bogs have pollen diagrams - the Canadian examples with diagrams are given above.
Penhallow 1896	209. Moose and Missinaibi rivers, Ontario		(Ed. note: macrofossils are probably of Sangamon Interglacial age (see Skinner 1973)).	Macrofossils from peat - *Larix americana*, *Picea nigra*, *Distichium capillaceum*, *Hypnum recurvans*, *Lycopodium* sp.
	227. Besserers Wharf 14 miles downstream from Ottawa, Ontario		(Ed. note: age of organic material preserved in clay nodules is probably about 10000 B.P. (see Harington 1978)).	Macrofossils from clay nodules: *Typha latifolia?*, *Populus balsamifera*, *Vallisneria* sp., *Hypnum fluitans*, Cyperaceae, *Potamogeton perfoliatus*, *P. rutilans*, *P. pusillus*, *P. pectinatus*, *Equisetum limosum*, *Betula lutea?*, *Potentilla anserina*, *Fucus digitatus*.
Porsild 1938	109. Pingorssarajuk, Northwest Territories 69°04'N, 134°18'W			Lists plant macrofossils (*Sphagnum*, *Potamogeton epihydrus*) and gives short list of pollen (*Alnus*, *Betula*, *Picea*, *Salix*, *Sphagnum*, Ericaceae). General discussion of pingos.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr. B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS		
				Zonal Characteristics of Geographic Regions based on Analyses of Bog Deposits		
			Suggested Climate	Gaspé	St. Lawrence Lowland	Laurentian Shield
Potzger 1953	256. L. des Loups, Québec	14.5 ft				
	257. L. Coupal, Québec	10.5	5. Colder and moist	Spruce-fir, paper birch, decline of pine.	Increase of spruce-fir, paper birch, broadleaved genera, yellow birch, appearance of chestnut, decline of pine and hemlock.	Spruce-fir, decline of pine and hemlock, increase of paper birch, yellow birch. Declining oak and beech.
	260. Bellerive, Québec	30.5				
	260. Nominingue, Québec	5.5				
	262. Saint-Michel, Québec	4.5				
	263. Sainte-Agathe, Québec	21.75	4. Warm, moist	Pine, paper birch, yellow birch, beech intrusion, decreasing oak.	Hemlock, pine, beech, and other broadleaved genera; rising spruce-fir.	Pine, hemlock, yellow and paper birch, low beech peak, spruce-fir increase, persistent low oak.
	263. Nantel, Québec	8				
	264. Saint Janvier, Québec	5	3. Warm, dry	Pine, decline of spruce-fir, increase of broadleaved genera.	Pine peak, decline of paper birch and hemlock. Spruce-fir very low. Increase in oak.	Pine peak, increase in oak. Decrease in paper birch. Very low spruce-fir.
	267. Farnham, Québec	15				
	270. Sainte-Victoire, Québec	16.5	2. Colder, moist	Spruce-fir, decrease in pine, increase in paper birch. Some oak.	Spruce-fir higher. Small decrease in pine, small increase in paper birch. Increase in oak and other broadleaved genera.	Spruce-fir increase, slight decrease in pine, slight increase in paper birch.
	270. Lanoraie, Québec	8.5				
	297. R. Eternité I, Québec	5.5				
	297. R. Eternité II, Québec	22.5	1. Initial warm period	Pine high, spruce-fir low, rising paper birch, some oak.	Pine high, spruce-fir low, low hemlock peak, rising paper birch, low oak.	Pine high, low spruce-fir and paper birch, low oak prominence.
	298. Saint-Siméon, Québec	23.4				

	299. Rivière-du-Loup, Québec	15.33		
	300. Saint-Fabien, Québec	16.5		
	301. Amqui I, Québec	12.5		
	301. Amqui II, Québec	30		
	302. Saint-Omer, Québec	6		
Potzger and Courtemanche 1954A	260. 6 bogs in Mont Tremblant Park, Québec 46°30'N, 74°30'W	11.5 to 40 ft		Initial invaders were *Pinus banksiana*, *Betula papyrifera*, some *Picea*, *Abies* and *Quercus*. Initial warm period. Then spruce-fir increased (boreal period - deterioration of climate). Pine peak at mid-profile - warm-dry period. Then an increase in hemlock and white and red pine - moister, cooler climate. Continued cooling favoured spruce, fir and yellow birch.
Potzger and Courtemanche 1954B	248. Smoky Hill Rapids Bog, Québec 51°28'N, 78°45'W		2350 ± 200 (Lamont Geol. Observatory) (Ed. note: date corresponds to that on basal peat from nearby Smoky Hill Falls (locality 247) given the laboratory number "Lamont 219").	During the past 2350 years, climate has cooled and become more humid.
Potzger and Courtemanche 1956A	228. Newington, Ontario 45°07'N, 74°58'W	21.25 ft		Zone Q-1 - initial warm period; prominent pine peaks and minor oak peak. Zone Q-2 - colder, moist - spruce-fir period. Zone Q-3 - maximum warmth, dryness - long, prominent pine climax. Red-white pine group occurred north to the
	246. Jack R., Québec 51°59'N, 78°04'W	9.5 ft		

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Potzger and Courtemanche 1956A continued	247. Rupert House, Québec 51°28'N, 78°45'W	6.5 ft		Lacroix River area; jack pine occurred from Clova north. Zone Q-4 - warm, moist. Zone Q-5 - colder, moist. Similar to present-day vegetation.
	247. Smoky Hill Falls, Québec 51°27'N, 78°32'W	10 ft	basal peat 2350 ± 200 Lamont 219	
	249. L. Horden, Québec 50°54'N, 77°55'W	14 ft		
	250. Iroquois Falls, Québec 50°39'N, 78°02'W	9.75 ft		
	250. L. Soscumica, Québec 50°24'N, 77°46'W	13.5 ft		
	251. Bachelor L., Québec 49°32'N, 76°08'W	9 ft		
	252. L. Lacroix, Québec 49°02'N, 75°23'W	19.5 ft		
	253. Clova Bog, Québec 48°07'N, 75°22'W	21.5 ft		
	259. L. Mazanaskwa, Québec 47°07'N, 74°32'W	26 ft		
	259. L. Rouge, Québec 46°56'N, 74°40'W	21 ft		

	259. Creek Savanne, Québec 46°26'N, 74°12'W	20.6 ft	
	260. L. Shaw, Québec 46°19'N, 74°32'W	24.5 ft	
	260. Mont Tremblant, Québec 46°15'N, 74°34'W	7 ft	
	260. Lac à Pit, Québec 46°11'N, 74°29'W	36 ft	
	261. Lac des Plages, Québec 46°00'N, 74°51'W	39 ft	
	263. Saint-Lin, Québec 45°55'N, 73°47'W	21 ft	
	229. Alfred, Ontario 45°30'N, 74°48'W	20.5 ft	
Potzger and Courtemanche 1956B	258. Gatineau Valley Kazabazua Bog, Québec 45°57'N, 76°04'W	30.3 ft	Initial warm period - high oak and pine, low spruce and fir. Cooling - increased spruce. Followed by increased *Pinus banksiana*, decreased spruce and fir. Then *Pinus strobus/resinosa* forest with minor hemlock peak. Then pine - spruce-fir - birch forest which suggests cooling climate during the recent past.
	258. Lacroix Bog, Québec 46°16'N, 76°00'W	16.3 ft	
	258. Hobblety Ck., Québec 46°11'N, 76°21'W	21.3 ft	
	258. Cleaver L., Québec 46°13'N, 76°27'W	17 ft	

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Potzger and Courtemanche 1956B continued	258. Brock L., Québec 46°17'N, 76°21'W	13 ft		
Prest, Terasmae, Matthews, and Lichti-Federovich 1976	304. Portage-du-Cap, Amherst I., Québec	Buried peat deposit 2-23cm analyzed.	"age of peat is more than 35000 radiocarbon years"	*Picea*, *Pinus*, *Abies*, *Betula*. High *Quercus*, *Fagus*. Low *Carya*, *Acer*, *Tilia*, *Alnus* and *Salix*. Similar to postglacial peat deposits.
	304. Boudreau I., Québec	Peat exposure 250cm.		Macrofossils and diatoms also studied. Evidence indicates that Portage-du-Cap peat was deposited during a warmer interglacial.
Radforth 1945	296. Shipshaw area, Québec			Whole peat layer mixed and sampled - not successive layers studied. Tree pollen identified to genus. Other pollen and spores identified to family. Pine predominated in the ancient flora. Concludes that deposit is interglacial (possibly Sangamon).
Radforth and Terasmae 1960	237. Don and Scarborough Beds, Toronto area, Ontario		Sangamon interglacial to early Wisconsin glacial.	Three assemblages (lower, middle and upper) from both the Don and Scarborough beds. Don beds - lower - temperate conditions; middle - thermal maximum; upper - cooler climate (coniferous). Scarborough beds - lower - boreal forest spectrum; middle - not stated; upper - coniferous. Don beds belong to Sangamon interglacial. Scarborough beds deposited during a non-glacial interval, cooler than the present.

Railton 1975	Nova Scotia		Gives C^{14} dates from previous papers on Nova Scotia.	Compares Nova Scotian pollen stratigraphy with that of Maine (Deevey, 1951). From previous work, states that Nova Scotian spectra show the classical sequence of climatic changes.
Rampton 1971	102. Antifreeze Pond, Yukon Territory 62°21'N, 140°50'W	6.4 m	250-255cm 5690 ± 140 GSC 1040 293-298 8710 ± 160 GSC 1242 317-320 9980 ± 150 GSC 1042 398-403 13500 ± 300 GSC 1110 512-532 31500 ± 700 GSC 1048 515-524 28500 ± 440 GSC 1257 540-552 27100 ± 390 GSC 1198 622-634 29700 ± 700 GSC 1230 Base of adjacent bog (550cm) >36000 GSC 496	Zone 1 (base to 27100 BP) - dominated by Cyperaceae and Gramineae. Some spruce, alder, willow, *Artemisia*. Zone 2 (5.5-5.2m) - begins with sharp drop in spruce, alder *Lycopodium*, *Sphagnum*. High birch, NAP. Upper boundary defined by drop in birch. Zone 3 (5.2-3.2m, 9980 BP) - similar to Zone 1 but less spruce, alder and *Lycopodium* and more birch. Zone subdivided at 4m due to rise in *Myriophyllum*, *Hippuris* and Cyperaceae. Zone 4 (9980-8710 BP) - high birch; lower Cyperaceae and Gramineae. Some Ericaceae, *Potentilla*, *Equisetum*. Zone 5 (8710-5690 BP) - high spruce and birch; some alder and *Menyanthes*. Cyperaceae and Gramineae decrease toward top of zone. Zone 6 (5690-top) - increase in alder at base; *Menyanthes* and *Artemisia* decrease at base. 31000-27000 BP - fell-field or sedge-moss tundra followed by shrub tundra. 27000-10000 BP - sedge-moss tundra. 10000-8700 BP - shrub tundra. 8700-5700 - spruce woodland. 5700-present - spruce forest.
Richard 1971	289. St-Jean Bog, Québec 47°56'N, 71°56'W	420 cm	80cm 1180 ± 100 Gif 1756 280 3800 ± 140 Gif 1757 340 6100 ± 160 Gif 1758	(Bottom to 395) - *Picea mariana* dominated forest. (395-370) - *Abies balsamea* - *Betula papyrifera* forest. (370-350) - *Abies balsamea* - *Betula lutea* forest. (350-310) - *Pinus strobus* maximum - not thought to be from the region. (320 to surface) - *Acer saccharum*

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Richard 1971 continued				present with *Tilia americana*, *Betula lutea*. 260 - *Fagus grandifolia* increases. 40 to top - deforestation. *Ambrosia* increases.
	290. L. Joncas Bog, Québec 47°15'30"N, 71°09'45"W	450 cm	220cm 4710 ± 170 I 4756 380 7140 ± 130 I 5083	(Bottom to 380) - tundra-like, low pollen productivity. Cyperaceae, Gramineae, willow, alder and *Artemisia* present. (380-300) - afforestation phase. (375-340) - dwarf birch present. (340-315) - increase in *Picea mariana;* still abundant *Betula glandulosa* but also some *B. papyrifera*. (315-300) - dominated by *Abies balsamea*. (260-40) - *Abies-Betula* forest. (40 to top) - tree felling. *Rumex*, *Plantago* occur.
Richard 1973A	287. Saint-Raymond, Québec 46°53'30"N, 71°48'30"W	570 cm	270-285cm 3550 ± 120 Gif 1759 550-560 7970 ± 140 GSC 1400	First vegetation was herbs and shrubs; rapidly replaced by open spruce forest (most *Picea glauca* but also some *P. mariana*). Followed by white birch-balsam fir community; then by yellow birch-balsam fir community. Sugar maple stands containing yellow birch replaced fir stands and maintained themselves until the present.
Richard 1973B	293. Montagnais, Québec 47°54'30"N, 71°10'30"W	450 cm	410-420cm 8510 ± 140 GSC 1417	(450-415) - open vegetation. Dominated by Gramineae, Cyperaceae (also herb species with arctic distributions). Some *Betula glandulosa*, *Shepherdia canadensis*, *Salix*, *Alnus crispa*. (415-385) - afforestation phase - decrease in dwarf birch, alder. Increase in *Betula papyrifera*, *Pinus divaricata*, *Picea glauca*, *Abies balsamea*.

