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Canada, and comparison with other forest-tundra assemblages**
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et comparaison avec d'autres spectres de la toundra forestière**
**Heutige Pollenspektren im Tieffland der James Bay und
Vergleiche mit anderen Wald-Tundra Verbindungen**

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Résumé de l'article

Nous avons étudié les spectres polliniques contemporains de 28 sites au sud-ouest de la baie de James afin de faciliter l'interprétation des diagrammes polliniques postglaciaires. La présence de *Picea* est dominante alors que la proportion de *Pinus banksiana* et de *Betula* (surtout comme arbuste) est assez forte. Certaines espèces d'arbres (des genres *Larix*, *Abies*, *Populus*), qui croissent encore dans la région, sont sous-représentées dans les assemblages. Parmi les arbustes, le pollen de deux espèces d'*Alnus*, *A. crispa* et *A. rugosa*, est représenté à l'échelle régionale. Nous avons noté la présence locale de *Salix* et de *Myrica* là où poussent ces espèces. La fréquence des *Éricacées* varie selon le site de prélèvement. La représentation du pollen de *Sphagnum* et de *Cypéracées* varie beaucoup selon la proximité de ces taxons du site d'échantillonnage. Nous avons comparé les assemblages polliniques des principaux taxons de six sites, de la toundra forestière de la Saskatchewan jusqu'à la région à l'est de la baie de James, au Québec. Les différents genres sont partout représentés de façon semblable. Il semble que l'on retrouve à travers toute la région les mêmes influences locales, régionales ou extra-régionales ainsi que les mêmes sur- ou sous-représentations de groupes taxinomiques distincts. Les spectres polliniques semblent donc être valables pour toute la toundra forestière du centre du Canada.

CONTEMPORARY POLLEN SPECTRA IN THE JAMES BAY LOWLAND, CANADA, AND COMPARISON WITH OTHER FOREST-TUNDRA ASSEMBLAGES

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ABSTRACT Contemporary pollen spectra obtained from twenty-eight sites in the southwestern James Bay area were examined as an aid to the interpretation of postglacial pollen diagrams. *Picea* is the dominant pollen type. *Pinus banksiana* and *Betula* pollen are prominent, with the shrub birches contributing most of the latter. Other tree genera (*Larix*, *Abies*, *Populus*) extant in the area are underrepresented in the pollen assemblages. Among the shrub taxa present, pollen of two species of *Alnus*, *A. crispa* and *A. rugosa*, are regionally represented. *Salix* and *Myrica* pollen are notable locally at sites where these plants occur. Ericaceae values vary according to the type of sampling site. Cyperaceae and *Sphagnum* values fluctuate greatly depending on the proximity of these taxa to the sampling site. Pollen assemblages of the major taxa in six data sets extending from the forest-tundra of Saskatchewan to the eastern James Bay area in Québec were examined. Comparison yielded similar values of most genera. Local, regional and extra-regional influences, as well as over- and underrepresentation of individual taxa appear to apply uniformly over the entire area thereby providing pollen spectra representative of the forest-tundra of central Canada.

RÉSUMÉ Spectres polliniques dans les basses terres de la baie de James et comparaison avec d'autres spectres de la toundra forestière. Nous avons étudié les spectres polliniques contemporains de 28 sites au sud-ouest de la baie de James afin de faciliter l'interprétation des diagrammes polliniques postglaciaires. La présence de *Picea* est dominante alors que la proportion de *Pinus banksiana* et de *Betula* (surtout comme arbuste) est assez forte. Certaines espèces d'arbres (des genres *Larix*, *Abies*, *Populus*), qui croissent encore dans la région, sont sous-représentées dans les assemblages. Parmi les arbustes, le pollen de deux espèces d'*Alnus*, *A. crispa* et *A. rugosa*, est représenté à l'échelle régionale. Nous avons noté la présence locale de *Salix* et de *Myrica* là où poussent ces espèces. La fréquence des *Ericacées* varie selon le site de prélèvement. La représentation du pollen de *Sphagnum* et de *Cypéracées* varie beaucoup selon la proximité de ces taxons du site d'échantillonnage. Nous avons comparé les assemblages polliniques des principaux taxons de six sites, de la toundra forestière de la Saskatchewan jusqu'à la région à l'est de la baie de James, au Québec. Les différents genres sont partout représentés de façon semblable. Il semble que l'on retrouve à travers toute la région les mêmes influences locales, régionales ou extra-régionales ainsi que les mêmes sur- ou sous-représentations de groupes taxinomiques distincts. Les spectres polliniques semblent donc être valables pour toute la toundra forestière du centre du Canada.

ZUSAMMENFASSUNG Heutige Pollenspektren im Tiefland der James Bay und Vergleiche mit anderen Wald-Tundra Verbindungen. Heutige Pollenspektren von ca 28 Plätzen der sud-westlichen James Bay Gegend, wurden untersucht und sollen bei der Auslegung von postglazialen Pollendiagrammen helfen. *Picea* ist der hervorragende Pollentyp. *Pinus banksiana* und *Betula* Pollen sind zusammen mit den Buschbirken in der Mehrheit, die am meisten zu den zweiten beitragen. Andere Baumarten (*Larix*, *Abies*, *Populus*), die in der Gegend häufig vorkommen, sind in den Pollensammlungen zu gering vertreten. Unter den gegenwärtigen Buschpflanzen sind Pollen von zwei *Alnus* Arten, *A. crispa* und *A. rugosa*, in der Region vertreten. *Salix*- und *Myrica*pollen findet man an den Stellen, wo diese Pflanzen vorkommen. Ericaceen Werte schwanken im Einklang mit den verschiedenen Sammlungsstellen. Cyperaceae und *Sphagnum* Werte schwanken sehr, je nach dem Abstand dieser Pflanzarten vom Forschungssitz. Die Pollenverbindungen der hauptsächlichen Pflanzarten in sechs Datensammlungen, die sich von der Wald-Tundra Saskatchewan bis zur östlichen James Bay Gegend in Québec erstrecken, wurden untersucht. Vergleiche zeigen ähnliche Werte für die meisten Arten. Örtliche, regionale und ausser-regionale Einflüsse, sowie eine zu grosse oder zu geringe Vertretung der einzelnen Arten kommen gleichmässig in dem ganzen Raum vor und ergeben somit Pollenspektren die die ganze Wald-Tundra zentral Kanada's repräsentieren.

INTRODUCTION

Reconstruction of the pattern of past vegetation and climate from fossil pollen spectra requires knowledge of how the distribution of modern pollen is related to the distribution patterns of modern vegetation and climate. To determine this relationship, pollen diagrams are constructed in which pollen data are transformed into vegetation and/or climatic terms. This requires an inventory of modern pollen rain from differing vegetation and climatic regions.

Correlation of modern pollen spectra with vegetation for use in vegetational reconstruction from fossil pollen spectra has been achieved in numerous studies (e.g. DAVIS, 1967; RITCHIE, 1967; LIVINGSTONE, 1968; OGDEN, 1969; DAVIS *et al.*, 1975; RICHARD, 1977). However, it has long been recognized that pollen spectra do not precisely reflect the vegetation composition (DAVIS and GOODLETT, 1960; TERASMAE and MOTT, 1965; JANSSEN, 1966; LICHTI-FEDEROVICH and RITCHIE, 1968; NICHOLAS, 1969; DAVIS and WEBB, 1975) so this correlation can only be accomplished after the anomalous nature of the relationship is considered.

