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PALYNOLOGICAL STUDIES IN THE OTTAWA AREA

(Report and 6 figures)

R. J. Mott and M. Camfield

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ABSTRACT

One large bog and five buried bog deposits were sampled in the Ottawa area. Radiocarbon dates, obtained near the base of four of these sections, ranged from about 7,650 years B.P. to roughly 8,830 years B.P.

Pollen analysis of samples from the six sites revealed four zones, Terasmae's zone IV being the oldest. At only two of the sites were all four zones present; at the others, all or part of some zone was missing.

PALYNOLOGICAL STUDIES IN THE OTTAWA AREA

INTRODUCTION

During the past decade several bog deposits in the Ottawa area have been exposed during construction work. Where possible, samples of these deposits were taken for palynological study and radiocarbon dating. This contribution presents the results of studies of five such deposits and compares these results with studies made by Camfield (1969) of Mer Bleue, a large bog east of Ottawa.

In the past, few pollen studies have been made on deposits in the Ottawa area. The only published information is an incomplete pollendiagram from Mer Bleue in the report on peat bogs in Eastern Canada (Auer, 1930), which also includes profiles from other large bogs in eastern Ontario. Pollen studies of several bogs north and east of the Ottawa area are included in reports by Potzger (1953) and Potzger and Courtemanche (1956 a and b).

POSTGLACIAL HISTORY

Physiographically, Ottawa is located on the boundary between the Ottawa - St. Lawrence Lowland and the Laurentian Highlands of the Precambrian Shield. The Ottawa - St. Lawrence Lowland is underlain by flat-lying sedimentary rocks of Paleozoic age, and the Laurentian Highlands are composed of metamorphic and igneous rocks. Not only did this location influence post-glacial history but it also influences the present vegetation of the region.

No Pleistocene deposits older than Wisconsin age have yet been found in the Ottawa area. The Wisconsin ice sheet, the latest to cover the area, scoured the bedrock surfaces and deposited abundant drift. Moraine ridges of sand and gravel mark minor halts in the general retreat of the ice from the Ottawa Valley.

With retreat of the ice into the highlands to the north, and with the opening of the St. Lawrence Valley, the Champlain Sea inundated the depressed lowland which had not yet adjusted isostatically after the removal of the weight of glacial ice. Radiocarbon dates of Champlain Sea fossils in the Ottawa area range between 10,200 years B.P. and 11,300 years B.P. (Mott, 1968). Wave action reworked the glacial deposits and marine clay was deposited over the area. Isostatic uplift ended the Champlain Sea episode, and erosion of glacial

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and marine deposits by the ancestral Ottawa River and, to a minor extent, the Rideau River, began. As channels were abandoned by the shifting rivers, organic accumulation began in suitable depressions. The organic deposits included in this study are located in this type of old channel.

Details of the surficial geology of the Ottawa area have been described by Gadd (1962).

REGIONAL VEGETATION

The predominantly deciduous forest of the upper St. Lawrence section of the Great Lakes - St. Lawrence forest region (Rowe, 1959) corresponds closely to the physiographic boundaries of the Ottawa - St. Lawrence Lowland within which the city of Ottawa is located. The description of this forest follows closely that outlined by Rowe. The dominant cover type is composed of sugar maple (Acer saccharum) and beech (Fagus grandifolia), with abundant red maple (Acer rubrum), yellow birch (Betula lutea), white elm (Ulmus americana), basswood (Tilia americana), white ash (Fraxinus americana), large-toothed aspen (Populus grandidentata), and red and bur oaks (Quercus rubrum, Q. macrocarpa). White oak (Quercus alba), red ash (Fraxinus pennsylvanica), wire birch (Betula populifolia), rock elm (Ulmus thomasi), blue-beech (Carpinus caroliniana var. virginiana), and bitternut hickory (Carya cordiformis) occur locally. Butternut (Juglans cinerea), cottonwood (Populus deltoides), and slippery elm (Ulmus rubra) occur sporadically along rivers. Small pure stands of black maple (Acer nigrum) and silver maple (Acer saccharinum) are found on fertile, fine-textured soils, while black ash (Fraxinus nigra) is prominent in hardwood swamps.