					(380-330) - dominated by *Abies balsamea;* decreased white birch. (330-260) - *Picea mariana- Abies balsamea* forest. (260-100) - increase in white birch. (100-0) - increase in *Picea mariana, Abies balsamea;* decrease in white birch.
	295. Kénogami, Québec 48°22'N, 71°34'W	700 cm	690-700cm	7630 ± 120 I 7158	(700-660) - *Picea glauca* and *P. mariana* initial vegetation. (660-610) - white birch on mesic sites. (610-465) - decrease in white birch; increase in *Picea mariana.* (465-440) - increase in yellow birch. Some *Ulmus americana, Fraxinus nigra.* (440-340) - increase in *Ulmus* and *Fraxinus* (on wet sites). Decrease in *Pinus divaricata.* More favourable climate. (340-190) - yellow birch forest. (190-30) - yellow birch remains the same; increase in *Picea mariana.* (30-0) - colonization. Cereal, *Ambrosia, Rumex* pollen appear.
Richard 1973C	279. Dosquet, Québec 46°27'N, 71°30'W	600 cm	580-590cm	8835 ± 145 I 7157	(590-550) - *Betula glandulosa, Alnus crispa, Juniperus communis, Shepherdia canadensis* and *Populus tremuloides.* (550-490) - increase in *Abies balsamea. Betula papyrifera* replaces *B. glandulosa.* (490-335) - increase in *Pinus strobus, Betula lutea, Acer saccharum;* decrease in fir. (335-55) - *Fagus grandifolia, Tilia americana, Carpinus/Ostrya, Juglans cinerea, Fraxinus pennsylvanica* - similar to present-day forest. (55-0) - colonization.
	280. Lac à Busque, Québec 46°17'N, 70°36'W	0-610cm and 690-720	520-570cm	9100 ± 150 I 7156	(720-595) - tundra - *Alnus crispa* and herbs. High tree pollen due to long-distance transport. (595-575) - dominated by Cyperaceae, *Artemisia, Shepherdia canadensis,*

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Richard 1973C continued				*Juniperus* and herbs with arctic distributions. (575-525) - dominated by dwarf birch; increased *Picea mariana;* some *Populus tremuloides.* (525-460) - increased *Abies, Betula papyrifera.* (460-280) - increased *Acer saccharum, Betula lutea.* This forest has dominated until present.
Richard 1975A	275. Princeville, Québec 46°08'N, 71°56'W	320 cm		(320-290) - very open dwarf birch landscape. (290-243) - vegetation becomes more dense. *Pinus divaricata* appears. (245-185) - *Abies balsamea-Betula papyrifera* forest. (185-85) - *Acer saccharum-Betula lutea* forest. *Tsuga canadensis, Fraxinus nigra, Ulmus* increase slightly. (85-20) - increase in *Fagus;* decrease in *Tsuga, Quercus.* (20-0) - frequency low.
	277. Lotbinière, Québec 46°36'20"N, 71°46'30"W	350 cm		(250-335) - afforestation. High *Picea mariana, Betula glandulosa.* Open *Betula glandulosa, Salix, Alnus crispa* thickets. (335-300) - *Picea mariana* forest with some *Betula papyrifera* and *Abies balsamea.* (300-250) - dominated by *Abies balsamea,* first in association with *Betula papyrifera,* then with *B. lutea.* (250-190) - *Acer saccharum-Betula lutea* forest. (190-0) - mosaic of vegetational associations (with *Quercus rubra, Ulmus americana, Fraxinus nigra, Tilia, Juglans cinerea* and others).

Richard 1975B	283. Albion, Québec 45°40'15"N, 71°19'30"W	500 cm	190-200cm 290-300 390-400 470-480	4000 ± 115 7160 ± 140 9005 ± 150 10880 ± 160	I 8144 I 8143 I 8142 I 8141	(500-480) - shrub tundra phase with *Shepherdia canadensis, Alnus crispa, Betula glandulosa*, grass, sedges, and arctic distribution herbs. (480-455) - decrease in arctic herbs. Open dwarf birch forest. (455-435) - white birch replaces dwarf birch forming more closed forest. Increase in *Abies balsamea, Quercus* at end of the phase. (435-385) - increase in white birch and *Abies balsamea* to form the forest. (385-230) - *Acer saccharum* appears. *Pinus strobus* and *Quercus* on dry sites. *Tsuga canadensis* and *Betula lutea* appear at end of phase. (230-185) - dominated by *Acer saccharum* and *Betula lutea*. *Tsuga* replaces pine and oak. (185-0) - continued *Acer saccharum-Betula lutea* forest but with more *Fagus grandifolia, Tilia americana, Castanea dentata.*
	283. Weedon, Québec 45°41'30"N, 71°25'45"W	150 cm				Profile begins with dominance of *Acer saccharum.* (Around 100) - *Acer saccharum-Betula lutea* forest. (90) - *Fagus grandifolia* appears.
Richard and Poulin 1976	291. L. Mimi Québec 47°29'50"N, 70°22'35"W	530 cm	400-410cm 425-435 455-460 470-480 480-490 500-515	7770 ± 130 9460 ± 280 10180 ± 330 9770 ± 260 9945 ± 225 11050 ± 460	QU 54 QU 70 QU 56 QU 67 I 7159 QU 55	(530-485) - tundra. 3 sub-phases. (530-513) - very low tree pollen numbers. High Gramineae and Cyperaceae. Arctic herbs well represented. Open herb tundra. (513-502) - arctic herbs decrease or disappear. Increase in willow, Ranunculaceae, *Artemisia.* Shrub tundra. (502-485) - dwarf birch phase of shrub tundra. (485-443) - afforestation. 2 sub-phases. (485-468) - *Populus tremuloides* forest with *Betula glandulosa, Juniperus, Shepherdia canadensis, Salix* and *Alnus crispa.* (468-443)- *Picea* (probably *P. mariana*) dominates. Alder very abundant.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Richard and Poulin 1976 continued				(443 to top) - forested phase - begins with appearance of *Abies balsamea*. (443-395) - *Populus tremuloides*, *Alnus crispa*, *Myrica gale*, *Juniperus*, *Shepherdia canadensis*. (395-335) - white birch forest. (335) - increase in *Acer saccharum*. (240) - increase in *Fagus grandifolia*. (140-50) - decrease in *Abies balsamea* and *Picea mariana* - recent climatic deterioration.
Ritchie 1962	Manitoba			Discussion of vegetation of northern Manitoba in relation to geology, geography and climate of the area. Short comment on post-glacial history of the region.
Ritchie 1964	203. Riding Mtn., Manitoba R Lake	4.9 m		Zones described below. Zone RI (4.25 to base). Zone RII (2.5-4.25m). Zone RIII (1.25-2.5m). Zone RIV (0-1.25m).
	203. E Lake	3.8 m	(Ed. note: see amplification and revision of results in Ritchie 1969).	Zone EI (3.3 to base). Zone EII (1.8-3.3m). Zone EIII (.9-1.8m). Zone EIV (0-.9m).
	203. F Lake	3.8 m		Zone FI (2.3 to base). Zone FII (1.5-3.2m). Zone FIII (.4-1.5m). Zone FIV (0-.4m)
				Zone I - high spruce, willow and herbs; some *Shepherdia canadensis*. Closed white spruce forest. Zone II - high NAP (including Gramineae, *Shepherdia argentea*, *Artemisia*) - widespread treeless vegetation on

				upland sites. Zone III - oak maximum; some birch and NAP - deciduous forest dominated by *Populus*, oak, birch; extensive shrub areas of hazel and willow. Zone IV - increase in spruce and alder; decrease in oak, NAP. Mixed conifer-deciduous forest - similar to present-day vegetation.
Ritchie 1966	Canada			Simplified pollen diagrams from Crestwynd and Hafichuk, Saskatchewan; Glenboro and Riding Mountain, Manitoba. Discusses late glacial and postglacial floristic history of the Western Interior (some comparisons with Minnesota).
Ritchie 1967B	202. Russell, Manitoba	368-398 cm	390 cm 10350 ± 140 I 2106 (10250 printed on pollen diagram)	About 10500 BP, shift from assemblage dominated by spruce and *Artemisia* associated with *Shepherdia canadensis* and *Juniperus* to an assemblage that cannot be equated with any contemporary spectrum. Vegetation was a mosaic of trees, shrubs and herbs. Using other cores as well, vegetational history of the area is reconstructed.
Ritchie 1969	203. Riding Mtn., Manitoba (resampling of E Lake)	4.4 m	15-20cm 775 ± 110 I 3585 40-45 1170 ± 110 I 3586 70-75 1780 ± 130 I 3587 190-195 5025 ± 120 I 3820 230-235 6130 ± 130 I 3472 270-275 7280 ± 130 I 3473 340-345 7750 ± 130 I 3474 430-435 11140 ± 200 I 3475	(440-420) - spruce-Cyperaceae assemblage. (420-390) - spruce still chief component, but increase in *Ulmus*, *Juniperus*, *Salix*, *Shepherdia canadensis*, herbs. Early Holocene spruce forest. (400) - spruce decreases sharply; grasses, Chenopods, composites, *Artemisia* increase. Grassland vegetation as a response to warmer, drier climate. (250-100) - invalidates original reconstruction (Ritchie 1964) of a Zone III deciduous forest, but diagram does not suggest a possible alternative.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Ritchie 1969 continued				(200) - increase in *Corylus;* beginning of decrease in juniper, grass, chenopods, ragweed. (100 to top) - increase in spruce, pine, larch, birch, oak, alder. Deterioration of regional climate - immigration of boreal trees and shrubs; diminution of grassland areas.
Ritchie 1972A	108. Tuktoyaktuk Peninsula, Northwest Territories			See Ritchie 1972B
Ritchie 1972B	105. Hooper I., Northwest Territories 69°42'N, 134°52'W	Diagram illegible	Lowest 11800 Near top 3720	Zonation similar to MK-5 below.
	106. Richards I., Northwest Territories 69°26'N, 134°30'W	Diagram illegible	360 cm 9390	Zonation similar to MK-5 below.
	108. Tuktoyaktuk Peninsula, Northwest Territories 69°03'N, 133°27'W	306 cm (Core MK-5)	250cm 12970 ± 170 200 11500 ± 200 180 8680 ± 230 125 5540 ± 140 70 3630 ± 140 These dates are all tentative as print on diagram is nearly illegible.	Zone 1 (180 to base) - dominated by dwarf birch; some Gramineae, Cyperaceae, *Salix*, *Shepherdia canadensis*, *Juniperus*, *Artemisia*. Shrub tundra. Zone II (130-180) - birch, shrubs and NAP decrease. Spruce increases. Forest tundra. Zone III (80-130) - high spruce. Decrease in birch and *Shepherdia*. Closed spruce forest. Zone IV (0-80) - decrease in spruce; increase in alder. Forest-tundra.
Ritchie 1976A	191. Reindeer L., Saskatchewan 56°40'N, 102°35'W	2 m	.2 m 940 ± 180 .65 2280 ± 290 1.7 5970 ± 230	Sixteen pollen diagrams presented. Only these four have not been previously published.