Local, regional and extra-regional vegetation (JANSSEN, 1972) are incorporated in varying proportions in most pollen assemblages. If a pollen diagram is used to infer climatic changes, then the diagram must register the regional pollen rain which is characterized by a combination of pollen types independent of the local environment. Local influences may be reflected in the pollen diagram by the presence of some taxa which have no regional significance. These taxa will reflect the vegetation in the immediate vicinity of the site. Pollen may also be transported long distances by wind. In some instances a significant part of the pollen assemblage, e.g. *Pinus*, may be attributed exclusively to extra-regional representation. Other factors to be considered in correlating modern pollen spectra with vegetation are those of over- and underrepresentation of certain species (DAVIS, 1963). Although modern pollen spectra may not always be analogous to fossil pollen assemblages, data concerning over- and underrepresentation of present-day pollen should equally apply to the same species in the past.

Generally tree genera exhibit regional or extra-regional representation in pollen spectra. Pollen productivity, dispersal and preservation determine the extent of representation in the assemblages. Pollen values of a tree taxon will therefore usually be quite consistent within a region. Shrub and herb genera, on the other hand, can be either locally or regionally represented. Wind pollinated shrubs and herbs exhibit regional and even extra-regional representation. Plants that are insect pollinated and aquatic taxa are usually

observed as a local representation without any regional significance (JANSSEN, 1966). As a result, adjacent sites may have similar regional pollen assemblages, but will differ in pollen values of taxa exhibiting a local influence.

In this study, the contemporary pollen spectra of the Hudson Bay Lowland were examined in order to augment the inventory of modern pollen distribution and thereby provide data necessary for the interpretation of postglacial pollen spectra. Twenty-eight surface samples were collected by a team from Fisheries and Environment Canada in 1976 and 1977. The samples are primarily from bogs, fens, forested beach ridges and conifer swamps in an area extending from 6 km east of the Ontario-Québec border to the Albany River (Fig. 1). The investigation had two objectives: 1) to establish the relationship between the modern pollen assemblages and vegetation in the James Bay Lowland and 2) to compare the regional abundance of the major taxa with respect to other pollen assemblages from the forest-tundra of central Canada. Pollen abundances of the major taxa are discussed with a view to determining the origin of the pollen, *i.e.* local, regional or extra-regional.

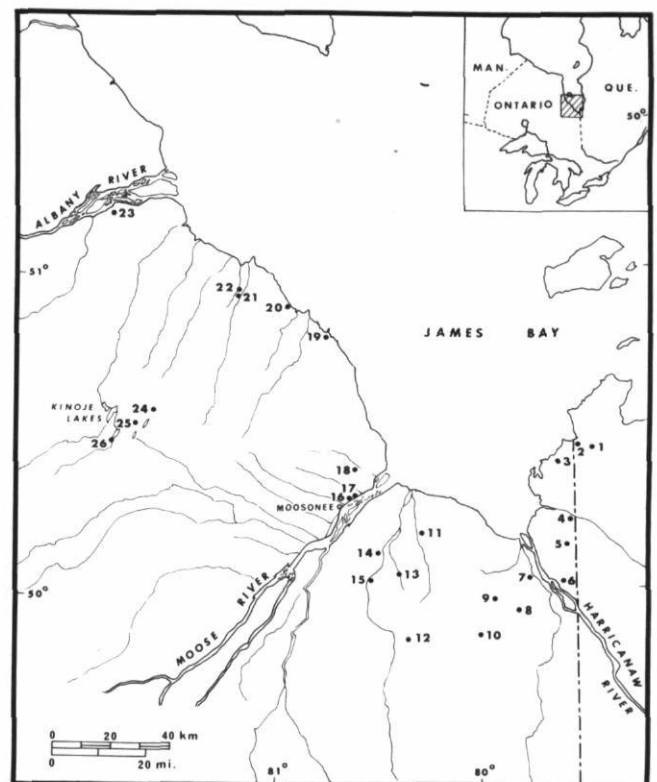


FIGURE 1. Map of southwestern James Bay basin showing location of sites analysed in this study.

Carte du bassin du sud-ouest de la baie de James montrant l'emplacement des sites étudiés.

Over- and underrepresentation of individual taxa are also assessed. In an attempt to determine the effect of local vegetational differences on the pollen assemblages, samples were collected from adjacent sites at each of two localities and the resulting pollen assemblages assessed.

Previous contemporary palynological work in the region is sparse. WEBB and McANDREWS (1976) have included sites in the western part of the Lowland in their report on contemporary pollen and vegetation patterns in central North America. Lichti-Federovich (SKINNER, 1973) reported on nine surface sample sites, eight of which are in the Moose River Basin. POTZGER and COURTEMANCHE (1956) have, in their study of bogs across Québec, included six sites in the region. FARLEY-WILSON (1975) studied surface samples to the east of James Bay and RICHARD (1979) has included in his report on postglacial history, a contemporary pollen assemblage derived from analyses of eighteen lake sites northeast of the James Bay area. Results of these five studies together with the new data comprise the total data available for correlation.

PHYSIOGRAPHY AND SURFICIAL GEOLOGY

The Hudson Bay Lowland is one of the largest wetland areas in the world. It is an area of very low relief, a vast plain of continuous swamp covered with a thick, water-soaked blanket of bog mosses (TYRRELL, 1916). The regional slope is gently northeastward and eastward, and the rivers draining into James Bay are remarkably parallel. Extensive low, flat, clay plains occur between the much-incised rivers and streams. Because the clay plains are so poorly drained, a continuous cover of muskeg has evolved consisting of perpetually wet fens and bogs which often contain shallow rounded lakes (SJÖRS, 1959).

The sampling sites lie within the Hudson Bay Lowland physiographic division of the Hudson Region of the Canadian Shield (BOSTOCK, 1970). Flat-lying Paleozoic rocks of Ordovician, Silurian and Devonian ages consisting of limestones, dolostones, shales, sandstones and evaporites overlie the Precambrian in this large sedimentary basin (SANFORD *et al.*, 1968). Lower Cretaceous non-marine clastic beds cover the Paleozoic.

The Quaternary history of the area has been studied by CRAIG (1969), LEE (1960, 1962, 1968), McDONALD (1969), SKINNER (1971, 1973) and others. Five till sheets, separated by non-glacial deposits, attest to major advances and retreats of the ice margin over the area. The Missinaibi Formation, one of the non-glacial intervals, overlies three of the till sheets and includes organic deposits of probable Sangamon Interglacial age (TERASMAE and HUGHES, 1960; SKINNER, 1973; STUI-

VER *et al.*, 1978). Sediments overlying the Missinaibi Formation indicate recession of the Wisconsinan ice and formation of proglacial lakes between the ice front and the drainage divide, readvance of Cochrane ice, retreat and incursion of the sea, and finally emergence above the sea. The limits of postglacial marine submergence extend southward more than 40 km beyond the study area (PREST *et al.*, 1970).

CLIMATE

Considering its latitude, the climate of the area is severe, but is moderated somewhat in summer by its proximity to the coast and the water-covered muskeg. A mean January daily temperature of -21°C , a mean July daily temperature of 16°C , and a mean annual temperature of -2°C characterize the area. Winter lows of -46°C and summer highs of 36°C have been recorded (CHAPMAN, 1953; METEOROLOGICAL BRANCH, 1960, 1967; THOMAS, 1953). The low temperatures allow the formation of discontinuous permafrost in the peat (BROWN, 1970). Prevailing winds are northwesterly with summer winds from the southwest and south. At Moosonee there are 190 days with measurable precipitation. Mean annual total precipitation is 79 cm, 51 cm of which falls as rain, the remainder as snow. The growing season lasts 140-145 days of which there are approximately 80 frost-free days.