In the generally broad-leaved forest, conifers are represented by hemlock (Tsuga canadensis), white pine (Pinus strobus), white spruce (Picea glauca) and balsam fir (Abies balsamea). Coarse-textured soils commonly support stands of white pine, red pine (Pinus resinosa) or jack pine (Pinus banksiana), and wet sites support black spruce (Picea mariana) and tamarack (Larix laricina), or eastern white cedar (Thuja occidentalis). This latter species is also found on dry, rocky or stony sites. Pioneer stands after fires include large-toothed aspen and white birch (Betula papyrifera), with balsam fir and white spruce. Much of this forest has been cleared for agriculture or altered by lumbering.

The middle Ottawa section, which adjoins the upper St. Lawrence section in the Laurentian Highlands to the north, and extends also west and south, undoubtedly also contributes significantly to the total regional pollen deposition in the Ottawa area and has done so in the past. This is especially true of the coniferous species of the forest.

Usual constituents of the middle Ottawa section are sugar maple, beech, yellow birch, red maple and hemlock accompanied by white and red pine. Dry ridges and sand flats support white and red pine in conjunction with jack pine. Also present throughout are white spruce, balsam fir, red oak and basswood. Hardwood and mixedwood swamps containing eastern white cedar, tamarack, black spruce, black ash, red maple and elm are common. Butternut, bur oak, white ash and black cherry (Prunus serotina) are present as scattered occurrences.

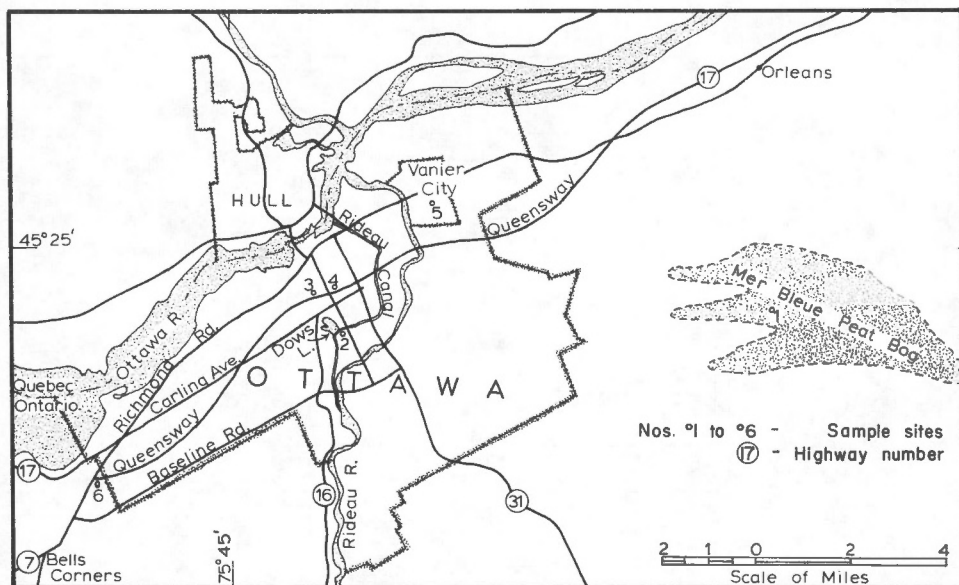


Figure 1. Location of sites of palynological studies in the Ottawa area

SITE LOCATIONS AND DESCRIPTIONS

Site 1, Mer Bleue Peat Bog (45° 24'N, 75° 30.4'W)

Mer Bleue (Fig. 1), located east of Ottawa in Gloucester Township, developed in an ancient abandoned channel of the Ottawa River where three narrow channels coalesce to form a single broad one (Gadd, 1962). The channels were eroded into marine and alluvial clay following retreat of the Champlain Sea and early stages in the development of the Ottawa River. Alluvial sand caps the ridges between the channels.

Samples were collected by R. J. Mott and J. Terasmae from the deepest part of the bog which is located in the central channel where the three small channels begin to merge. A Hiller peat borer was used for coring, and material for radiocarbon dating was obtained with a 2-inch G.S.C. piston corer, described by Mott (1966). The basal clay of the bog at this site is overlain by about 45 centimetres of lake sediment (gyttja) and sedge peat which, in turn, is overlain by 485 centimetres of more or less decomposed woody peat and sphagnum peat.