				Zone 1 (6500-5900 BP) - spruce dominates; some birch, juniper, willow, *Artemisia*. Zone II (5900-2300 BP) - increase in pine. Zone III (2300 - top) - increase in spruce; decrease in pine.
	195. Thompson, Manitoba 56°10'N, 97°50'W	1.7 m	Base 6920 ± 150	Zone I (6900-5800 BP) - dominated by spruce; some birch, juniper. Zone II (5800-3200 BP) - high pine; some spruce, birch and alder. Zone III (3200 - present) - increase in spruce; decrease in pine.
	197. Flin Flon, Manitoba 54°45'N, 102°05'W	5.1 m	3.8m 8080 ± 150	Zone IV (10500 BP - 5m) - spruce-herb zone. Zone III (5m to 8200 BP) - spruce, some *Artemisia*, *Salix*, *Juniperus*. Zone II (8200-6400 BP) - rise in tree birch; decline in spruce, alder, NAP. Zone I (6400 to present) - increase in pine, alder. Juniper disappears.
	204. Sewell L., Manitoba 49°35'N, 99°15'W	4.5 m	Base 13900 ± 240	Zone I (14000 - 12000 BP) - dominated by spruce, associated with grass, willow, *Artemisia*. Zone II (estimated 12000-10000 BP) - decrease in spruce; increase in juniper. Zone III (estimated 10000-4000 BP) herb assemblage - *Artemisia*, *Ambrosia*, Chenopods, Gramineae. Increase in birch, elm. Zone IV (estimated 4000-1500 BP) - decrease in elm; increase midway in oak. Zone V (estimated 1500 to present) - increase in spruce, juniper, Chenopods and *Ambrosia*.
Ritchie 1976B	111. Campbell Dolomite Upland, Northwest Territories	2.5 m		Pollen diagram will be published elsewhere. Synopsis of Quaternary vegetational history: (13000-11500 BP) - sagebrush-grass-willow assemblage. Steppe-tundra.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Ritchie 1976B continued				(11400-10300 BP) - dwarf birch assemblage. Shrub tundra. (10200-9700 BP) - dwarf birch with poplar assemblage. Dwarf birch shrub tundra on dry sites; poplar groves in valleys. (9600-9000 BP) - dwarf birch - juniper assemblage. Fully developed dwarf shrub tundra. Early herbs (several megaberingian). (8900-4900 BP) - spruce-birch-juniper assemblage. Boreal forest. (4800 - present) - spruce-birch-alder assemblage. Modern vegetation.
Ritchie and DeVries 1964	185. Missouri Coteau, Saskatchewan Hafichuk Site	5.1 m	285cm 10270 ± 150 S 188 390 10630 ± 150 S 189 495 11650 ± 150 S 190	(5.1 - 3.7) - spruce-*Shepherdia canadensis-Salix-Artemisia* assemblage. Spruce forest on all but wettest and dryest sites. Boreal forest. (3.7 - 2.85) - decrease in spruce; increase in hydric plants (*Typha*, *Scirpus*, *Carex*, *Lemna*, *Hippuris*, *Elodea*, *Ceratophyllum*). Well-developed marsh and aquatic communities around the lake. *Picea glauca-Populus tremuloides* forests on mesic sites; *Picea mariana* forest on poorly-drained sites. Climatic amelioration. (2.85 - 2.65) - similar to lower assemblage. Also lists plant macrofossils.
Ritchie and Hadden 1975	199. Grand Rapids, Manitoba (2 cores - diagram given for core 2GR)	220 cm	GR 60-70cm 3265 ± 110 I 6267 GR 140-150 6345 ± 115 I 6033 2GR 60-70 4035 ± 95 I 6265 2GR 130-140 6150 ± 110 I 6264 2GR 200-210 7220 ± 120 I 6591	Zone 2GR1 (220-120) - dominated by herbs (Gramineae, Chenopods, *Artemisia*, *Ambrosia*). Trees represented by pine, spruce, birch, some oak, *Carpinus-Ostrya*, *Ulmus*, *Fraxinus*, *Juglans*. Aquatic pollen

					at maximum. Zone 2GR2 (120-60) - dominated by pine, some spruce, birch, alder, willow, *Corylus*. NAP sharply reduced. Zone 2GR3 (60-0) - spruce, birch increases. Pine and NAP decrease. Zone 2GR1 (7300-6200 BP) - reconstructed as spruce parkland on well-drained sites. Zone 2GR2 (6200-3500 BP) - closed mixed forest dominated by *Populus* (not preserved) with local pine and spruce; herbs on xeric sites. Zone 2GR3 (3500-0 BP) - mixed coniferous-broad leaved deciduous forest on lowland.
Ritchie and Hare 1971	108. Tuktoyaktuk Peninsula, Northwest Territories 69°03'N, 133°27'W	300 cm	230cm 200 175-180 125-130 70-75	12900 ± 170 GSC 1321 11500 ± 220 GSC 1237 8690 ± 180 GSC 1354 5440 ± 140 GSC 1269 3630 ± 140 GSC 1338	Zone I (250-200) - dominated by dwarf birch, some willow, Gramineae, Cyperaceae, *Shepherdia canadensis*, *Juniperus*, *Artemisia*. Tundra with abundant herb dominated communities. Zone II (175-200) - increase in spruce; decrease in birch, shrubs and NAP. Forest tundra. Zone III (125-175) - high spruce; decrease in birch, *Shepherdia*, NAP; increase in alder. Continuous spruce forest with associated tree birch. Zone IV (75-125) - dominated by alder. Decrease in spruce. Fairly low birch (equal numbers shrub and tree birch). Alder invasion, scattered spruce; heath and herb communities on open sites. Zone V (0-75) - disappearance of arboreal cover, replaced by dwarf birch-heath tundra on all except wettest and dryest sites. Same as present-day.
Ritchie and Koivo 1975	199. Grand Rapids, Manitoba 53°02'N, 99°43'W	190-380 cm			Diatom stratigraphy. For pollen analysis, see Ritchie and Hadden 1975.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Ritchie and Lichti-Federovich 1968	205. Glenboro, Manitoba 49°26'N, 99°17'W	1050 cm	980-990cm 12800 ± 350 I 1682 565-575 5220 ± 550 I 1514 445-455 4500 ± 250 I 1513 310-320 3200 ± 240 I 1512 205-215 2430 ± 130 I 1511	Zone V - dominated by spruce; with Cyperaceae, Gramineae, *Artemisia*, *Salix*, *Populus*, *Betula*, *Shepherdia canadensis*. Zone IV - decrease in spruce; increase in pine, *Populus*, *Ulmus*, *Salix*, *Juniperus (Thuja)* and NAP. Zone III - dominance of NAP (Gramineae, Chenopods, *Artemisia*). Some pine and other trees. Zone II - increase in oak; decrease in NAP. Zone I - increase in Chenopods and Ambrosieae.
	205. Belmont L., Manitoba 49°26'N, 99°26'W	740 cm	210-220cm 3570 ± 130 I 3156 605-610 9430 ± 160 I 3157	
Rowe and Scotter 1973	Canada			Some mention of evidence of fire in the boreal forest in the past.
Rowe, Spittlehouse, Johnson and Jaseniuk 1974-75	372. Chara L., Northwest Territories 65.52°N, 127.75°W	Upper 1 cm		Short lists of pollen found at these two sites.
	372. East Mountain L., Northwest Territories 65.68°N, 128.57°W	Upper 1 cm		
	372. Beach L., Northwest Territories 65°13'N, 127°02'W	105 cm	95-105cm 2850 ± 85 I 8478	Chapter 6: profile shows no change in vegetation.
	374. Willow L., Northwest Territories 62°18'N, 119°25'W	173 cm	30-40 cm White River volcanic ash (dated *ca.* 1500 BP)	Chapter 7: development of peat plateaus. Composition of peat is described including plant macrofossils. Succession: first colonized by wet forest (*Picea*, *Carex*), followed by treed bog (*Sphagnum*, *Picea*), then shrub bog (*Sphagnum*, *Chamaedaphne*, *Ledum*), then fen (*Drepanocladus*, *Carex*),

				then sequence of sedges and shrubs until *Sphagnum* and associated ericads and trees reappear.
Sangster and Dale 1961				*Populus*, *Pinus* and *Typha* pollen placed in a pond, a lake, a swamp and a bog. *Populus* disintegrated in all 4 sites; *Pinus* was preserved at all 4; *Typha* was preserved only in the bog. Fossil spectra from bogs may be more accurate.
Schofield and Robinson 1960	346. Gillis L., Nova Scotia	7 m	Bottom of 5th metre (Zone L-3) 10160 ± 160 Y 524	Macrofossils. Zone L-1 - *Chara*, *Nitella*, *Potamogeton berchtoldii*. Zone L-2 - no macrofossils. Zone L-3 - one *Potamogeton* seed. Zone A-1 - *Betula lutea*, *B. papyrifera* seeds. *Carex*, *Myrica gale*, *Nymphaea odorata*, *Nuphar*, *Najas flexilis* seeds. Zone A-2 and part of B - *Betula papyrifera*, *Nuphar*, *Nymphaea*, *Najas*, *Scirpus*, *Carex*. Part of Zones B and C-1 - *Betula papyrifera*, *Cladium*, *Sparganium*, *Rubus pubescens*. Part of Zone C-1 and of Zone C-2 - *Betula papyrifera*, *B. lutea*, *Chara*, *Nitella*. Part of Zone C-2 - *Betula lutea*. Lower 1/3 of Zone C3a - *Betula lutea*, *Nuphar*, *Nymphaea*, *Najas*, *Potamogeton berchtoldii*, *Myriophyllum heterophyllum*, *Sparganium*. Top of Zone C3a and part of Zone C3b - similar to above. Part of Zone C3b - similar to above but reduction in *Betula lutea*. One seed of *Potamogeton epihydrus*. (First metre) - *Betula lutea*, *B. papyrifera*, *Nuphar*, *Nymphaea*, *Potamogeton epihydrus*, *Sagittaria cuneata*. Plant macrofossil data largely support results of pollen analysis.
Schweger 1972	181. Robinson, Cypress Hills area, Alberta	170-200 cm		The soil at the Ah horizon developed 10000 years ago in an open prairie-steppe environment.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Short and Nichols 1976	Québec, Newfoundland			Abstract only - see Short and Nichols 1977
Short and Nichols 1977	308. Track L., Québec 55°46'N, 65°10'W	340 cm	57-62cm 3060 ± 115 SI 2255A	Profiles begin with tundra vegetation. Low tree and shrub values. Somewhat higher sedge, grass and *Lycopodium* values. Then transition to shrub tundra approximately 7000-6500 BP. Increase in alder, birch. Wetter, relatively warmer climate. Between 4500 and 4000 BP - open spruce woodland. Further regional warming. 3000-2500 BP - vegetation cover became more open; drier environment. Suggests climatic cooling since at least 3000 BP to present. Anomalies in C^{14} dates preclude more precise interpretation.
			82-87 3275 ± 125 SI 2257	
			102-109 1605 ± 120 SI 2254	
			152-158 2845 ± 140 SI 2256	
			252-258 3945 ± 75 SI 2253	
			312.5-317.5 4280 ± 95 SI 1956	
			317.5-322.5 4755 ± 85 SI 1957	
	309. Pyramid Hills L., Québec 57°38'N, 65°10'W	200 cm	22-28cm 2315 ± 100 SI 2251	
			62-68 3395 ± 140 SI 2252	
			108-115 4690 ± 95 SI 2249	
			129-136 4210 ± 85 SI 2248	
			150-156 5885 ± 155 SI 2250	
			164-170 5215 ± 105 SI 2247	
			181-185 6815 ± 125 SI 1959	
	315. Ublik Pond, Québec 57°23'N, 62°03'W	197 cm	16-24cm 2435 ± 50 SI 2916	
			62-68 4430 ± 85 SI 2917	
			124-130 6745 ± 80 SI 2918	
			183-198 10260 ± 360 SI 2739	
	316. Nain Pond, Newfoundland 56°32'N, 61°49'W	237.5 cm	32.5-39cm 2450 ± 155 SI 2246	
			62.5-68 1655 ± 120 SI 2245	
			82.5-88 5385 ± 100 SI 2244	
			176-183 6550 ± 285 SI 2242	
			195-197 13235 ± 780 SI 1958	
			212-217 8725 ± 410 SI 1960	
			217-225 7195 ± 210 SI 2738	
	317. Kogaluk Plateau, Newfoundland 56°04'N, 63°45'W	55 cm	0-5cm 2945 ± 85 SI 2740	
			5-10 4360 ± 160 SI 2241	
			12-17 4290 ± 115 SI 2239	
			22.5-27.5 4655 ± 140 SI 2240	
			44-47.5 8610 ± 925 SI 1955	