VEGETATION

The area of this study, a forest-tundra environment, lies within the Hudson Bay Lowlands Section of the Boreal Forest Region (ROWE, 1972). An open woodland of scrubby black spruce (*Picea mariana*) and tamarack (*Larix laricina*) in the bogs and patterned fens lends a distinctly subarctic appearance to the vegetation. These two species, as well as white spruce (*Picea glauca*), form the northern tree-line along the coast of James Bay and are the dominant tree species in the area. Black spruce grows on bogs or muskeg; pure stands of tamarack are found scattered on the extensive peatlands. White spruce occupies well drained, rich soils and extreme maritime localities on dry ridges near the sea (HUSTICH, 1966). Aspen (*Populus tremuloides*) and balsam poplar (*Populus balsamifera*) form young stands on areas of former burns and are found locally on cut-over areas. Balsam fir (*Abies balsamea*) and white birch (*Betula papyrifera*) are common near rivers, but white birch is the only tree birch in the area and it seldom forms pure stands. Cedar (*Thuja occidentalis*) occurs as scattered small cedar swamps in wooded areas. Occasionally American elm (*Ulmus americana*) is seen growing on the banks of deeply entrenched larger streams, thereby taking advantage of the more

favourable microclimate. Shrub birch (*Betula minor*, *B. glandulosa* and *B. pumila*) appears on low ridges in fens, and is frequently found among low stands of tamarack, although *Betula glandulosa* is not as common in this area as it is farther north (HUSTICH, 1955, 1957). Speckled alder (*Alnus rugosa*) is a prominent shrub, as are sweet gale (*Myrica gale*) and the heaths (Ericaceae); green alder (*Alnus crispa*) is common along the coast but is scarce inland. Willow (*Salix* sp.) occurs at the margins of small swamps and along small brooks. Shrub species found as scattered occurrences in the understory include juniper (*Juniperus communis*), mountain maple (*Acer spicatum*), buckthorn (*Rhamnus alnifolia*), mountain-ash (*Sorbus decora*) and red osier (*Cornus stolonifera*) (BALDWIN, 1959; 1962).

Jack pine (*Pinus banksiana*) is a continental species characteristic of, and adapted to, dry sites. Due to the depth of its root system it avoids areas of permafrost (HUSTICH, 1966). These factors suggest restricted occurrence of jack pine in the study area. HOSIE (1969) and HUSTICH (1966) place the northern range of this species in the Boreal Forest Region to the south. HAL-

LIDAY and BROWN (1943) appear to agree. HUSTICH (1955) has suggested the limit of marine submergence as a northern boundary for jack pine. However, Sims (pers. comm.) has noted the occurrence of this species within the study area, favouring burnt over beach ridges, and he specifically noted a stand of about 4 km² approximately 60 km northwest of Moosonee.

In this area of broad expanses of open string bogs and overlapping bogs and fens, man's influence has little impact. Agriculture is restricted to the vicinity of the settlements and the forests are still primarily virgin.

METHODS

Surface samples were collected from moss polsters, bog and fen surfaces, conifer swamps and forested beach ridges. Their locations are shown in Figure 1. In an attempt to determine the effect of local vegetational differences on the pollen assemblages, samples were collected from adjacent sites at each of two localities. Table I lists all sites by number, giving the specific locations and briefly describing the local settings. Eleva-

TABLE I
Specific location and local settings of sites analyzed in this study

SITE NO.	N. LAT.	W. LONG.	LOCAL SETTING
1	51°26'00"	79°26'00"	shrub rich fen
2	51°26'45"	79°30'00"	conifer swamp
3	51°24'00"	79°36'00"	graminoid fen
4	51°12'45"	79°31'30"	shrub rich fen
5	51°08'15"	79°33'30"	shrub rich fen
6	51°01'30"	79°34'30"	treed fen
7	51°02'15"	79°45'00"	treed fen
8	50°56'00"	79°48'30"	treed bog
9	50°58'15"	79°55'00"	treed bog
10	50°51'45"	79°59'30"	treed fen
11	51°10'30"	80°16'00"	unknown
12	50°51'15"	80°21'00"	shrub rich bog
13	51°03'30"	80°23'00"	graminoid fen
14	51°07'00"	80°28'45"	treed fen
15	51°02'00"	80°32'00"	conifer swamp
16	51°17'25"	80°37'30"	conifer swamp
17	51°17'45"	80°36'45"	tamarack fen
18	51°22'45"	80°36'30"	treed fen
19	51°47'50"	80°43'45"	black spruce/lichen woodland
20	51°53'15"	80°55'00"	black spruce ridge
21	51°55'15"	81°10'00"	treed bog
22	51°57'00"	81°10'00"	treed bog
23	52°10'45"	81°47'00"	black spruce ridge
24a	51°34'35"	81°34'45"	burned bog (now open lichen bog)
24b	51°34'35"	81°34'45"	open unburned bog
25a	51°31'55"	81°40'15"	shrub/lichen open bog ridge
25b	51°31'55"	81°40'15"	black spruce bog rimming lake
26	51°29'00"	81°47'15"	black spruce mound in bog

tions at most sites are 30 m a.s.l. or less with the exception of Site 12, which is at about 50 m a.s.l.; the five sites in the Kinoje Lakes area are all at approximately 60 m a.s.l.

Samples were collected by hand from the growing layer and placed in plastic bags. The water and fine detritus that could be squeezed from the sample in the laboratory were used for analysis. Chemical treatment involved heating in 10% potassium hydroxide, sieving, and sequential digestion in concentrated hydrofluoric acid, dilute hydrochloric acid, 10% nitric acid and acetolysis (FAEGRI and IVERSEN, 1975). The residue was dehydrated in tertiary butyl alcohol and suspended in silicon oil for counting.

The pollen sum used in calculating percentages included only arboreal taxa in order to minimize distortion caused by overrepresentation of local vegetation from one site to another. The proportions of shrub, herb and aquatic pollen and spores present at a particular site are evaluated relative to the total arboreal pollen present at that site and expressed as a percentage of it. Therefore, values in excess of 100% will be encountered at sites where a local abundance of a taxon exceeds the total arboreal pollen count. *Sphagnum* is particularly abundant in the study area and this is reflected in values exceeding 100% at 16 of the 28 sites. The mossy nature of the samples and the absence of sediment accumulation rates precluded calculation of pollen concentration and pollen influx values.

The most prominent taxa are included in the pollen diagram (Fig. 2); percentages for the less prominent pollen and spore taxa are listed in Table II. The regional pollen abundance of a taxon is expressed as a percentage based on the sum of the counts of that taxon at all sites relative to the sum of the total arboreal pollen counts at all sites. It is shown at the base of the pollen diagram and is included in Table II. Total arboreal pollen counts (pollen sum) at each site are also shown in Table II.

RESULTS AND DISCUSSION

The pollen spectra are dominated by *Picea* (spruce) but *Pinus banksiana* (jack pine) and *Betula* (birch) are also prominent among the arboreal taxa. Shrub genera are represented by two species of *Alnus*, *A. crispa* (green alder) and *A. rugosa* (speckled alder), both of which are present at all sites. *Salix* (willow) and *Myrica* are also notable in the region. Ericaceae, although present at most sites, attains major prominence in the Kinoje Lakes area. Cyperaceae (sedge) and *Sphagnum* values vary depending on their proximity to the site.