Surface vegetation includes Sphagnum and ericaceous plants, with abundant black spruce and tamarack patches. A wet zone along the borders of the bog contains wild holly (Nemopanthus mucronatus), alder (Alnus rugosa), and cattail (Typha latifolia). The interfluves and the surrounding area probably supported a forest similar to the general forest of the region as it existed before being cleared by man.

A radiocarbon age determination on basal organic matter from the deepest part of the bog yielded a date of $7,650 \pm 210$ years (GSC-681; Lowdon and Blake, 1968). Another determination on similar organic matter from the

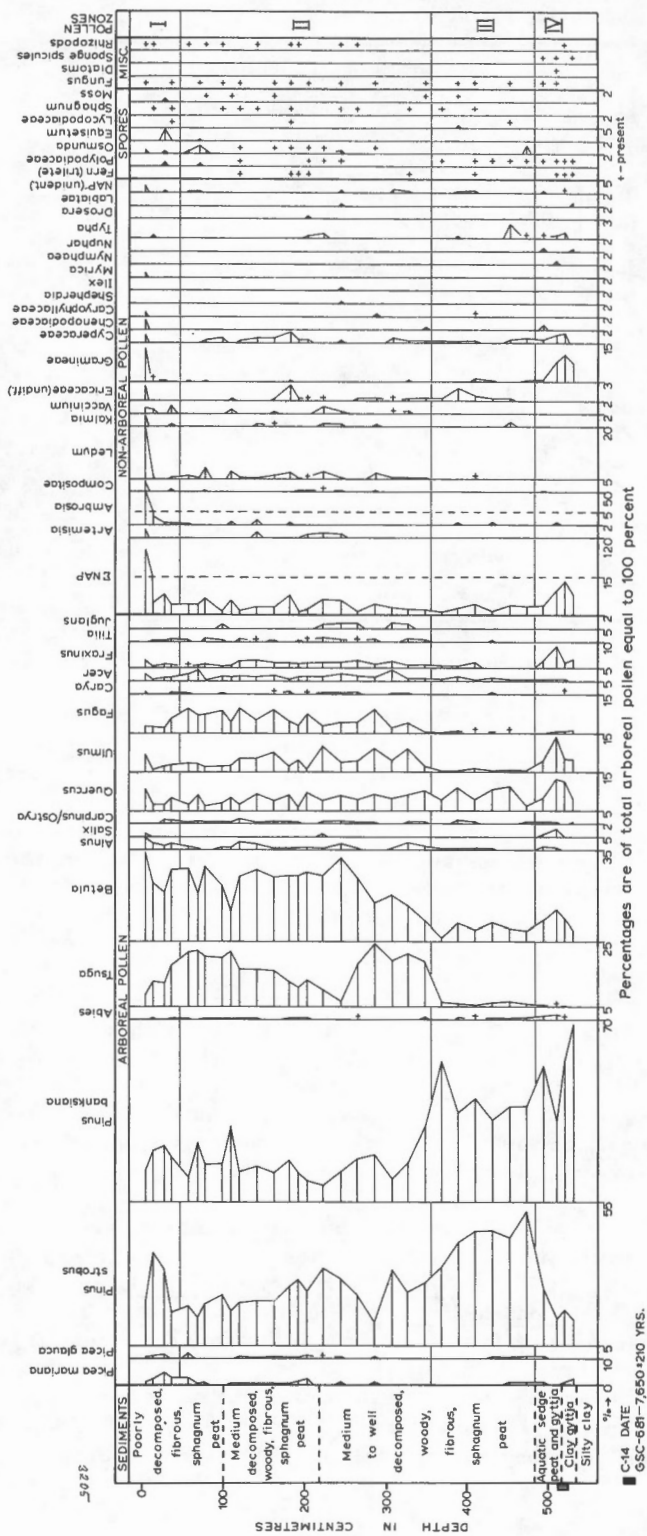


Figure 2. Site 1 - Mer Bleue Peat Bog

most southerly of the three small channels gave an age of $6,750 \pm 150$ years (GSC-548; Lowdon et al., 1967). Results of pollen analysis are shown in Figure 2.