	318. Hopedale Pond, Newfoundland 55°28'N, 60°17'W	145 cm	11-17cm	2895 ± 235	SI 2735	
			66-73	3865 ± 85	SI 2736	
			91-98	4725 ± 80	SI 2737	
			124-130	4240 ± 85	SI 2316	
			133-138	5440 ± 150	SI 1961	
Sigleo and Karrow 1977	241. St. Marys, Ontario	525-1000cm analyzed.	Erie Interstadial Age (*ca.* 16000 years BP)			Zone I (855-1000) - dominated by pine. Also spruce, oak, *Abies*, *Juniperus/Thuja*, *Betula*, *Carpinus/Ostrya*, *Ambrosia*, Cheno-Ams and Gramineae. Zone II - reduction in pine; increase in deciduous trees and NAP. Willow, alder, Gramineae, Cyperaceae increase. Zone III - initial decrease in pine and increase in Ericaceae. Increase in oak, birch, alder, Compositae, *Corylus*, *Artemisia*, *Ambrosia*, Gramineae.
Smith 1940	E. North America					General discussion of pollen diagrams of eastern North America and their correlation with glacial and postglacial climates.
Sorenson and Knox 1973	Northwest Territories		Abstract: "Paleopodzols and frost wedge polygons in and near the forest/tundra ecotone indicate that Holocene fluctuation of the forest border has varied from 280 km (170 mi) north to a minimum of 50 km (30 mi) south of the modern forest border in southwest Keewatin. The 330 km (200 mi) wide range for Keewatin appears to decrease systematically northwestward across Mackenzie."			
Strong 1977	172. Red Deer L., Alberta 52°44'N, 113°05'W	15 cm				Cores counted for Cheno/Ams, Cyperaceae, Gramineae, *Ambrosia*, *Artemisia*, *Populus*, *Selaginella*, and *Taraxacum* for pre- and post-settlement time. Settlement boundary based on the presence of *Taraxacum officinalis* and the increase in Cheno/Ams. Since settlement times there has been: an increase in Short Grass prairie due to increased grazing; a decrease in Mixed Grass prairie;
	173. Keiver L., Alberta 51°42'N, 113°34'W	21 cm				
	174. Bellshill L., Alberta 52°36'N, 111°33'W	13 cm				

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Strong 1977 continued	175. Gooseberry L., Alberta 52°08'N, 110°45'W	19 cm		and migration of *Populus* south into Fescue Grassland (possibly due to fire control).
	175A. Little Fish L., Alberta 51°23'N, 112°15'W	13 cm		
	177. Lloyds L., Alberta 50°53'N, 114°10'W	11 cm		
	178. Eagle L., Alberta 51°00'N, 113°18'W	13 cm		
	179. Twelve Mile Coulee, Alberta 50°08'N, 111°55'W	17 cm		
	180. Chappice L., Alberta 50°10'N, 110°23'W	15 cm		
Terasmae 1951				Pollen morphology of *Betula nana*, *B. tortuosa* and *B. pubescens*.
Terasmae 1956	126. Cape Kellett, Banks I., Northwest Territories	2 samples from plant debris beds.		Contain *Picea*, *Pinus*, *Betula*, *Alnus*, *Tsuga heterophylla*, *T. mertensiana*, *Ulmus*, *Carya*, *Tilia*, and *Salix* grains. One sample had 2 *Ephedra* grains — this species was probably eliminated during successive Pleistocene glaciations.
Terasmae 1957	Québec, Ontario Locations in Terasmae 1958			Palynologic evidence indicates boreal conditions for most of the non-glacial interval. Temperature was not as warm as at present. See Terasmae 1958.

Terasmae 1958 Part I	268. St. Germain Bog, Québec	.1-3.1 m		Presented as an example of a pollen diagram — not discussed.
Terasmae 1958 Part II	269. Pierreville, Québec	4 ft	Wood >29630 Y 256	Absence of *Tsuga* (non-glacial interval too short and climatic ecological conditions not favourable). Temperate deciduous trees form a very small part. Spruce predominates through interval, pine also common. Occasional high values of birch and alder due to local ecological conditions. Subarctic conditions near the bottom and top. Moderately cool in the middle (Boreal Forest).
	271. Les Vieilles Forges, Québec	2.5-27 ft	Wood and peat from lower peat layer. >29630 Y 254 >30840 Y 255	
	274. Ste. Monique, Québec	5.6 ft		
	274. Ste. Brigitte, Québec	20-29 ft		
	277. St. Pierre, Québec	9.5 ft	All 3 dates are from the same piece of wood. 11050 ± 400 L 190A >40000 W 189 >30840 Y 242	
Terasmae 1958 Part III	209. Missinaibi R., Ontario Location 24M		>38000 (Ed. note: deposits are probably of Sangamon Interglacial age (see Skinner 1973)).	See Terasmae and Hughes 1960B.
Terasmae 1959B	110. East branch of Mackenzie River in delta area, Northwest Territories (Locality dot in Fig. 4 approximate).			Macrofossils from buried peat include: *Chamaedaphnae calyculata*, *Ledum*, *Oxycoccus microcarpus* leaves; *Larix laricina* cones. Also lists pollen found. Vegetation and climate similar to present; possibly even more favourable climate.
Terasmae 1960A	268. St. Germain Bog, Québec	2.6 m	Basal deposits 9550 ± 600 L 441-C 9430 ± 250 L 441-C	Diagram chosen for representative standard.
	268. Birch Bog, Québec	5.5 m		

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Terasmae 1960A continued	268. St. Eugène Bog, Québec	2.1 m		
	268. Wilson Pond Bog, Québec			No diagram given. Earliest sediments in Zone V.
	269. Pierreville, Québec	5.8 ft		
	269. St. Bonaventure Bog, Québec	4.5 ft		
	271. St. Paulin Bog, Québec	1.8 m		
	271. Patterson L., Bog, Québec	3 m		
	271. St. Boniface Bog, Québec	1.7 m		
	271. St. Etienne Bog, Québec	1.6 m		
	271. Marchand Bog, Québec	2 m		
	272. Red Mill peat deposit, Québec			No diagram given. Earliest sediments early in Zone III.
	272. Champlain Bog, Québec			No diagram given. Earliest sediments early in Zone III.
	273. St. Valère Bog, Québec			No diagram given. Earliest sediments at end of Zone VI.
	273. St. Albert Bog, Québec			No diagram given. Earliest sediments early in Zone V.

	276. Blandford Bog, Québec			No diagram given. Earliest sediments in Zone V.
	276. Louise L. Bog, Québec			No diagram given. Earliest sediments in Zone V.
	278. Grondines Bog, Québec	2.8-3.4 m		
	278. St. Alban Bog, Québec	3.0-3.5 m		
	278. St. Adelphe Bog, Québec	2.2-2.8 m		
	279. Dosquet Bog, Québec	4.3 m		
				Zonation for all sections: Zone I - 2000 BP to present - decline of hemlock, pine; increase of spruce and *Quercetum mixtum* (QM). Zone II (5000-2000 BP) - high beech, hemlock. Decline of pine, QM; slight increase of spruce, fir, birch. Zone III (7800-5000 BP) - low spruce, fir, hemlock, beech; high white pine, QM. Zone IV (8800-7800 BP) - high jack pine, fir; low birch, QM; decline of spruce. Zone V (9300-8800 BP) - spruce maximum; low pine; decline of NAP. Zone VI (9500-9300 BP) - low spruce; high pine, birch, alder, NAP.
Terasmae 1960B	237. Don Beds, Toronto area, Ontario	35 ft	Sangamon Interglacial deposits.	Begins with temperate assemblage of *Quercus*, *Ulmus*, *Carya*, *Tilia*, *Acer*. Some *Betula*, *Alnus*, *Salix*, *Populus*, *Thuja*, *Juniperus* present. Small amounts of pine and spruce. Warm interglacial climate. Assemblages from top part of beds show change to boreal climate. Decline in hardwoods, increase in conifers.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Terasmae 1960B continued	237. Scarborough Beds, Ontario	140 ft	Early Wisconsin deposits.	A Boreal climate during the greater part of the non-glacial interval, but with probably sub-arctic climates at the beginning and end of interval. Don Beds lie below Scarborough Beds.
Terasmae 1961	Canada			Mentions meteorology, glaciology, oceanography, paleontology, paleobotany, palynology and soil study as sources of information on Quaternary climate. Discusses present and past climates for the various geographical regions of Canada.
Terasmae 1963A	Ontario			Varved sediments studied from Glacial Lake Barlow-Ojibway near Ramore, Ontario. Pollen and spores are present in the light-coloured summer layers and are absent or rare in the dark winter layers indicating the annual origin of the sediments.
Terasmae 1963C	Québec, Atlantic Provinces			Pollen zone correlation and deglaciation in SE Québec and the Atlantic Provinces.
Terasmae 1965A	230. Northfield Bog, Ontario	480 cm (analyzed from 20-230 cm)	465cm 9430 ± 140 GSC 8	Uses same 6 zones as described in Terasmae 1960A. Zones VI and V - boreal forest. Spruce, balsam fir, jack pine, birch, some oak. Zone IV - jack pine increases; spruce decreases. Zone III - *Pinus strobus* and *P. resinosa* increase. Zone II - hemlock and other hardwoods increase. Zone I - increase in spruce; decrease in hemlock.

Terasmae 1965B	Atlantic Provinces					List of references and studies being conducted in Atlantic Provinces.
Terasmae 1967A	Canada					Review of history of Quaternary paleobotany in Canada from the late 1800's to 1967.
Terasmae 1967B	Yukon Territory and adjacent regions					Review of vegetation, the fossil record, postglacial climatic changes, archaeological implications, and geobotanical problems of the Yukon Territory and adjacent regions.
Terasmae 1967C	206. Nungesser L., Ontario	450 cm	450cm	8860 ± 250	GSC 9	Both sections are truncated at the base, but basal parts have high *Artemisia*, *Ambrosia*, Compositae, Gramineae and *Salix*. Consistently high birch and jack pine; low deciduous tree pollen. Late glacial episode.
	206. Nungesser R., Ontario	330 cm				
	215. Thane L., Ontario	200 cm	195-200cm	8590 ± 170	GSC 257	Basal part - high *Pinus banksiana*, *Quercus*, *Salix*, NAP - late glacial. Hemlock, oak, elm did not reach prominence in this area during postglacial time. *Abies* and *Picea* have increased.
	220. Quadrangle L., Ontario	280 cm	280cm	8460 ± 140	GSC 334	No late-glacial assemblages - truncated at base. Mid-postglacial prominence of *Tsuga*, *Quercus*, *Ulmus* indicates Hypsithermal. Birch, spruce and pine have been important throughout postglacial time.
Terasmae 1967D	119. MacAlpine L., Northwest Territories 66°35'N, 103°15'W	50 cm	50-55cm	2330 ± 150	GSC 300	Pine and spruce pollen blown in from boreal forest. There has been little change in these 2 curves, thus no change in meteorological factors responsible for pollen dispersal during last 2,000-3,000 years.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Terasmae 1968A	207. Attawapiskat L., Ontario	240 cm		Discussion of history of vegetation in northern Ontario. 7000-5000 BP - climate was warmer and possibly drier. Subsequent trend to increased moisture and later a change to cooler climate. 3000 or 2500 years BP - expansion of muskeg favoured.
	222. North Bay Bog, Ontario 46°27'N, 79°28'W	280 cm	Basal sediments 9570 ± 150 S 100	
	223. Alderdale Bog, Ontario 46°03'N, 79°12'W	450 cm	Basal peat 6090 ± 85 GRO 1924 (Suggests this date is too young.)	
	232. Harrowsmith Bog, Ontario 44°25'N, 76°42'W	590 cm	Basal organic sediments 10390 ± 160 GSC 270	
	233. Victoria Road Bog, Ontario 44°37'N, 78°57'W	590 cm	Basal organic sediments 9600 ± 190 GSC 132	
Terasmae 1968B	101. Chapman L., Yukon Territory	14 ft	See Terasmae 1973.	Zone I (14000-11000 BP) - high Cyperaceae and Gramineae; low willow, alder, birch. Dominated by sedge-cottongrass tussock tundra. Zone II (11-12000 - *ca.* 6000 BP). Subzone IIa - increase in birch, alder, *Artemisia;* decrease in grass, Cyperaceae. Increased temperature and possibly precipitation. Subzone IIb - birch still dominates, but increasing sedge-grass tussock tundra due to drier climate. Subzone IIc - tussock tundra invaded by muskeg (Ericaceae, *Sphagnum*, *Lycopodium*). Cooler than present, more precipitation than IIb. Zone III (6000 to top) - increase in spruce, alder. Increased temperature.