ARBOREAL SPECTRA

Picea

As would be expected, spruce is generally the most abundant taxon present in the pollen spectra. The pollen values range from 18% at Site 11, east of the Moose River, to 85% at Site 19, a spruce/lichen woodland setting located within 1 to 2 km of the coast. Spruce pollen was not differentiated due to the difficulty of separating grains of overlapping size. However, the presence of the large and smaller spruce grains was noted, with the preponderance being of the black spruce (smaller) pollen type. Even at localities favoured by white spruce, black spruce pollen is more abundant. Population density of spruce is over 60% of trees in this area of the Lowland (HALLIDAY and BROWN, 1943), whereas, in the pollen assemblages, the regional pollen abundance of spruce is only 47.7%. Spruce pollen abundance is usually directly proportional to number of trees growing in the area (DAVIS and GOODLETT, 1960), however, the inclusion of pine (which has limited occurrence in the area) in the pollen sum reduces the overall spruce value and causes this discrepancy.

Pinus

Jack pine pollen attains values of 42% in the eastern part of the study area, with lows of 8 to 10% in the coastal areas to the northwest. In the Kinoje Lakes area, the westernmost sites studied, it is in the 15 to 20% range.

Pinus strobus (white pine) pollen values of up to 1.9% appear to be a result of long distance wind transport as the northern limit of this species is in the southeastern part of the Boreal Forest Region, more than 200 km to the south (HOSIE, 1969). The regional pollen abundance of jack pine and all three pines together was determined to be 24.1% and 25.8%, respectively.

In partially forested and non-forested regions, the relative frequency of pine pollen resulting from long distance wind transport is much higher than in forested regions. This is due to the paucity of pollen contributed by other arboreal taxa. At sites where spruce trees are locally present, for example, the spruce pollen abundance reduces the impact of the jack pine pollen introduced from some distance. This is evident at Sites 19 and 20 where black spruce is locally abundant and where the lowest jack pine pollen values were obtained (8 to 10%). However, at Site 23 (the most northerly site) where black spruce is also prominent in the landscape, and the northern locale of this site would be expected to yield a low pollen value for jack pine, the actual jack pine pollen value is 28%.

The present study confirms the findings of DAVIS and GOODLETT (1960), JANSSEN (1966) and McANDREWS

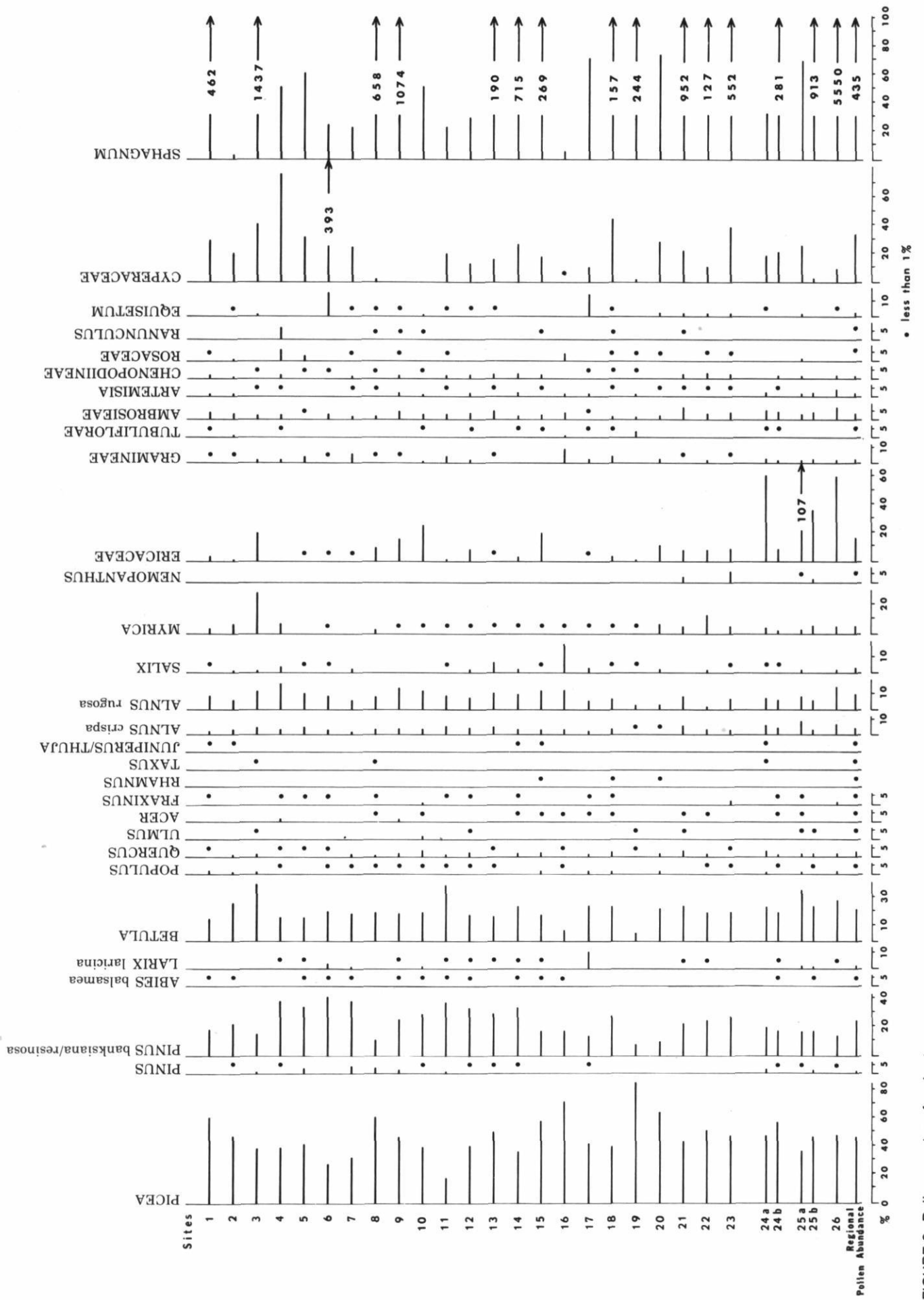


FIGURE 2. Pollen spectra of major taxa.
Spectres polliniques des principaux taxons.