Site 2, Dows Lake Bog (Fig. 1) ($45^{\circ}23.5'N$, $75^{\circ}42'W$)

Excavations in 1957 for a road extension south of the bridge over the Rideau Canal exposed part of the upper peat layer in Dows Lake Bog. On the suggestion of Dr. W.G. Dore of the Plant Research Institute, Ottawa, a study of the exposure was made, followed by sampling. The swamp occupies a low area to the south of Dows Lake, at the southern end of a narrow depression that extends northwestward, roughly along the line of one of the main streets, from the Rideau River to the Ottawa River. The depression was originally formed by faulting in the Ordovician limestone bedrock. Glacial and Champlain Sea sediments deposited in the depression were partially removed by later downcutting of the ancestral Ottawa and Rideau rivers. Samples were collected by J. Terasmae; the coring was made with the Hiller peat sampler.

In Dows Lake Bog, basal clay is overlain by 600 centimetres of fossiliferous gyttja and about 50 centimetres of woody peat. Vegetation on the bog surface, now completely removed, consisted of several hardwood species including elm, ash and abundant white cedar.

The pollen diagram (Fig. 3) shows the results from this site.

Site 3 ($45^{\circ}24.3'N$, $75^{\circ}42.5'W$)

Site 3 (Fig. 1) is on the eastern flank of the same bedrock depression occupied by the Dows Lake Bog but a quarter mile north of Dows Lake.

In 1965, foundation excavations for the new High School of Commerce exposed organic sediments overlying limestone bedrock in the southwest corner. Except for this corner, the excavation was completely cut into bedrock. Here 3 inches of coarse sand and pebbles are overlain by 3 inches of clay, 30 inches of fossiliferous marl and gyttja, and 17 inches of peat. The top 3 or 4 feet of peat had been disturbed by past building activity in the area which has been urban for a considerable length of time, with the result that no remnants of the original forest cover remain. Samples were collected from the exposure by Dr. R.L. Christie who brought the site to the attention of the writers.

Basal organic matter gave a radiocarbon date of $8,830 \pm 190$ years (GSC-546; Lowdon et al., 1967). Figure 4 shows the results of pollen and spore analysis.

Site 4 ($45^{\circ}24.5'N$, $75^{\circ}42'W$)

In 1959, excavation for a building at this site (Fig. 1) exposed organic sediments overlying sand and gravel. A layer of gyttja up to 18 inches thick overlies the sand and gravel and is overlain by an 18-inch layer of peat and 4 to 5 feet of ~~peat~~. Both organic layers become thin toward the west. These sediments accumulated in a shallow depression drained by a former

fill.