	118. Gordon Bay Bathurst Inlet, Northwest Territories	20-360 in.	70-82 in. 145 307-319	1850 ± 140 GSC 137 2170 ± 140 GSC 138 2280 ± 150 GSC 785	Alder maximum in middle of diagram (2200-2000 BP) - warmer with increased moisture. Followed by drier climatic conditions - ranges of spruce and pine extended northward - small maxima of pine and spruce pollen at 2000-1000 BP. Deterioration in climate - increase in birch - lower temperature, increased precipitation at 300-400 BP. Climatic trend reversed again - increase in willow.
Terasmae 1969	Québec				History and present state of knowledge of Quaternary palynology in Québec.
Terasmae 1970A					Short review of Quaternary palynology including history, current problems and possible future contributions.
Terasmae 1970B	212. Chin L., Ontario	215 cm analyzed	230-235cm 200-205	7660 ± 140 GSC 487 7150 ± 140 GSC 309	Both sites similar. Gradual decrease in jack pine and increase in spruce from early postglacial time to present. Chin Lake - early postglacial wetland vegetation dominated by sedge meadows and *Typha* marsh with birch and alder shrub layer.
	213. Nineteen Mile L., Ontario	520 cm	500-505cm	7560 ± 180 GSC 670	
					Discussion of muskeg development. Peat accumulation did not begin until 6500-5000 BP although areas were available between 8000 and 7500 years BP. Author suggests warmer and drier climate of 8000-6000 BP suppressed muskeg growth. Also discusses economic implications of muskeg areas.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Terasmae 1971	N.W. Canada			Correlation of Late-Wisconsin and postglacial chronology, pollen zones, climatic fluctuations and changes in vegetation.
Terasmae 1972	Canada			Pleistocene-Holocene boundary of 10000 years BP should be accepted. Palynostratigraphy can be used to support this boundary in areas not covered or immediately affected by ice.
Terasmae 1973	101. Chapman L., Yukon Territory	14 ft	5 ft 9620 ± 150 GSC 310 8.2 10900 ± 150 GSC 311 12.8 13870 ± 180 GSC 296	Recolonized by vegetation from unglaciated parts of Alaska and the Yukon.
	109. Eskimo Lakes, Northwest Territories	.5-7.5 ft	7.2 ft 7400 ± 200 GSC 16	
	186. Kayville, Saskatchewan	100-190 cm analyzed		Forest covered from 14000-11000 BP. Then expansion of prairie in early Holocene.
	206. Nungesser L. Bog, Ontario	460 cm	455 cm 8860 ± 250 GSC 9	Earliest assemblages resemble subarctic region; remainder clearly indicative of boreal forest.
	233. Victoria Road Bog, Ontario	600 cm	560 cm 9600 ± 190 GSC 132	Zones I, IIa, IIb, IIc, III, IV marked on diagram.
	340. Grand Falls, New Brunswick	30 ft	17 ft 9830 ± 160 GSC 56	Zone II (5000 BP) - hemlock-beech. Zone III (6100 BP) - white pine. Zone IV (6800 BP) - hemlock. Not numbered (8200 BP) - jack pine. Zone Va (9600 BP) - spruce-birch. Zone Vb (10400 BP) - spruce. Zone VI (11500 BP) - birch-alder-willow. Zone VII (12200 BP) - herbs-spruce-birch-alder.
	340. Hartland Bog, New Brunswick	750 cm		

					Zone VIII (13000 BP) - spruce-birch-pine. Zone IX (>13000 BP) - herbs.
Terasmae 1974	348. Port Hood I., Nova Scotia Lower organic beds.	76 cm	4-8 cm	11000 ± 170 GSC 540	Dwarf birch, willow, alder, Ericaceae. Some spruce towards top. Cyperaceae and Gramineae prominent. Subarctic vegetation. Thought to be equivalent to "L" zones of Livingstone 1968.
	348. Port Hood I., Section 2	180 cm	180 cm	7140 ± 140 GSC 484	Pollen record incomplete at top and base. Corresponds to C-1 and C-2 zones of Livingstone 1968.
Terasmae 1975	Canada				Study of climatic change as it affects environment and vegetation. Summarizes Heusser's (1967A) sequence of postglacial vegetation and climatic change in the Pacific Northwest and Terasmae (1968B) for the Yukon.
Terasmae 1977	Canada				Discussion of postglacial climatic changes in relation to muskeg and regional aspects of muskeg history. Also present-day distribution and energy relations of muskeg.
Terasmae and Anderson 1970	254. Val.St.-Gilles, Québec 49°0'N, 79°05'W	3.29 m	Basal part of exposure *Pinus strobus* fossil log	6460 ± 140 GSC 788 5030 ± 130 GSC 585	*Pinus strobus* pollen maximum coincides with stratigraphic bed in which macrofossils found. Northward extension of *Pinus strobus* past its present limit took place in the warmer Hypsithermal (5000 years BP). Twenty surface samples taken in the area.
Terasmae and Craig 1958	117. Pingo in abandoned channel of Thelon R., Northwest Territories 64°19'N, 102°41'W			5400 ± 230 L 428	Fossil *Ceratophyllum demersum* found. Laid down during postglacial thermal maximum when it was warmer than present.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Terasmae and Fyles 1959	82. Englishman R., Vancouver I., British Columbia		Wood - bottom-set delta beds 12150 ± 250 L 391D Shells - clays beneath delta 12360 ± 250 L 391E	Fossil *Pinus contorta* cones and *Dryas drummondii* leaves. Short list of pollen found. Indicates that climate was substantially colder than present.
Terasmae and Hughes 1960A	209. Missinaibi R., Ontario		Shells from near upper limit of the marine submergence 7875 ± 200 I GSC 14	
	211. Opazatika R., Ontario		Shells from near upper limit of the marine submergence 7280 ± 80 GRO 1698	
	214. Frederick House Bog, Ontario		6730 ± 200 6970 ± 310 (Ed. note: Y 222 applied to both dates according to Terasmae and Hughes (1960A, p. 1446)).	
	214. Cochrane, Ontario		6380 ± 350 W 136	
	221. Manitoulin I., Ontario		Bog bottom sample from Sheguiandah 9130 ± 350 W 345 Bog bottom sample from High Hill bog 9560 ± 110 GRO 1926 Bog bottom sample from Little Current bog 9450 ± 350 I GSC 3	
	223. Fossmill, Ontario		Basal peat 6090 ± 85 GRO 1924	Pollen profile shows mixed hardwood forest, therefore ice retreat must have occurred much earlier.

	226. Ottawa, Ontario		10850 ± 330 Y 216	
Terasmae and Hughes 1960B	207. Attawapiskat R., Ontario 53°08'N, 85°18'W	.4-4.9 ft	Base of peat section 4.4 ft 4700 ± 80 GRO 1925	First phase - sedge and grass fen development with plentiful birch. Then bog development - Ericaceae, *Sphagnum*, *Rubus chamaemorus*, black spruce and tamarack.
	208. Ogoki Post Site, Ontario 51°39'N, 85°57'W	5-29 in.		Black spruce muskeg environment - black spruce, Ericaceae, tamarack, birch, alder, *Rubus chamaemorus*, *Sphagnum*.
	209. Missinaibi R., Ontario. Location 24M	.5-8.3 ft	Probable age of >53000 BP (Ed. note: deposits are probably of Sangamon Interglacial age (see Skinner 1973)).	Forest dominated by *Picea glauca;* some *Picea mariana*, *Pinus banksiana*, *Betula*, *Alnus*, *Abies balsamea*, *Larix laricina*. High proportion of NAP and ferns at base and toward top.
	209. Missinaibi R., Ontario. Location 26M	0-9.6 ft	Probable age of >53000 BP (See above note).	Forest similar to previous section. Bog developed in 7 to 8 foot interval - decreased *Picea glauca*, increased birch, alder, willow, Ericaceae and *Sphagnum*.
	214. Frederick House R. Bog, Ontario	.3-7.5 ft		Pollen diagram given. Not discussed.
Terasmae and Hughes 1966	100. Gill L., Yukon Territory	8 m	Basal sediments 12550 ± 190 GSC 128	Increase in *Rubus chamaemorus* and Ericaceae near top reflects change from lacustrine to bog phase.
	101. Chapman L., Yukon Territory	12 m	Bottom of organic deposit 13 ft 13870 ± 150 GSC 296 8 10900 ± 150 GSC 311 5 9620 ± 150 GSC 310	Zone I (basal) - abundant Cyperaceae. Zone II - begins at sudden increase of birch. Zone III - begins at significant increase in spruce and alder.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.) LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Terasmae and LaSalle 1968	266. L. Hertel, Québec 45°33'N, 73°09'W	620-800 cm	780 cm 10880 ± 260 GSC 482	Base - assemblage of NAP, willow, alder, spruce and pine. Sequence correlates with Zones I to V (Terasmae 1960A).
	266. St.-Hilaire Bog, Québec 45°33'N, 73°09'W	843-900 cm analyzed	870-890 cm 12570 ± 220 "GSC 519" (Ed. note: GSC 419 (see Lowdon and Blake 1968, and LaSalle 1966 above) is correct laboratory number).	Probably an early cool interval (northern boreal) more than 12500 BP, was followed by a colder interval (tundra) about 12500 BP. Evidence of a cold period in the middle of the rest of the sequence - willow and NAP maxima, spruce minimum. Preceded and followed by somewhat more clement episodes with higher spruce, lower NAP. Top of this diagram thought to be in lower Zone VI of Lac Hertel sequence.
				This area (part of Monteregian Hills) deglaciated more than 12500 years BP as a nunatak.
Terasmae and Mott 1963	Ontario			Wood and other datable material in beach deposits may or may not yield a correct age. Palynological studies from more than 1 or 2 sites are necessary to obtain reliable age estimates.
Terasmae and Mott 1971	358. Sable I., Nova Scotia		Buried soil layer 240 ± 80 (Ed. note: laboratory number not given. Evidently date derived from James and Stanley 1967). Top of peat slab 320 ± 130 GSC 1009 Bottom of peat slab 650 ± 130 GSC 1010 Peat balls 6980 ± 140 GSC 917 7770 ± 140 GSC 916	Fossil spectra from 2 and 3 m depths. Exotic pollen - *Pinus*, *Picea*, *Abies*, *Tsuga*, *Betula*, *Alnus*, *Ambrosia*. Pollen contributed by local vegetation - Gramineae, Ericaceae, Cyperaceae, *Myrica*. Plant habitats not much different over the past 11000 years. Although the island was larger, it never supported forests. Surface spectra given.