TABLE II
Percentage values of taxa not included in the pollen diagram

Taxa	Sites																										Regional Abundance			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24a	24b	25a		25b	26	
TREES																														
<i>Pinus strobus</i>	1.1	-	1.1	1.4	-	1.9	1.1	0.7	1.0	1.5	1.1	1.3	0.4	0.4	0.9	-	1.2	-	-	0.5	-	-	0.5	0.6	0.8	0.7	0.5	-	0.66	
<i>Taxus canadensis</i>	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06	
<i>Carya</i>	-	-	-	-	-	-	-	-	-	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	0.6	-	-	1.1	-	0.08	
<i>Carpinus/Ostrya</i>	-	-	-	0.5	-	0.5	-	-	-	-	-	-	-	0.4	-	-	0.4	0.4	-	-	0.5	0.4	-	-	-	-	0.7	1.1	1.3	0.19
<i>Juglans nigra</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.7	0.5	0.6	0.03
<i>Platanus</i> type	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02
SHRUBS																														
<i>Corylus</i>	-	-	-	0.5	1.8	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4	-	-	0.4	-	1.1	-	0.13
HERBS																														
Liguliflorae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	0.03
<i>Sarcobatus</i>	-	-	-	-	-	-	-	-	0.5	-	0.4	-	-	-	0.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06
<i>Lirica</i> type	-	-	-	-	-	0.5	-	-	-	-	-	-	-	0.4	-	-	-	0.4	-	-	0.9	-	0.5	-	-	-	-	-	-	0.09
<i>Rumex</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.6	-	-	-	0.5	-	0.03
Caryophyllaceae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	0.02
<i>Thalictrum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4	-	-	-	-	-	-	-	0.5	-	-	0.03
<i>Calla</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06
<i>Oxysora</i>	-	-	-	-	0.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4	0.5	-	-	-	-	-	0.03
Leguminosae	-	-	-	-	-	-	-	-	-	0.4	-	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03
Umbelliferae	-	-	-	-	-	-	-	-	-	-	-	0.4	-	-	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03
Andropogon	-	-	-	-	-	-	-	-	-	-	-	0.4	-	-	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06
<i>Lycopus</i>	0.4	-	-	-	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.6	-	-	-	-	-	0.05
<i>Plantago</i>	-	-	-	-	-	-	-	-	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	0.03
<i>Gallium</i>	-	-	-	-	3.1	0.5	-	-	-	-	-	-	-	-	-	-	-	-	1.3	-	-	-	-	-	-	-	-	-	-	0.17
<i>Linnaea</i>	-	1.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05
<i>Lycopodium clavatum</i>	-	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	0.06
<i>L. annotinum</i>	-	0.4	-	-	-	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9	-	-	0.4	1.4	0.5	0.6	0.14
<i>L. complanatum</i> type	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4	-	-	-	-	-	-	-	0.4	0.7	-	-	0.03
<i>L. lucidulum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4	0.7	-	-	0.03
<i>Selaginella selaginoides</i>	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9	-	-	-	-	-	-	-	-	0.05
Pteridophyta	-	0.7	0.6	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.1	-	-	-	0.5	3.8	0.20
<i>Botrychium</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.7	-	-	0.02
Polypodiaceae	0.4	-	-	-	0.4	0.5	-	-	-	-	-	0.4	1.3	0.4	-	-	0.4	0.4	-	0.5	-	-	-	-	-	-	-	-	-	0.19
<i>Dryopteris</i>	-	-	-	-	-	-	-	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03
Unidentified	0.4	1.3	1.1	0.9	0.9	1.4	0.7	-	0.5	0.4	-	-	0.4	-	-	4.0	-	-	-	-	-	0.9	-	-	0.6	0.4	2.7	1.1	1.9	0.62
AQUATICS																														
<i>Zypha</i>	0.4	1.5	-	0.5	0.4	0.5	0.4	-	-	0.4	-	0.4	-	-	1.0	-	-	-	0.7	-	-	-	-	-	-	-	-	0.5	0.6	0.26
<i>Sparganium</i>	0.4	0.4	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	0.8	-	-	-	-	-	-	-	-	-	-	-	0.08
<i>Potamogeton</i>	-	-	1.1	1.4	0.9	-	-	-	-	-	0.4	-	-	-	-	-	0.4	1.7	-	-	-	-	0.5	-	-	-	-	-	-	0.22
<i>Sagittaria</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03
Liliaceae	-	-	-	-	-	-	10.2	-	0.5	0.4	-	-	-	-	7.3	-	-	-	-	5.4	-	-	0.9	-	-	-	-	-	-	0.94
Myriophyllum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.8	-	-	-	-	0.5	-	-	-	-	-	-	0.03
<i>Menyanthes</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02
<i>Isoetes</i>	-	4.4	-	-	-	1.0	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.23
Pollen Sum	280	276	180	216	229	208	285	270	209	264	267	232	226	289	220	202	253	235	295	222	215	241	221	180	267	147	191	160	6480	

Percentages are based on total arboreal pollen (pollen sum).
Regional abundance is a percentage based on the total pollen count of each taxon at all sites.

and WRIGHT (1969) who found little difference in pine pollen percentages in modern assemblages from sites where pine was or was not locally common, and concluded that pine pollen is produced in great quantities and is evenly distributed over a wide area. TERASMAE and MOTT (1965) found pine pollen values in excess of 20% at sites 65 km northeast of the pine limit in the Nichicun Lake area, Québec. Pine pollen is overrepresented in the pollen spectra apparently due to its high productivity and dispersal properties, as well as the relative paucity of other arboreal taxa contributing pollen in this forest-tundra area. Even in this region which supports so little pine, the regional pollen abundance of all pine species is 25.8%.

Abies

Although *Abies balsamea* (balsam fir) plays an important role in the boreal forest, the population density of this species in the study area is less than 10% (HALLIDAY and BROWN, 1943). This species is generally underrepresented in pollen spectra (LIVINGSTONE, 1968). At Brownington Pond, Vermont, where the ratio of fir to spruce was approximately equal in the forest, the ratio of fir to spruce pollen in the samples was 1:4 (DAVIS and GOODLETT, 1960). At James Bay, it is not surprising, therefore, to find maximum *Abies* pollen values of 1% and a regional pollen abundance of only

0.34% for this species in these assemblages, indicating an underrepresentation in this area as well.

Larix

Tamarack also tends to be considerably underrepresented in pollen spectra. The highest tamarack pollen value obtained was 12% at Site 17 which is a tamarack fen. Considering the abundance of tamarack trees contributing pollen at this locality, the value is extremely low. Tamarack is also abundant at Sites 6, 7 and 11 (Sims, pers. comm.) yet the pollen values obtained at these three sites were 3%, 1% and 0.4%, respectively. Values at the other sites range from 0 to 3% with a regional pollen abundance of 1.03%. No tamarack pollen was observed in samples from 10 of the 28 sites examined, however. Considering the prominence of this species on the landscape of the area, the values illustrate that tamarack pollen is greatly underrepresented.

Betula

The broad-leaved trees are a minor component of the forest cover of the area. Population density of individual hardwood species is less than 10% with white birch, aspen and poplar predominating (HALLIDAY and BROWN, 1943). *Betula* (birch) is important because of its pioneering ability after fires or cuttings. In the study

area the shrub birch *B. pumila* var. *glandulifera* is more abundant than the other birches, but white birch was observed on suitable sites, such as large levees along rivers; the hybrid *B. Sandbergii* was also noted in the area (Sims, pers. comm.). Birch pollen attains a maximum value of 40% with a low of 5.8%. The regional pollen abundance is 21.5%.

Overlapping size ranges of white birch (*B. papyrifera*) and shrub birch (*B. glandulosa*, *B. pumila*, *B. minor*) pollen make differentiation of these species on size alone rather uncertain. RICHARD (1975) divides birch pollen into three size ranges; shrub birch is indicated as up to 26 μm in size, white birch ranges from about 24-31 μm , and yellow birch (*B. alleghaniensis*) exceeds 28 μm in size, with an arbitrary value of 25-30 μm for the white birch pollen type for purposes of segregation. Richard's measurements were made on samples mounted in glycerin, which tends to swell the pollen grains more than silicon oil, the mounting medium used in the preparation of the samples reported here. However, an examination of reference slides of birch pollen mounted in silicon oil (the diameters of 10 grains of each species were measured in equatorial view) yielded dimensions at least as large as Richard obtained. For example, white birch pollen (*B. papyrifera*) averaged 29.7 μm in diameter, yellow birch (*B. alleghaniensis*) had a mean diameter of 35.8 μm , and the shrub birches (*B. glandulosa* and *B. pumila* var. *glandulifera*) averaged 23.7 μm and 25.6 μm in diameter, respectively.