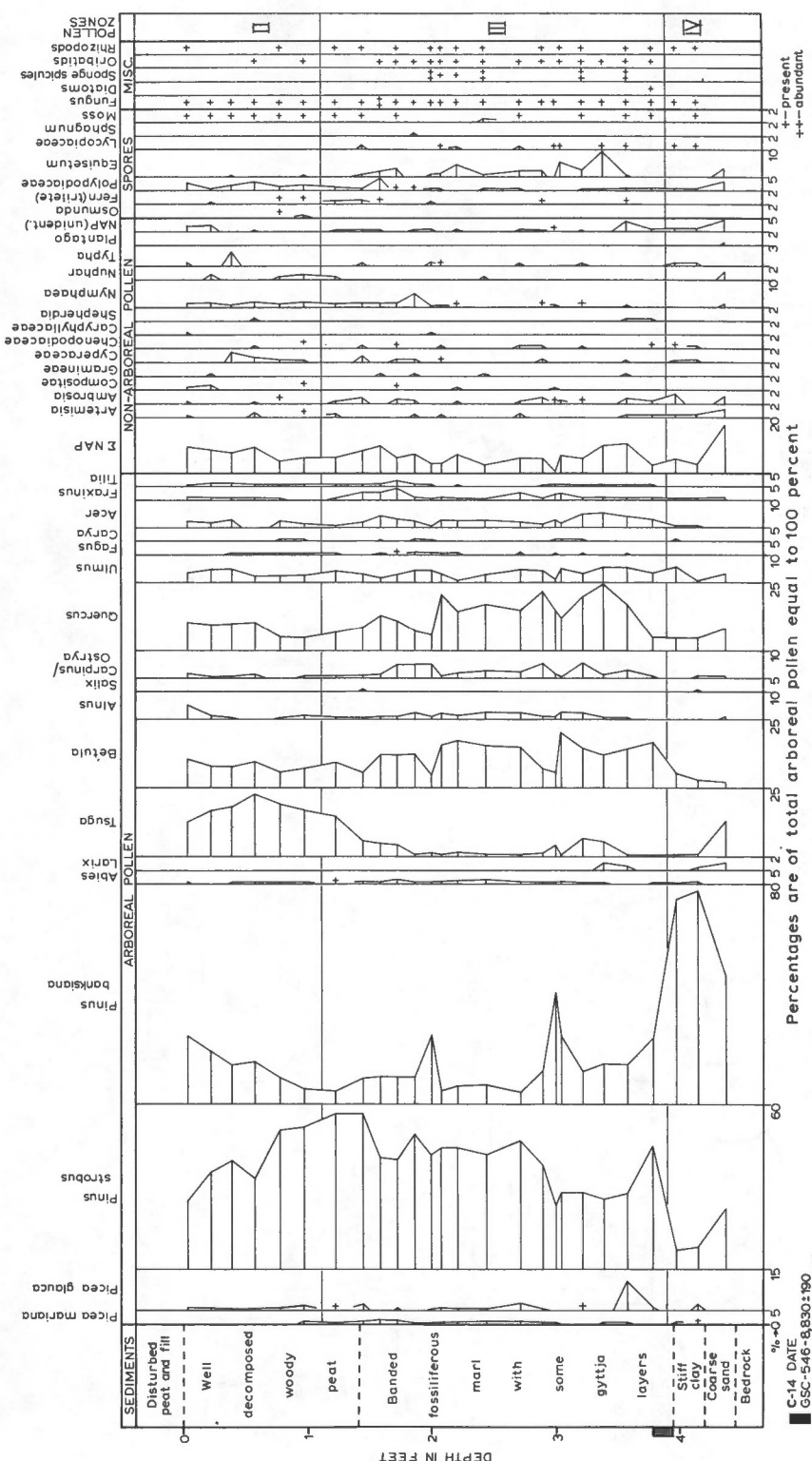


Figure 4. Site 3 (High School of Commerce - Ottawa)