			Peat in first 60 ft of drill hole 10900 ± 160 GSC 935	
Terasmae, Webber and Andrews 1966	146. Isortoq R., Baffin I., Northwest Territories	6 m	1.5-2 m 38830 GSC 259 Upper horizontally stratified beds (unnumbered) 14000 ± 400 I 1233 Top of folded beds (not from pollen profile section) >35000 I 1234 Base of folded beds (not from pollen profile section) >40000 I 1235 Folded sediments near river level >40000 GSC 427 Flitaway Lake plant-bearing beds >30000 I 1241	6 m numbered on diagram but pollen curves given for strata above and below the numbered section. Some very low pollen counts listed from nearby exposures. Macrofossils listed for Isortoq River and Flitaway Lake. Pollen diagram: High willow and NAP at base and top. Dwarf birch and alder consistently present throughout the diagram. Low pine and spruce indicate tree-line did not reach the area. Diagram compared with Sugluk Inlet, Lac Romanet and Gordon Bay. Conclusion: deposits accumulated during an interglacial more than 40000 years ago (Sangamon). Climate was as favourable or more favourable than at present on north-central Baffin Island.
	307. L. Romanet, Québec	3 m		Pollen diagram given but not zoned or discussed except in relation to Isortoq River section.
Vincent 1973	255. L. Louis Québec 47°17'15"N, 79°07'00"W	550 cm	235-240cm 4260 ± 240 GSC 1491 410-415 7280 ± 250 GSC 1481 531-538 9090 ± 240 GSC 1432	Zone VI (553-505) - *Pinus banksiana*, *Quercus*, *Picea*, *Betula*, *Juniperus*, Cyperaceae. First vegetation following deglaciation. Zone V (505-475) - high spruce; decrease in pine, NAP; increase in birch. More humid, cooler. Zone IV (475-425) - increase in *Pinus banksiana*; decrease in spruce, birch. Start of Hypsithermal. Zone III (435-425) - dominated by *Pinus strobus* and *P. resinosa*. Decreased spruce. Much warmer and drier than present.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Vincent 1973 continued				Zone II (235-45) - increased spruce, birch; decreased pine. Small amounts of *Fagus* and *Acer*. Warm but more humid. Zone I (45-0) - slight increase in spruce; slight decrease in pine. Increased birch. Climate deterioration.
Wenner 1947	Many locations (315-320) along Labrador coast, Newfoundland	Cores range from 30-150cm		In forested region of the area, pollen diagrams record the expansion of coniferous forest and extensive paludification. Periods of relative dryness have alternated with wet ones. Five heath layers are present and form a chronological system. Paludification has increased after Heath Layer III indicating climatic deterioration. Labrador pollen diagrams are compared with those from many other subarctic regions in the Old and New World. Some surface samples taken.
	Sites 322, 324, 325 and 326 in interior Labrador, Newfoundland	Cores range from 70-170cm		
	332. St. Anthony, Newfoundland	250 cm		Lower zone - high Cyperaceae and willow - tundra. Middle zone - "forest limit conditions". Upper zone - high birch, alder, NAP - less wooded conditions.
Westgate, Fritz, Kalas, Delorme, Green, Matthews and Aario 1971	155. Smoky R. Valley, Alberta		Peat 1 m above base >38000 GX 1207 1.5 43500 ± 620 GSC 1020 2.3 35500 ± 2300 or 1800 I 2516 4 35000 ± 3300 or 2300 I 2615 5.5 27400 ± 850 I 4878	Mid-Wisconsin depositional environment was floodplain of meandering river. Low spruce; fairly high Cyperaceae and Gramineae - suggests open vegetation with scattered conifers.

Wilson 1946	N. Ontario	In the vicinity of L. Nipigon and Cochrane, Ontario bogs have been found that contain no tree pollen in their lowest levels. The present tree line was extended northward from a position somewhere to the south of these bogs after glacial Lake Objibway time.
Wright 1964		Pollen diagrams from the Great Lakes area imply that during the Wisconsin retreat the area was dominated by spruce forest that contained no pine and little birch. Explanation is that jack pine took refuge in Appalachian Highlands during Wisconsin glaciation whereas spruce migrated to central U.S. Birch and pine were slower migrants from their far-away refuge and did not reach the Great Lakes area until after spruce forest had begun to deteriorate due to climatic warming.
Wright 1968	Manitoba, Ontario	Discusses postglacial history of pine and spruce mainly for northeastern United States, but some mention of Great Lakes area of Canada including Manitoba.
Wright 1971	North America	Discusses modern vegetational zones. Discusses pre-Wisconsin, Wisconsin, Late-Wisconsin and post-Wisconsin vegetational history for major geographical areas of North America. 3 pollen diagrams from Canada given - Hafichuk, Saskatchewan, Riding Mountain, Manitoba and Antifreeze Pond, Yukon.

TABLE 2: (cont'd)

AUTHOR & DATE	MAP OR GENERAL LOCATION	CORE LENGTH	C^{14} DATES (yr B.P.), LABORATORY NUMBERS, ASH LAYERS	ZONATION AND COMMENTS
Yarranton and Ritchie 1972	108. Tuktoyaktuk Peninsula 69°03'N, "123°27'W" (should be 133°27'W)	250 cm	See Ritchie and Hare 1971	Compares original "subjective" zones on pollen diagram with zones developed by using method of coefficients of correlation. The latter are concluded to be more internally consistent and more discrete.
Zoltai and Tarnocai 1975	108. Northwest Territories 69°07'N, 132°56'W		Surface peat 3150 ± 90 BGS 216 Basal peat 6020 ± 100 BGS 217	Discussion of 3 general types of peatland development in western arctic and subarctic Canada. Initial organic accumulation began between 14400 and 10000 BP. Main peat build-up took place between 10500 and 5600 BP. Minor cooling 3000-4000 BP produced an increase in peat plateaus. In more southern areas, a dry warm period which permitted only restricted peat accumulation occurred between 7500 and 6000 BP. This was followed by a cooler period of rapid peat accumulation. In the north, the climate was favourable for peat accumulation during the warm period (8000-4000 BP) but peat formation was reduced during the cooler period beginning 4000 BP.
	368. Yukon Territory 65°59'N, 135°03'W		Basal peat 10470 ± 80 BGS 144 Basal organic 14410 ± 110 BGS 143	
	368. Yukon Territory 66°10'N, 134°18'W		Basal peat 5910 ± 60 BGS 140 Basal organic 10820 ± 80 BGS 142	
	369. Northwest Territories 67°16'N, 135°14'W		Basal peat 8190 ± 60 BGS 159 Basal organic 9960 ± 80 BGS 139	
	367. Yukon Territory 69°15'N, 138°02'W		Surface peat 8260 ± 110 BGS 196 Basal peat 10100 ± 130 BGS 197	
	370. Northwest Territories 67°41'N, 132°05'W		Surface peat 2710 ± 60 BGS 147 Basal peat 7200 ± 60 BGS 149 Basal organic 8610 ± 100 BGS 148	

371. Northwest Territories 66°13'N, 130°52'W	Basal peat	5600 ± 70	BGS 146
373. Northwest Territories 61°50'N, 122°13'W	Surface peat	2650 ± 80	BGS 218

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LATE QUATERNARY PALEOENVIRONMENTS OF EASTERN CANADA

J. Gordon Ogden, III*

INTRODUCTION

The late Quaternary paleoenvironmental record of Eastern Canada (Ontario, Québec, and the Atlantic Provinces) has been the focus of numerous investigations since early surveys by Vaino Auer (see for example Auer 1930) for commercial deposits of peat. Recent reviews (Mott 1977; McAndrews 1976B; Ogden 1977A,B.; Richard 1977B) have shown that more than 300 sediment sequences have been described, of which nearly 50 percent have been in Eastern Canada. Approximately 15 Eastern Canadian sequences have had three or more radiocarbon determinations from which sedimentation rates can be inferred. Six sequences include 5 or more determinations, a number deemed minimal by Ogden (1967B) for reliable determination of sedimentation rates for absolute pollen influx determinations.

Many early studies (e.g., Potzger 1953; Potzger and Courtemanche, 1954, 1956; Potzger et al 1956) were based on arboreal pollen counts only, which makes the recognition of treeless or tundra paleoenvironments difficult. Deevey (1951) showed that non-arboreal components, such as sedge and grass pollen occurred in high proportions in the basal mineral sediments of deposits in northern Maine. Subsequent investigations have confirmed tundra or steppe-like conditions at the base of most deposits, including obligate high arctic herbs, such as Armeria labradorica (Ogden 1958; Richard 1977A). Terasmae (1976) has attempted to establish palynological criteria to categorize tundra environments.

Increasing attention to paleoclimatic inferences has led to a number of recent symposia dealing with integrative problems of environmental reconstruction. A by no means exhaustive recent list includes: "Environmental Change in the Maritimes" (edited by J.G. Ogden III, and M.J. Harvey, 1975) sponsored by the Associate Committee on Quaternary Research of the National Research Council of Canada; "Amerinds and their Paleoenvironments" (edited by W.S. Newman and B. Salwen, 1977), sponsored by the New York Academy of Sciences, "Geobotany" (edited by R.C. Romans, 1977), sponsored by Bowling Green State University; and the "Troisième Colloque sur le Quaternaire du Québec", (edited by S. Occhietti, 1977). All of these conferences had a common goal, to integrate paleoenvironmental information from a wide variety of disciplines into more detailed and accurate reconstructions of the environments of early man, and the biota with which he was associated.

There is no question that inferences are becoming more accurate, and reconstructions more sophisticated. This encouraging development is a consequence of three principal tools which have been developed in the past three decades:

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1) Radiocarbon dating

2 Digital computers

3) Multivariate statistics.

Although traditional training has left many palynologists ill-equipped to appreciate or capitalize on these tools, some spectacular 'technology transfers' are occurring. There are 98 radiocarbon dating laboratories in the world (Radiocarbon 19(3), 1977), of which four are in Canada. An additional Canadian laboratory is not included in the International list. With processing capacities limited, it is obvious that the demand exceeds the supply of services.

Radiocarbon dating, which was developed in the 1950s, permits the determination of the absolute age of organic material within the activity span of carbon 14. For most practical purposes, the limit is about 45,000 years, although special techniques are available to extend this somewhat. More particularly, multiple datings of sedimentary sequences permit calculations of absolute sedimentation rates and recognition of significant changes in sedimentation rate as a result of environmental change. More than 100 sediment sequences have been radiocarbon dated within the past 20 years. Unfortunately most sequences have only one or two determinations, which is insufficient to develop meaningful regression equations for the determination of absolute sedimentation rates.

Table I is a preliminary list of radiocarbon-dated sequences in Eastern Canada. Lack of chronostratigraphic precision precludes the development of meaningful regional pollen sequences based on an absolute time scale.

Another important technique which has become available is the increase in sophistication of sample preparation and counting techniques, spearheaded largely by M.B. Davis and her co-workers (Davis 1965, 1967; Davis et al. 1973), which have produced pollen diagrams based on absolute pollen influx rates (i.e. pollen grains per square centimetre per year). Simpler techniques outlined by Stockmarr (1971) make the method practical and feasible in most laboratories. More Canadian diagrams are being prepared as absolute pollen frequency diagrams (Green 1976; Mott 1977; Richard 1977B). These techniques eliminate the closed universe constraint for statistical manipulation of data based on ratios. I emphasize that use of this technique requires enough radiocarbon dates to provide absolute sedimentation rates.

Concurrent with the development of these techniques is the proliferation of large computers able to manipulate massive data sets with mind-boggling ease. Prospects and pitfalls of new statistical applications to pollen data are briefly reviewed in Ogden (1977B). Unfortunately, few Canadian sequences have been attacked using the full power of these modern tools, although Green (1976) has applied time series analysis for recognition of forest fire sequences at Everitt Lake, Nova Scotia, the pollen record of which was analysed at approximately 50-year intervals throughout the entire postglacial sequence.

Explosive development of larger and more powerful computers and software has provided the pollen analyst with tools of spectacular power. Manipulation of large data sets by powerful statistical treatments places an increasing responsibility upon the investigator to be sensitive to distributional problems associated with data sets of uneven quality (e.g. with or without non-arboreal pollen; moss polsters versus lake, bog, oak or atmospheric samples; absolute and relative pollen counts; and counting to fixed or variable pollen sums). Application of multivariate statistical tools has enabled the use of transfer functions to contrast pollen records and vegetation types with climatic shifts such as weather generating air mass movements since deglaciation (Webb and Bryson 1972). Among the exciting possibilities inherent in these approaches are recognition of changes in length of growing seasons, as well as other climatic variables of plant growth and distribution. These problems and prospects are reviewed by Ogden (1977C).