Time did not permit measurements of all birch pollen grains in the samples. As a compromise, seven samples were chosen across the area (Sites 3, 7, 12, 17, 20, 23, 25a) and random measurements of the equatorial view of 10 birch pollen grains in each of these samples were made. They range in size from 17 μm to 28 μm with a mean diameter of 22.9 μm for the 70 grains. It appears from the size data that shrub birch predominates in the pollen assemblages as it does on the landscape, although it is not possible to determine if more than one species is involved. The larger grains of birch pollen are probably white birch, and their presence reflects the occurrence of this species in the area, albeit in less abundance than in areas to the south. Yellow birch pollen was not encountered among the grains measured. The absence of yellow birch pollen was expected because the northern range of this species is more than 300 km south of the study area (HOSIE, 1969).

POTZGER et al. (1956) found birch pollen to be over-represented particularly in open areas such as moss polsters. In forested areas, birch had lower values that they postulated was due to interception of the pollen rain by the dense crowns of the conifers. The variability in the values of birch pollen in the assemblages reported here may be a reflection of this phenomenon.

Certainly the highest values were obtained at open localities and lower values at sites that were more heavily treed. However, when only relative values are being compared, the increase in the pollen value of one taxon necessitates a decrease in the others and, therefore, lower birch percentages may just be a reflection of the increase in spruce in areas where the latter is more abundant.

Populus

Both *Populus tremuloides* (trembling aspen) and *P. balsamifera* (balsam poplar) are common in the study area, although their population density is less than 10% (HALLIDAY and BROWN, 1943). They are early invaders after disturbances such as fire and play a major role in reforestation as shelters for conifer seedlings. *Populus* pollen is often poorly preserved and as a result is usually underrepresented in pollen spectra. MOTT (1969) noted the complete absence or very low values of this taxon in surface pollen assemblages at most sites he studied in Saskatchewan, including those where *Populus* is locally prominent in the landscape. JANSSEN (1966) also found much lower *Populus* pollen percentages than tree representation in the forests of southeastern Minnesota. *Populus* pollen values in the study area range from 0 to 2% with a regional pollen abundance of 0.75%, demonstrating a probable underrepresentation of this genus in these assemblages as well.

Quercus

Although *Quercus* (oak) pollen is present at every site and has a regional pollen abundance of 1.57%, the occurrence of this taxon has not been recorded in the area. Its pollen is readily dispersed by wind (RITCHIE and LICHTI-FEDEROVICH, 1967) and its presence in these assemblages is believed to be mainly as a result of long distance wind transport. This overrepresentation of oak pollen at sites where oak is infrequent or lacking has previously been noted by several authors (POTZGER et al., 1956; DAVIS and GOODLETT, 1960; MOTT, 1975).

Ulmus and *Fraxinus*

Ulmus (elm) and *Fraxinus* (ash) are genera that tend to avoid the areas of the Lowland below postglacial marine submergence. However, white elm (*U. americana*) has been observed in the area, taking advantage of the thermoclimate along incised streams and rivers, its height restricted by climate to the tops of the river banks (HILLS, 1962). In general however, the northern limit of both elm and ash is in the southern boreal forest, with ash extending farther north than elm (HUSTICH, 1957; HOSIE, 1969). Both are present (less than 3%) in the pollen spectra, ash present at more sites than elm.

Acer

Although the northern limit of *Acer spicatum* (mountain maple) is reported to correspond with the southern portion of the boreal forest (HOSIE, 1969), it nevertheless has been observed in the study area (BALDWIN, 1959). *Acer* pollen is underrepresented in surface pollen spectra (POTZGER *et al.*, 1956; DAVIS and GOODLETT, 1960; JANSSEN, 1966). This fact, coupled with the limited occurrence of this taxon in the area, is attested to by the minimal pollen values (less than 2%) obtained in this study.

Other Trees

Other tree genera represented in the pollen spectra in low amounts include *Tsuga canadensis* (hemlock), *Carya* (hickory), *Carpinus/Ostrya* (blue-beech/ironwood), *Juglans nigra* (black walnut) and *Platanus* type (sycamore). All of these taxa have a northern limit well to the south of the James Bay area. The sporadic presence of their pollen is a result of long-distance wind transport.

SHRUB SPECTRA

Alnus

Shrub taxa present in the pollen assemblages all represent genera which have been reported growing in the area (BALDWIN, 1959). One of the most common shrubs is *Alnus rugosa* (speckled alder), the pollen of which is present at all sites. Values range from 2 to 19% and the regional pollen abundance is 9.48%. *Alnus crispa* (green alder), the other alder species growing in the area, is also present in all the pollen assemblages with values of 0.5 to 10.2% and a regional pollen abundance of 3.87%. HUSTICH (1955) found green alder to be very common on the coast itself, but scarce inland. However, in the pollen spectra, the lowest values were found at sites closest to the coast (Sites 19 and 20); the highest value of green alder pollen was obtained in the Kinoje Lakes area at a site almost 70 km from the coast. The presence of alder pollen at all sites indicates that this genus has a regional representation in the spectra rather than being locally abundant at a few sites.

Salix

Salix (willow) plays the same pioneer role as poplar, birch and alder in the study area. Willow pollen is present in the spectra with values as high as 19.8% and a regional pollen abundance of 1.84%. The variability in the values demonstrates the local influence of this genus. JANSSEN (1966) stated that willow pollen values exceeding 3 to 4% indicate the presence of willow shrubs at the sampling site. This generalization equally applies to treeless regions where the absence of trees considerably reduces total pollen precipitation and willow would be expected to have a greater regional

representation. The high local values at some sites and complete absence at others demonstrate the poor dispersal properties of willow pollen and accordingly, a regional underrepresentation for this genus in the pollen spectra.

Myrica

Myrica also exhibits a local influence in these assemblages. Pollen values range from 0 to 28.9% and the regional pollen abundance is 3.47%. The lower values were obtained at sites in the central part of the region with higher values at the eastern and northwestern localities.

Other Shrubs

Pollen of other shrub genera, *i.e.*, *Rhamnus* (buckthorn), *Taxus* (yew), *Juniperus/Thuja* (juniper/cedar) type, *Corylus* (hazel-nut) and *Nemopanthus* (mountain-holly) occur in minimal amounts, generally less than 1% and not more than 8%. These occurrences are infrequent and scattered throughout the region with the exception of mountain-holly pollen that is only present at sites in the western part of the region.