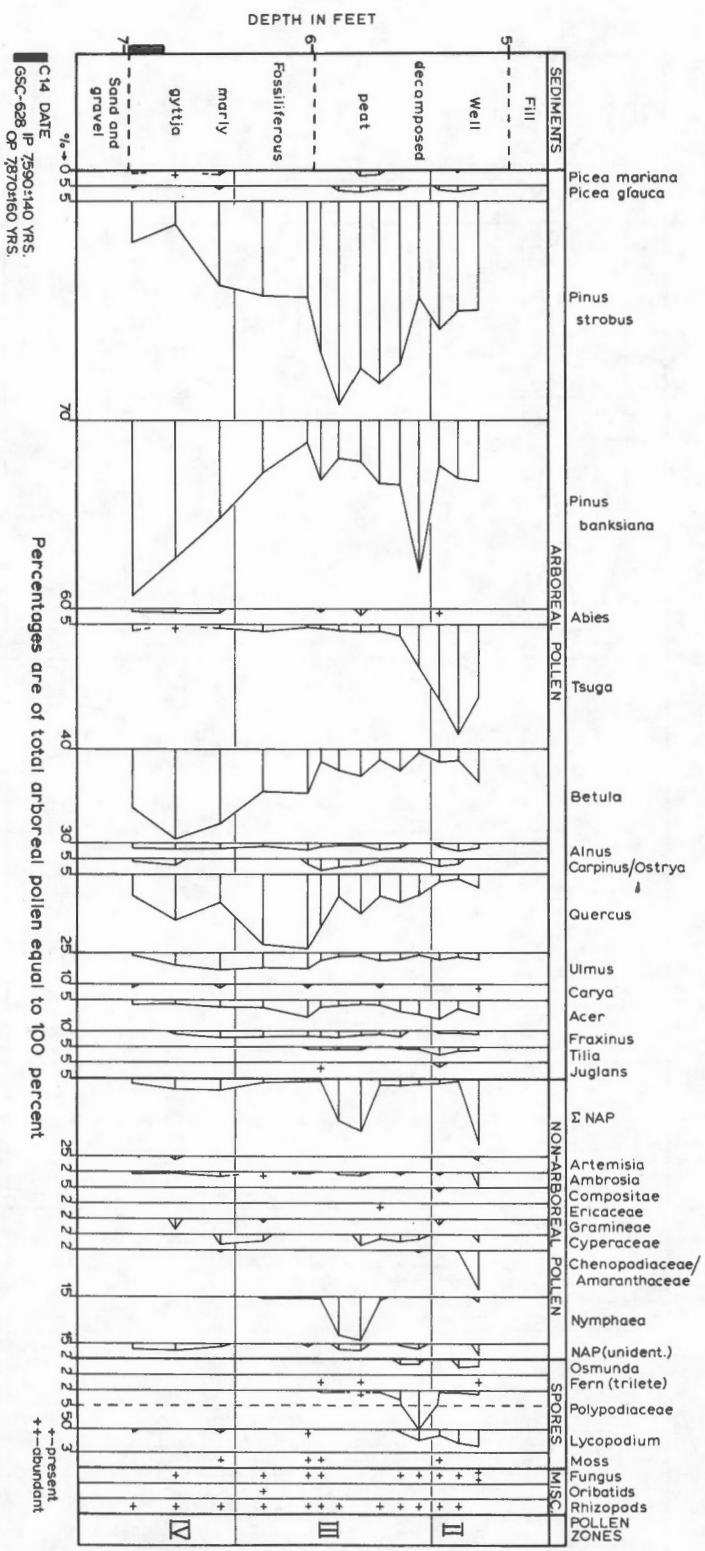


Figure 5. Site 4 (V. Quinney & E. Booth)

small tributary creek of the Rideau River. Samples for pollen study and radiocarbon dating were collected by J. Terasmae.

As in the case of Site 3, the upper part of the peat deposit has also been somewhat disturbed here by previous building activity. None of the original forest cover remains.

A sample of the basal organic material was treated with NaOH. The material soluble in NaOH gave a radiocarbon age of $7,590 \pm 140$ (GSC-628 IP; Lowdon *et al.*, 1967) while the undissolved material was dated at $7,870 \pm 160$ (GSC-628 OP; Lowdon *et al.*, 1967). The latter date is considered more reliable.

Results of pollen and spore analysis are shown in Figure 5.

Site 5 (45°26'N, 75°39.5'W)

In 1955, excavations for an apartment building in Vanier City (Fig. 1), revealed bouldery gravel and till overlain by 10 inches of coarse sand, 21 inches of gyttja and 40 inches of woody and aquatic peat. The upper part of the peat was disturbed and was not sampled. Samples for pollen study were collected by O. L. Hughes and J. Terasmae.

The bog formed in a shallow depression eroded either by the Ottawa River or the Rideau River. Presently an urban area, the district was previously farmland. No evidence of the original vegetation cover of the bog remains.

The pollen diagram (Fig. 6) shows the results of pollen and spore analysis of the organic sediments.

Site 6 (45°20.7'N, 75°48'W)

During water main excavations along the Queensway, west of the City of Ottawa in Nepean Township, alluvial sediments were exposed in an ancient channel of the Ottawa River. The exposure at Site 6 (Fig. 1) was described and sampled by N. R. Gadd during his mapping of the surficial deposits in the Ottawa area. Silty clay, of which about 1.5 feet is exposed, is overlain by about 6 feet of silt, silty sand, and fine sand, containing a woody peat layer at 4.0 to 4.5 feet and disseminated wood and organic matter beneath. Organic matter from a depth of 5 to 5.5 feet gave a radiocarbon date of $8,220 \pm 150$ years (GSC-547; Lowdon *et al.*, 1967). The sediment from 4 feet to 7.5 feet was examined for pollen and spores and the results are shown in Figure 7.

RESULTS OF PALYNOLOGICAL STUDIES

The results of pollen analysis are shown in Figures 2 to 7. All percentages are based on total arboreal pollen being equal to 100 per cent as outlined by Terasmae (1958).