Although the prospects are exciting and the promise of additional refinement of new approaches is great, the somewhat uncharitable observation by Ogden (1977C) "It is a basic tenet of paleoecologists that the data set, consisting principally of pollen spores, diatoms, and other microfossils and the enclosing sediment is better than anything yet done with it" still remains disappointingly true.

The following sections of this report outline preliminary results of an attempt to collate paleoecological information from Eastern Canada.

LATE WISCONSIN PALEOENVIRONMENTS IN EASTERN CANADA

Figure 1, adapted from Grant (1977), shows approximately the maximum ice position of late Wisconsin glaciation in Eastern Canada approximately 16,000 years ago. A significant characteristic of this reconstruction is that portions of the Cape Breton Highlands, eastern Prince Edward Island, and a corridor through the Cobequids in the vicinity of Parrsboro, Nova Scotia, appear to have been unglaciated during the last ice advance. Probably the separate Nova Scotian ice mass as shown in Figure 1 did not fuse with mainland New Brunswick ice, neither of which were continuous with the main Labradoran ice sheet. Evidence from the Cape Breton Highlands of Nova Scotia above the 350-metre level imply a lack of active ice in the vicinity. Observations include a lack of closed basins (e.g. kettles), integrated drainage, deep soils, very few residual erratics, and quartzite boulders thoroughly rotten as a result of long exposure to weathering. Soils tend to be rather deep and rather low in clay, further implying extensive periods of weathering. A search for appropriate sedimentary deposits to confirm these inferences is required.

Although ice retreat had begun by 14,000 years ago, few if any sedimentary deposits were accumulating organic records at this time. Basal radiocarbon dates of approximately 14,000 B.P. have been reported from sites in southern Ontario by Karrow and Anderson (1975) but are considered to be 1000 to 1500 years too old, perhaps due to carbonate carbon contamination.

By 12,000 B.P., apparently all Highland ice had melted, and remaining ice in the St. Lawrence estuary was calving rapidly to form the Champlain Sea. Studies by Mott (1977) imply earlier deglaciation and invasion of the Champlain Sea than had previously been considered. Isostatic depression of the Bay of Fundy area produced extensive marine transgression in the Hirundo, Maine, area (Sanger *et al*. 1977) as well as the high level deltas in the Parrsboro area of Nova Scotia. Rapid crustal uplift resulted in emergence of the Fundy basin to several tens of metres below present sea level (Grant 1975).

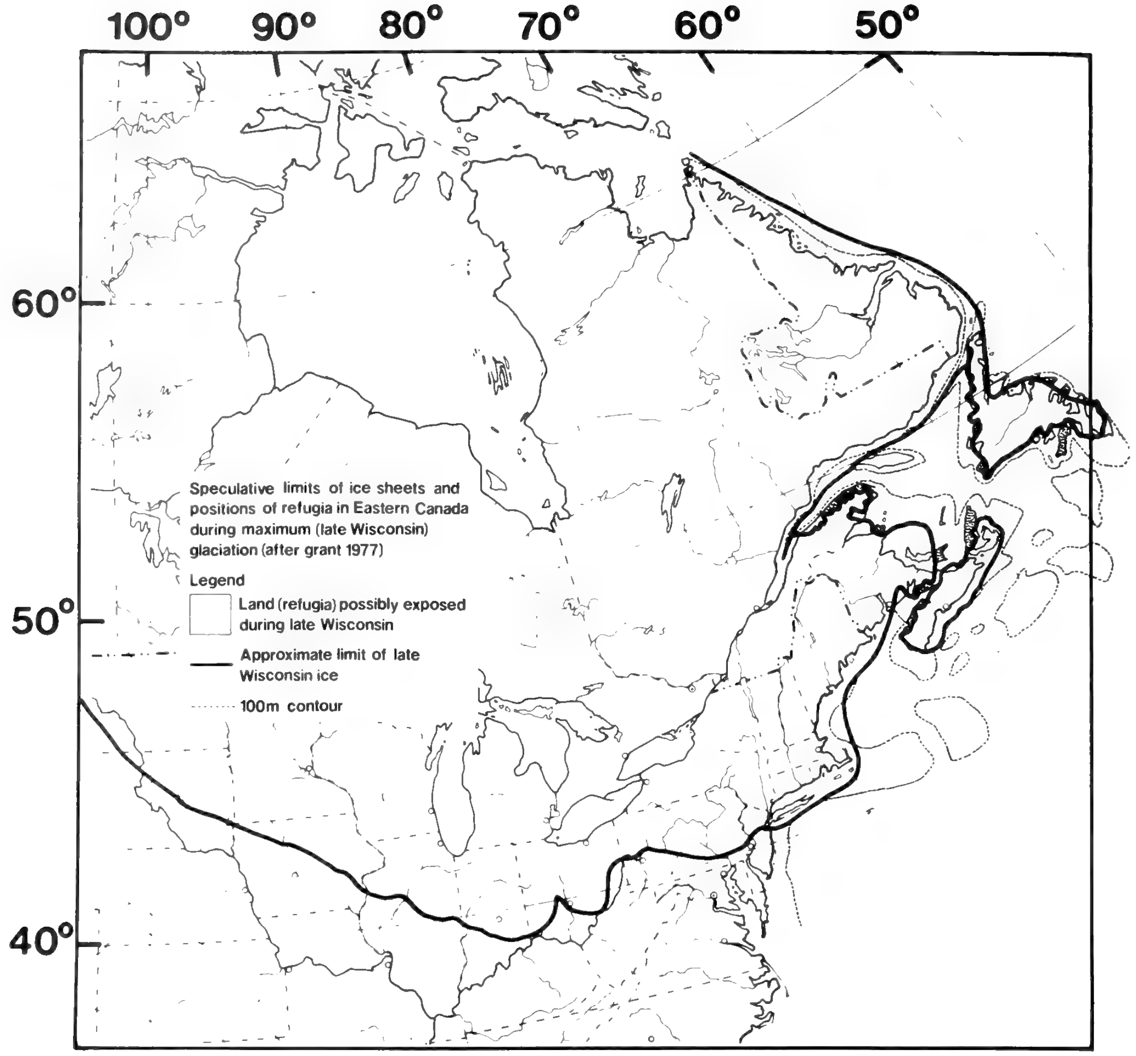

FIGURE 1: *Limits of ice sheets in eastern Canada (after Grant (1977)).*

PRELIMINARY LIST OF PALEOENVIRONMENTAL DATA

Table 2 is an incomplete list of sediment cores and basal radiocarbon ages as compiled to date. Several of these sequences have been coded for the Dalhousie University CDC-6400 computer, for which a mapping program has been developed. Approximately 1500 surface samples are available within the geographic region between 50-100° W. and between 40-88° N. Although the data set is unevenly distributed on the ground, the mapping program permits correlation of surface pollen spectra with dated pollen spectra from sediment cores throughout the region to determine vegetational composition at specific time intervals. It is a continuing goal of the Eastern Canada project to be able to provide investigators with geographic confidence limits in paleoenvironmental reconstruction. Data provided for the mapping program are either Spearman rank coefficients, or Pearson product moment coefficients. A subsequent report will deal with the particular constraints imposed by these statistical procedures. The mapping program permits the investigator to pre-select up to three levels of correlation for mapping purposes. Preliminary evidence indicates that correlation coefficients of .9 or greater provide grid resolution on the order of less than 100 sq. kilometres. While this is still too coarse for detailed environmental reconstruction, it is encouraging that very few exceptions are found.

TABLE 1 : *AGE-DEPTH REGRESSION OF SELECTED RADIOCARBON-DATED SEDIMENT SEQUENCES IN EASTERN CANADA.*

SITE	COORDINATES	NO. OF DATES	$x(\text{age}) = ay(\text{cm})^b$	r^2	REFERENCE
Ontario					
Boundary Pond	45°34'N 70°40.5'W	5	a=3.837 b=1.317	.99	Mott 1977
Found Lake	45°30'N 78°30'W	7	a=10.090 b= 1.039	.99	McAndrews (unpublished)
Quebec					
Unknown Pond,	45°36'N 70°38'W	4	a=46.593 b= .835	.78	Mott 1977
Lac Colin	46°43'N 70°17.5'W	5	a=82.948 b= .726	.95	Mott 1977
Lac Mimi	47°29'N 70°22.5'W	6	a=3.831 b=1.278	.81	Richard & Poulin 1976
Lac Louis	--	3	a=25.133 b= .939	.99	Vincent 1973
New Brunswick					
Basswood Rd. L.	45°15'N 67°19'W	3	a=20.26 b= .993	.99	Mott 1975D
Little L.	45°09'N 66°43'W	4	a=33.127 b= .955	.98	Mott 1975D
Collins L.	--	4	a=20.410 b= .914	.98	Green 1976
Nova Scotia					
Everitt L.	--	4	a=8.088 b=1.211	.99	Green 1976
Minard's L.	--	4	a= .228 b=1.778	.98	Railton 1972
Oak Hill L.	--	5	a=511.684 b= .471	.99	Railton 1972
Shaw's Bog	45°01'N 64°11'W	4	a=21.685 b= .926	.97	Hadden 1975
Frog Pond	45°20.8'N 63°23.5'W	5	a= .13170 b= .85956	.99	Livingstone (unpublished)

TABLE 2: *PRELIMINARY LIST OF RADIOCARBON DATES ON SEDIMENT CORES FROM EASTERN CANADA.*

SITE	COORDINATES	CORE DEPTH (CM)	RADIOCARBON AGE (YRS. B.P.) AND LABORATORY NO.	REFERENCE
ONTARIO				
Harrowsmith Bog	44°25'N 76°42'W	600	10390±160 GSC 270	Terasmae 1970A
Victoria Rd. Bog	44°37'N 78°57'W	600	9600±190 GSC 132	Terasmae 1970A
Grieff Kettle Bog	43°25'N 80°11'W	--	11950±350 I/GSC/-29	Terasmae 1970A
North Bay Bog	46°27'N 79°28'W	300	9570±150 S-100	Terasmae 1970A
Wood L.	46°12.9'N 80°44.1'W	--	9620±250 GSC 606	Terasmae 1970A
Blind River Bog	46°12.8'N 82°56.3'W	--	8760±250 GSC 514	Terasmae 1970A
Alderdale Bog	46°03'N 82°56.3'W	450	6090±85 GRO 1924	Terasmae 1970A
Attawapiskat L.	--	360	--	Terasmae 1970A
Maplehurst L.	--	300	12500±180 GSC 1156	Mott & Foster 1977
Louise L.	44°17'N 80°57'30"W	560	13900±211 GSC 1151	Karrow & Anderson 1975
Roblin L.	--	--	10500±160 GSC 925	Karrow et al. 1975
Erbsville Bog	--	--	10700±160 GSC 1006	Karrow et al. 1975
Sunfish L.	--	--	10550±220 I 6452	Karrow et al. 1975
Cookstown Bog	--	155	10200±150 GSC 1111	Karrow et al. 1975
Wylde Lake Bog	--	--	10800±180 GSC 1028	Karrow et al. 1975
Ballycroy Bog	--	--	10900±200 GSC 1143	Karrow et al. 1975
Eighteen Mile River W.	--	378-398	10600±160 GSC 1127	Karrow et al. 1975

TABLE 2. (Cont'd)