HERB SPECTRA

Herbaceous taxa in general are not well represented regionally in pollen spectra. In a comparison of pollen values with vegetation composition, JANSSEN (1966) found, with few exceptions, that herb pollen grains are only present at sites where the plant occurs locally. DAVIS and GOODLETT (1960) also noted a poor representation of the herbaceous flora in their pollen assemblages. This phenomenon is also evident in the James Bay region where Ericaceae, for example, demonstrates a local influence with values that range from 0 to 107%, the higher values being in the Kinoje Lakes area. This variability in pollen values is mainly a reflection of the type of sampling site. The bog sites, which are ericaceous-rich, have a mean value of 26.9% for ericaceous pollen. By contrast, the fen sites, and the conifer swamp and upland sites have a substantially less dense cover of ericaceous plants and lower mean values for ericaceous pollen (5.1% and 6.5%, respectively). Other herb genera present in these pollen assemblages are representative of the local vegetation at individual sites with the exception of Ambrosieae (ragweed type) and *Sarcobatus* (greasewood). Ambrosieae pollen occurs at every site and has a regional abundance of 3.78% even though the northern limit of these plants is well south of the study area (BASSETT, 1950). Its presence reflects the good dispersal properties of Ambrosieae pollen. BASSETT and TERASMAE (1962) reported a ragweed pollen value of 3% from a surface sample site near Moosonee, similar to the regional

abundance obtained here. The presence of *Sarcobatus* is interpreted to be a result of long distance wind transport as this genus is native to the American west and southwest (MAHER, 1964).

AQUATIC SPECTRA

Aquatic taxa present in the pollen spectra are extant in the area. Included with aquatics are the typical pond plants and such wetland taxa as Liliaceae (lily family), Cyperaceae (sedge family) and *Sphagnum*. Liliaceae (cf. *Smilacina trifolia*) pollen is present at six sites and has a maximum value of 10%. Its occurrence in the area has been noted by BALDWIN (1959) and Sims (pers. comm.), and its presence in these assemblages is a result of local influence.

Cyperaceae is represented by pollen values which range from 0 to 393%, with the higher values at fen sites. The fen/bog ratio of all the sedge pollen counts is about 5.4 to 1. However, higher sedge pollen values were obtained at some bog and upland sites than at some fen sites. Surprisingly, one of the two sites where sedge is not represented in the pollen spectrum is also a fen. Because sedge plants are so widespread in this region, the absence of sedge pollen in the spectra from two sites in the region is difficult to comprehend. Differential preservation from site to site may be the main factor. A closer examination of sedge pollen values in relation to the type of sampling site leads to the conclusion that, on an individual basis, there is no consistent relationship between the values and the type of site.

As expected in a region of extensive muskeg, *Sphagnum* spores are abundant and values exceeding 100%, based on total arboreal pollen, are common. The regional abundance is 434.7%. The values vary considerably throughout the region indicating the local representation of *Sphagnum*.

COMPARISON OF PAIRED SAMPLES

Pollen spectra were examined at four sites to determine the effect of local vegetational differences. At Site 24 (Fig. 1), samples were taken from the burned (Site 24a) and unburned (Site 24b) portions of an open bog. The results showed that tree and shrub pollen abundances demonstrate little variation between the two sites (Fig. 2, Table II). Ericaceae pollen values reach high proportions at the site of the former burn as would be expected considering the proliferation of these plants after fire (ROWE and SCOTTER, 1973).

At Site 25 (Fig. 1), the pollen assemblage from a ridge between ponds in an open bog (Site 25a) is compared with values from an adjacent treed bog (Site 25b). The tree and shrub pollen values again compare favourably from site to site. The great abundance of Ericaceae

pollen at Site 25a is probably a result of a strong local influence but may be indicative of earlier forest fire occurrences in the area. *Sphagnum* spore values are elevated at Sites 24b and 25b, reflecting the local abundance of *Sphagnum* moss at these sites.

These results suggest that the wind pollinated taxa such as spruce, pine, birch and alder can exhibit little variation in pollen abundance despite local differences in vegetation. Taxa which are not wind pollinated, mainly herbaceous and aquatic genera, demonstrate the greatest variation in pollen abundance despite the proximity of the collecting sites to one another.

COMPARISON WITH OTHER POLLEN SPECTRA

Table III lists relative pollen frequencies of 27 taxa in six data sets from a) the Hudson Bay Lowland and the adjacent area east of James Bay and b) the Manitoba-Saskatchewan-Keewatin region bordering western Hudson Bay (Fig. 3). To facilitate comparison, pollen values reported in this paper (Southwestern James Bay) have been recalculated to include shrub and herb taxa in the pollen sum as is the case in the other five data sets. Results listed under Forest-Tundra are from WEBB and McANDREWS (1976) and comprise forest-tundra areas in north-central Canada. The Moose River Basin results are from SKINNER (1973) and comprise eight sites in the area of the Moose and Albany Rivers, Ontario. The Québec Bogs data set is from POTZGER and COURTE-MANCHE (1956) and includes the six most northerly bogs they studied. The Eastern James Bay pollen assemblage is from FARLEY-WILSON (1975) and the Jamésie data set is the mean contemporary pollen spectrum of eighteen sites reported in RICHARD (1979).

The pollen values in both the Moose River Basin and Eastern James Bay data sets are a percentage of the mean count of each taxon at all sites in the data set, calculated from the original pollen counts, in order to obtain the same data base for comparison. The Québec Bogs data set was also recalculated in the same manner; however, because the percentages were based on total arboreal pollen, the values at each site were first revised to include shrub and herb taxa in the pollen sum. Although Cyperaceae was included in the pollen sum of both the Forest-Tundra and Jamésie data sets, it amounts to only about 5% and 2%, respectively. Had Cyperaceae been excluded, as in the other four data sets, only a slight increase in the values of the remaining taxa would be observed. For example, the *Picea* pollen value in the Forest-Tundra data set, the value which would be altered most, would be increased by only 1.7%. The Jamésie data set does not include values for individual "exotic" trees. These are indicated in Table III as + and together they total 1.3%. Likewise, individual herb taxa (probably mainly composites) other

TABLE III
Mean relative pollen spectra from central Canada

Taxa	Forest-Tundra (Webb and McAndrews, 1976)	SW James Bay (This paper)	Moose River Basin (Skinner, 1973)	Quebec Bogs (Potzger and Courtemanche, 1956)	E James Bay (Farley-Wilson, 1975)	Jamésie (Richard, 1979)
<i>Picea</i>	32.66%	31.48%	48.19%	57%	44.31%	38.2%
<i>Pinus</i>	22.84	16.94	16.49	19	20.66	18.9
<i>Abies</i>	0.55	0.16	0.09	5	0.43	0.1
<i>Tsuga</i>	0.06	0.05	0.13	0.1	0.02	+
<i>Larix</i>	0.14	0.68	0.37	0.1	0.54	0.4
<i>Betula</i>	13.99	14.54	13.54	5	10.33	10.3
<i>Populus</i>	0.09	0.52	0.36	-	0.09	-
<i>Quercus</i>	0.19	1.06	0.87	0.2	1.01	+
<i>Ulmus</i>	0.12	0.11	0.56	-	0.22	-
<i>Carya</i>	0.03	0.05	0.06	-	0.02	+
<i>Acer</i>	0.02	0.16	0.14	-	0.04	+
<i>Fraxinus</i>	0.06	0.38	0.14	-	0.29	-
<i>Carpinus/Ostrya</i>	0.01	0.14	0.04	-	0.12	-
<i>Juglans</i>	0.05	0.05	-	-	-	+
<i>Platanus</i> type	-	0.01	-	-	0.02	-
<i>Juniperus/Thuja</i>	0.02	0.06	0.30	-	0.08	0.4
<i>Alnus</i>	15.29	9.16	7.30	3	10.69	23.2
<i>Salix</i>	1.27	1.27	3.29	-	1.56	-
<i>Corylus</i>	0.12	0.11	0.36	0.3	0.08	-
<i>Myrica</i>	0.75	2.52	3.00	-	0.88	0.6
Ericaceae	1.75	10.03	2.80	2	1.41	1.1
Gramineae	0.95	1.35	0.61	3	0.54	0.9
Ambrosieae	1.07	2.61	1.37	-	2.21	-
Compositae	0.20	0.30	0.07	1	0.16	-
<i>Artemisia</i>	1.05	0.85	0.66	-	1.37	-
Chenopodiineae	0.50	1.01	0.37	0.3	0.42	-
Cyperaceae	5.11	22.46	2.96	2	26.67	1.8

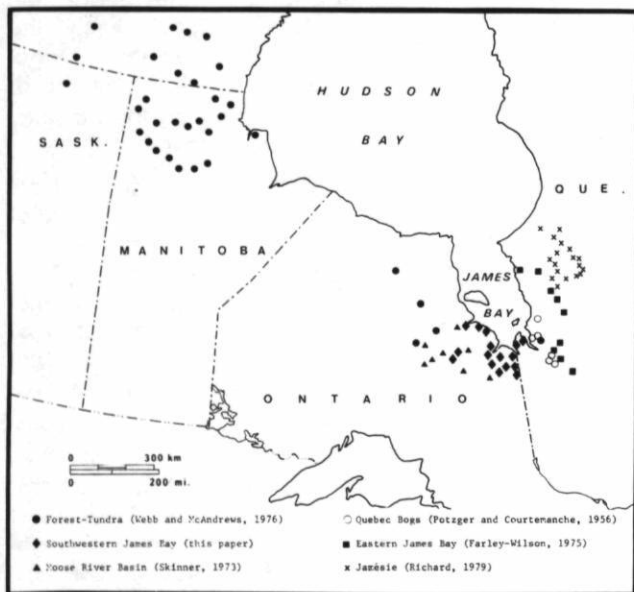


FIGURE 3. Location map of sites comprising the six data sets.
Carte de localisation des sites étudiés au cours de six recherches différentes.

than those listed have a total value of 1.4%. Although the Eastern James Bay and Québec Bogs data sets comprise sites primarily in the Boreal Forest Region, they are included because of the proximity of the sites to those examined in this paper.

Most striking is the similarity of the results in the six data sets. *Picea*, however, varies from a low of 31% in the Southwestern James Bay data set to as high as 57% in the Québec Bogs (Table III). The Québec Bogs and Eastern James Bay percentages are from the boreal forest region and would, therefore, be expected to be somewhat higher than a value from the forest-tundra, especially when the pollen sum includes shrub and herb taxa that are more abundant in the forest-tundra. The relatively high *Picea* value in the Moose River Basin probably reflects a better spruce growth along the river valley.

Values of *Pinus* pollen are similar in all six data sets. Although pine is common in the areas of the Eastern James Bay, Québec Bogs and Jamésie data sets, and sparse or absent in the areas of the other three data sets, pine pollen values vary by only about 6%, confirming its even distribution over extensive areas.

Abies pollen values are minimal with the exception of the Québec Bogs data set in which a value of 5% was recorded. In this instance, a value of 20% occurred at one site, thus elevating the mean value of fir in the data set.

Analogous *Betula* pollen values are recorded in five of the six data sets. There is no obvious reason why the birch pollen value in the Québec Bogs data set should be less than half the value registered in the other five data sets.

Pollen abundances of other arboreal genera, although similar, are too low to allow meaningful comparison, however, the persistence of *Quercus* pollen in small quantities, at sites well north of its northern limit, is evident.

Alnus pollen values vary considerably. The highest value (23%) was recorded in the Jamésie data set which is compiled from an upland area of rock outcrops and DeGeer moraines, an environment in which *A. crispa* would abound. An *Alnus* pollen value of 15% was recorded in the Forest-Tundra data set. The majority of the sites contributing to this data set are from northern Manitoba (LICHTI-FEDEROVICH and RITCHIE, 1968) and comprise both upland and lowland sites. Again, the upland sites support abundant alder, and, in fact, pollen values are considerably higher at their upland sites, raising the mean percentage value calculated by WEBB and McANDREWS (1976) for the Forest-Tundra data set. Areas of extensive bog and muskeg are not conducive to alder growth and lower alder pollen values are found in the data sets from these areas.

Myrica pollen values are highest in the Southwestern James Bay and Moose River Basin data sets. These higher values presumably reflect the wetland terrain of these areas.

Cyperaceae pollen values are considerably higher in the Eastern and Southwestern James Bay data sets. This can be attributed to abundant Cyperaceae at one site in each data set that has elevated the mean pollen value.

The prominence of Ericaceae pollen in the Southwestern James Bay data set probably results from the greater abundance of heath plants in this area of extensive muskeg.

The pollen values of the major taxa contained in the six data sets are comparable. Long-distance wind transport and a similar over- and underrepresentation of certain taxa appear to apply, with some uniformity, to the entire region.

SUMMARY AND CONCLUSIONS

The most prominent tree genera in this forest-tundra area are *Picea* and *Larix*. In the pollen spectra, *Picea* is slightly underrepresented in relative terms. The presence of *Pinus* pollen, transported from regions to the south, has diluted the *Picea* percentages. *Larix* is vastly underrepresented in the pollen assemblages in relation to its prominence in the region.

Although *Pinus* has limited occurrence in the region, it is represented in the pollen spectra at all sites. The abundance of pollen produced by this taxon, and its dispersal ability over immense areas, result in *Pinus* pollen values which seem to vary according to total arboreal

representation rather than the proximity of the sampling sites to localities where *Pinus* is present.

Betula pollen measurements indicate a preponderance of shrub birch species in the pollen assemblages, although the pollen of white birch (*B. papyrifera*) is also present. *Betula* pollen appears to be overrepresented, at least at open localities, with lower values in areas more heavily treed, but the absence of pollen influx determinations prevents confirmation of this overrepresentation as real, rather than being an artifact of the percentage calculations. Other tree genera (*Abies*, *Populus* and *Acer*) appear to be underrepresented in the pollen spectra.

Pollen abundances of shrub taxa vary according to local influences with the exception of *Alnus*, which exhibits both local and regional representation.

Most herbaceous and aquatic taxa are not well represented in the regional pollen rain. An exception is Ambrosieae, which is consistently present in small amounts in the pollen spectra. Such low, uniform, background values of this taxon are the result of long distance wind transport.

The effect of local influence is evident in the comparison of differing wetland sites. For example, bog sites have a mean value of Ericaceae pollen more than five times higher than the fens and, conversely, the mean value of Cyperaceae pollen obtained at the sedge-rich fens is more than five times that of the bogs. *Sphagnum* spore values vary tremendously from locality to locality as a result of local representation.

Comparison of pollen assemblages obtained from paired sites at two locales to determine the effect of differing local vegetation on the pollen spectra yielded similar values for wind pollinated genera. Taxa which are not wind pollinated exhibited the greatest variance in pollen abundance despite the proximity of the sampling sites. The regional rather than the local pollen rain therefore, should be used as the basis for inferring Holocene changes in climate.

Pollen spectra of the principal taxa in the six data sets appear to be comparable. Values of genera indigenous to the area as well as those present as a result of long distance wind transport are consistent throughout the region. Over- and underrepresentation of individual taxa appear to apply uniformly in the six data sets. Therefore, the modern pollen data presented is representative of the forest-tundra of central Canada, extending from the Manitoba-Saskatchewan-Keewatin region to eastern James Bay.

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