SITE	COORDINATES	CORE DEPTH (CM)	RADIOCARBON AGE (YRS. B.P.) AND LABORATORY NO.	REFERENCE
ONTARIO (Cont'd)				
Eighteen Mile River E.	--	292-308	10500±150 GSC 1126	Karrow *et al.* 1975
Kincardine Bog	--	206.5-208.5	7620±70 GSC 1816	Karrow *et al.* 1975
Kincardine Bog	--	300-317	10300±200 GSC 1644	Karrow *et al.* 1975
Kincardine Bog	--	300-317	10600±150 GSC 1366	Karrow *et al.* 1975
Kincardine Bog	--	405	11200±170 GSC 1374	Karrow *et al.* 1975
Champlain Sea (Clayton Gravel Pit)	--	--	12800±220 GSC 1859	Mott 1977
QUEBEC				
Coffin I.	--	--	1032±29 1073±29 GSC 2453	Prest *et al.* 1976 Prest *et al.* 1976
Portage du Cap, Amherst I.	47°14.5'N 61°54.3'W	--	11300±160 GSC 541	Prest *et al.* 1976
Portage du Cap, Amherst I.	47°14.5'N 61°54.3'W	--	35000 GSC 256	Prest *et al.* 1976
Portage du Cap, Amherst I.	47°14.5'N 61°54.3'W	--	38000 GSC 2313	Prest *et al.* 1976
Boudreau I.	--	250	--	Prest *et al.* 1976
Baie du Bassin, Amherst I.	--	--	10000±130 BGS 313	Prest *et al.* 1976
St. Pierre	--	--	65300±1400 GRN 1799	Mott & Prest 1967
St. Pierre	--	--	6700±100 GRO 1711	Mott & Prest 1967
Sept Iles	--	--	9140±200 GSC 1337	Mott 1976
Rivière Manicougan Valley	--	--	19150±150 I 3868	Mott 1976
Baie Comeau	--	--	8890±150 GSC 1746	Mott 1976

TABLE 2. (Cont'd)

SITE	COORDINATES	CORE DEPTH (CM)	RADIOCARBON AGE (YRS. B.P.) AND LABORATORY NO.	REFERENCE
QUEBEC (Cont'd)				
Baie Comeau	--	--	9280±140 GSC 1565	Mott 1976
"LD" Lake	50°08'25"N 67°07'55"W	168-172	3390±110 GSC 2032	Mott 1976
"LD" Lake	50°08'25"N 67°07'55"W	335-345	6960±30 GSC 1811	Mott 1976
Boundary Pond	45°34'N 70°40.5'W	82.5-88.5	1390±80 GSC 1954	Mott 1977
Boundary Pond	45°34'N 70°40.5'W	167.5-172.5	3080±120 GSC 1934	Mott 1977
Boundary Pond	45°34'N 70°40.5'W	257.5-262.5	5720±130 GSC 1895	Mott 1977
Boundary Pond	45°34'N 70°40.5'W	341-344	7750±150 GSC 1932	Mott 1977
Boundary Pond	45°34'N 70°40.5'W	389-392	11200±200 GSC 1245	Mott 1977
Unknown Pond	45°36'N 70°38'W	117.5-122.5	2810±180 GSC 1929	Mott 1977
Unknown Pond	45°36'N 70°38'W	512-518	4970±140 GSC 1907	Mott 1977
Unknown Pond	45°36'N 70°38'W	685-688	12600±280 GSC 1404	Mott 1977
Unknown Pond	45°36'N 70°38'W	695-700	14800±200 GSC 1339	Mott 1977
Lac Dufresne	45°51'N 70°21'W	345-349	9660±140 GSC 2345	Mott 1977
Lac Dufresne	45°51'N 70°21'W	357-363	11200±160 GSC 1294	Mott 1977
Lac Colin	46°43'N 70°17.5'W	147.5-152.5	3360±100 GSC 2337	Mott 1977
Lac Colin	46°43'N 70°17.5'W	296-300	4900±90 GSC 2333	Mott 1977
Lac Colin	46°43'N 70°17.5'W	468-472	6360±110 GSC 2329	Mott 1977
Lac Colin	46°43'N 70°17.5'W	664-668	8990±100 GSC 2325	Mott 1977

TABLE 2. (Cont'd)

SITE	COORDINATES	CORE DEPTH (CM)	RADIOCARBON AGE (YRS. B.P.) AND LABORATORY NO.	REFERENCE
QUEBEC (Cont'd)				
Lac Colin	46°43'N 70°17.5'W	688-694	11100±180 GSC 2282	Mott 1977
Petit Lac Terrien	46°35'N 70°36.5'W	626-638	12640±190 GSC 312	Mott 1977
Barnston L.	45°06.7'N 70°53'W	485-495	11020±330 GSC 420	Mott 1977
St. Narcisse	--	--	11000	Mott 1977
Lac des Bouleaux	--	2700	13000±290 GSC 1344	Mott & Foster 1977
Lac des Bouleaux	--	2650	12400±170 GSC 1803	Mott & Foster 1977
Lac au Araignées	--	920	10700±310 GSC 1352	Mott & Foster 1977
Lac Colin (see above)	46°43'N 70°17.5'W	670	8990±100 GSC 2325	Mott & Foster 1977
Lac Colin	46°43'N 70°17.5'W	690	11100±180 GSC 2282	Mott & Foster 1977
Montagnais	47°54'N 71°10'W	410-420	8510±140 GSC 1417	Richard 1977B
Caribou	47°38'N 71°14'W	215-220	5145±105 I 8139	Richard 1977B
Malbaie	47°36'N 70°58'W	190-200	8095±155 I 8137	Richard 1977B
Mimi	47°30'N 70°22'W	425-435	9460±280 --	Richard 1977B
Mimi	47°30'N 70°22'W	455-460	10180±330 QU 56	Richard 1977B
Mimi	47°30'N 70°22'W	470-480	9770±260 QU 67	Richard 1977B
Mimi	47°30'N 70°22'W	480-490	9945±225 I 7159	Richard 1977B
Mimi	47°30'N 70°22'W	500-514	11050±460 QU 55	Richard 1977B
Joneas	47°15'N 71°10'W	380-390	7140±130 I 5083	Richard 1977B

TABLE 2. (Cont'd)

SITE	COORDINATES	CORE DEPTH (CM)	RADIOCARBON AGE (YRS. B.P.) AND LABORATORY NO.	REFERENCE
QUEBEC (Cont'd)				
Saint-Raymond	46°53'N 71°48'W	270-285	3550±120 Gif 1759	Richard 1977B
Saint-Raymond	46°53'N 71°48'W	550-560	7970±140 GSC 1400	Richard 1977B
Sud du Lac du Noyer	46°47'N 72°50'W	425-430	8230±270 I 8825	Richard 1977B
Sud du Lac du Noyer	46°47'N 72°50'W	440-445	9205±385 I 8842	Richard 1977B
Sud du Lac du Noyer	46°47'N 72°50'W	448-455	9670±190 I 8497	Richard 1977B
Baie des Onze Iles	46°45'N 73°08'W	--	--	--
Wapizagonke	46°43'N 73°02'W	560-570	9730±140 I 8496	Richard 1977B
Gabriel	46°16'N 73°28'W	645-650	7605±380 I 8785	Richard 1977B
Gabriel	46°16'N 73°28'W	700-705	7965±200 I 8784	Richard 1977B
Gabriel	46°16'N 73°28'W	725-733	9105±175 I 9038	Richard 1977B
Rond	46°13'N 74°31'W	340-350	7920±155 I 9277	Richard 1977B
Borne	46°00'N 74°22'W	550-555	5830±300 I 9452	Richard 1977B
Borne	46°00'N 74°22'W	595-610	8570±215 I 9427	Richard 1977B
Borne	46°00'N 74°22'W	610-630	8620±165 I 9281	Richard 1977B
Tania	45°46'N 74°18'W	790-800	9380±130 I 9278	Richard 1977B
Tania	45°46'N 74°18'W	810-820	10000±195 I 9279	Richard 1977B
Lotbinière	46°36'N 71°46'W	--	--	Richard 1977B
Dosquet	46°27'N 71°30'W	580-590	8835±145 I 7157	Richard 1977B

TABLE 2. (Cont'd)

SITE	COORDINATES	CORE DEPTH (CM)	RADIOCARBON AGE (YRS. B.P.) AND LABORATORY NO.	REFERENCE
QUEBEC (Cont'd)				
Saint-Benjamin	46°17'N 70°36'W	520-570	9100±150 I 7156	Richard 1977B
Albion	45°40'N 71°19'W	365-375	9005±150 I 8142	Richard 1977B
Albion	45°40'N 71°19'W	445-455	10880±160 I 8141	Richard 1977B
Shefford	45°21'N 72°35'W	505-515	11100±230 I 8839	Richard 1977B
Shefford	45°21'N 72°35'W	543-550	11170±230 I 8840	Richard 1977B
Shefford	45°21'N 72°35'W	565-575	11400±340 I 8841	Richard 1977B
Lac des Roches Moutonnées	56°46'N 64°49'W	0-20	510±150 I 9064	McAndrews & Samson 1977
Lac des Roches Moutonnées	56°46'N 64°49'W	100-120	2600±170 I 9065	McAndrews & Samson 1977
Lac des Roches Moutonnées	56°46'N 64°49'W	200-220	3510±175 I 9066	McAndrews & Samson 1977
Lac des Roches Moutonnées	56°46'N 64°49'W	250-260	4090±250 I 9067	McAndrews & Samson 1977
NEW BRUNSWICK				
Collins L.	--	33-45	910±90 Dal 234	Green 1976
Collins L.	--	122-133	2175±20 Dal 236	Green 1976
Collins L.	--	242-256	5500±170 Dal 238	Green 1976
Collins L.	--	306-332	5450±200 Dal 239	Green 1976
Basswood Road L.	45°15'N 67°19'W	500	9460±220 GSC 1643	Mott & Foster 1977
Basswood Road L.	45°15'N 67°19'W	630	11300±180 GSC 1645	Mott & Foster 1977
Basswood Road L.	45°15'N 67°19'W	650	12600±270 GSC 1067	Mott & Foster 1977

TABLE 2. (Cont'd)

SITE	COORDINATES	CORE DEPTH (CM)	RADIOCARBON AGE (YRS. B.P.) AND LABORATORY NO.	REFERENCE
NOVA SCOTIA				
Port Hood	46°02'N 61°34.5'W	--	11000±170 GSC 540	Terasmae 1974
Port Hood	46°02'N 61°34.5'W	--	11300±160 GSC 541	Prest *et al.* 1976
Hillsborough	46°04'N 61°22'W	335	>51000 GSC 370	Mott & Prest 1967
Whycocomagh	45°58'N 61°07'W	396	>44000 GSC 290	Mott & Prest 1967
Bay St. Lawrence	47°01'N 60°27'W	12.5 m	39270* GSC 283	Mott & Prest 1967
Shaw's Bog	45°01'N 64°11'W	300-305	4415±130 I-7077	Hadden 1975
Shaw's Bog	45°01'N 64°11'W	500-505	6290±140 I-7078	Hadden 1975
Shaw's Bog	45°01'N 64°11'W	600-605	8505±160 I-7079	Hadden 1975
Shaw's Bog	45°01'N 64°11'W	670-675	9180±255 I-7080	Hadden 1975
Everitt L.	--	50-60	1070±200 DAL 208	Green 1976
Everitt L.	--	150-160	1940±180 DAL 209	Green 1976
Everitt L.	--	250-260	7030±340 DAL 210	Green 1976
Everitt L.	--	450-460	8080±410 DAL 212	Green 1976
Curry Pond	--	180-190	8130±400 DAL 232	Green 1976
River Inhabitants	45°40.75'N 61°19.58'W	--	39000 GSC 1406	Mott 1971B
River Inhabitants	45°40.75'N 61°19.58'W	4570	32100±900 GSC 1408	Mott 1971B

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*A date of >38,300 (GSC 283) is given in Dyck *et al.* (1966, p.5).

TABLE 2. (Cont'd)

SITE	COORDINATES	CORE DEPTH (CM)	RADIOCARBON AGE (YRS. B.P.) AND LABORATORY NO.	REFERENCE
NEWFOUNDLAND				
Grand Falls (L)*	--	--	1350±500 SM 352	Morrison 1970
Grand Falls (L)	--	70	3400±600 SM 353	Morrison 1970
Greenbush L. (L)	--	--	5300±800 SM 355	Morrison 1970
Lac Aulneau/ Marymac L. (L)	--	--	6400±900 SM 356	Morrison 1970
Sona L. West (L)	53°35'N 63°57'W	250	5575±250 --	Morrison 1970
Churchill Falls North (L)	53°36'N 64°19'W	300	5255±200 --	Morrison 1970
Churchill Falls South (L)	53°35'N 64°18'W	450	5440+200 --	Morrison 1970

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* (L) = Labrador

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