To facilitate discussion, pollen diagrams are commonly divided into pollen stratigraphic zones based on the relative abundance of various characteristic genera or species in different parts of the section. Potzger (1953) and Potzger and Courtemanche (1956 *a* and *b*) divided postglacial pollen diagrams from Quebec and eastern Ontario into five zones numbered, from the

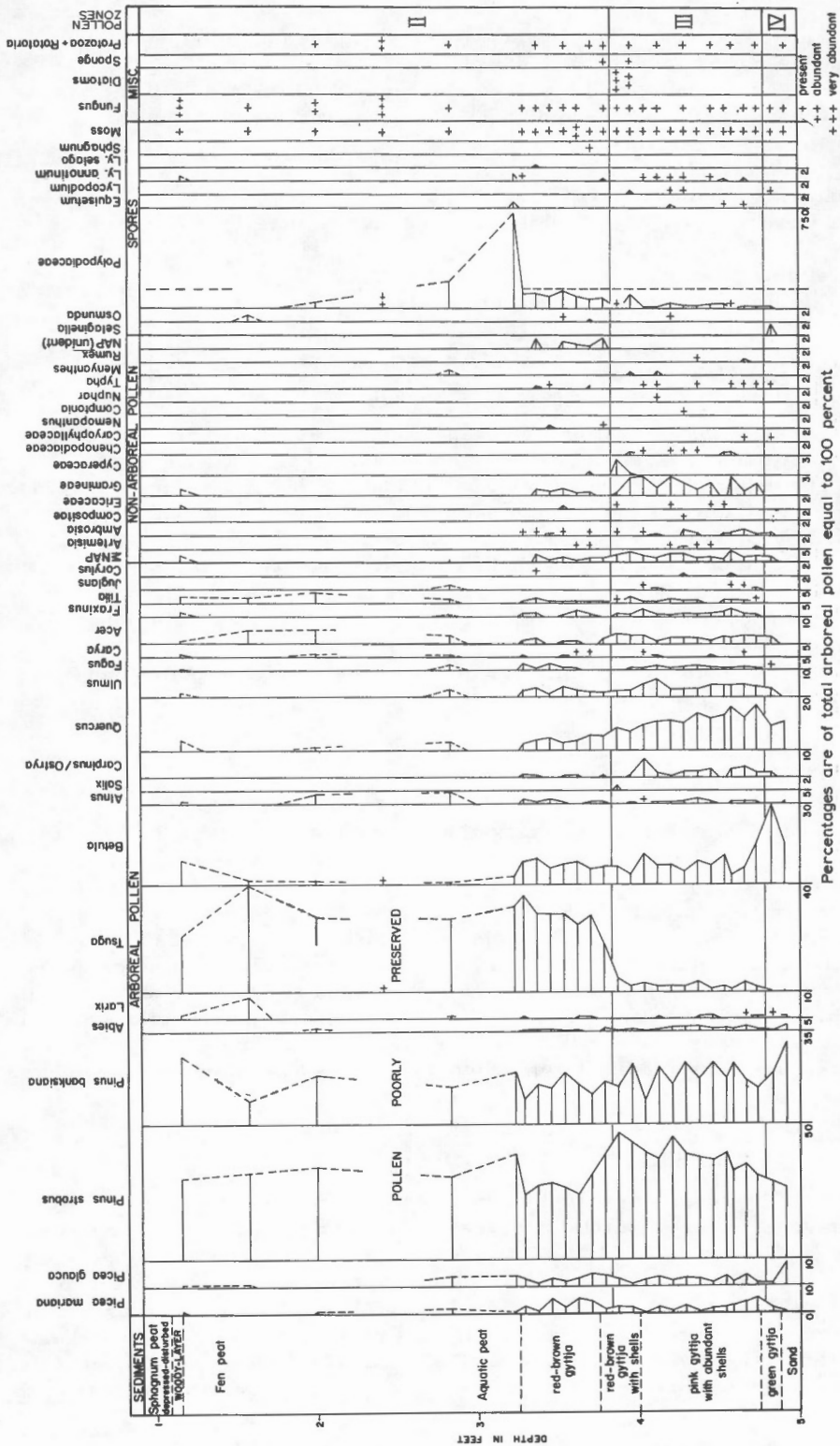


Figure 6. Site 5 (Vanu City, Apr. 21, 1954)

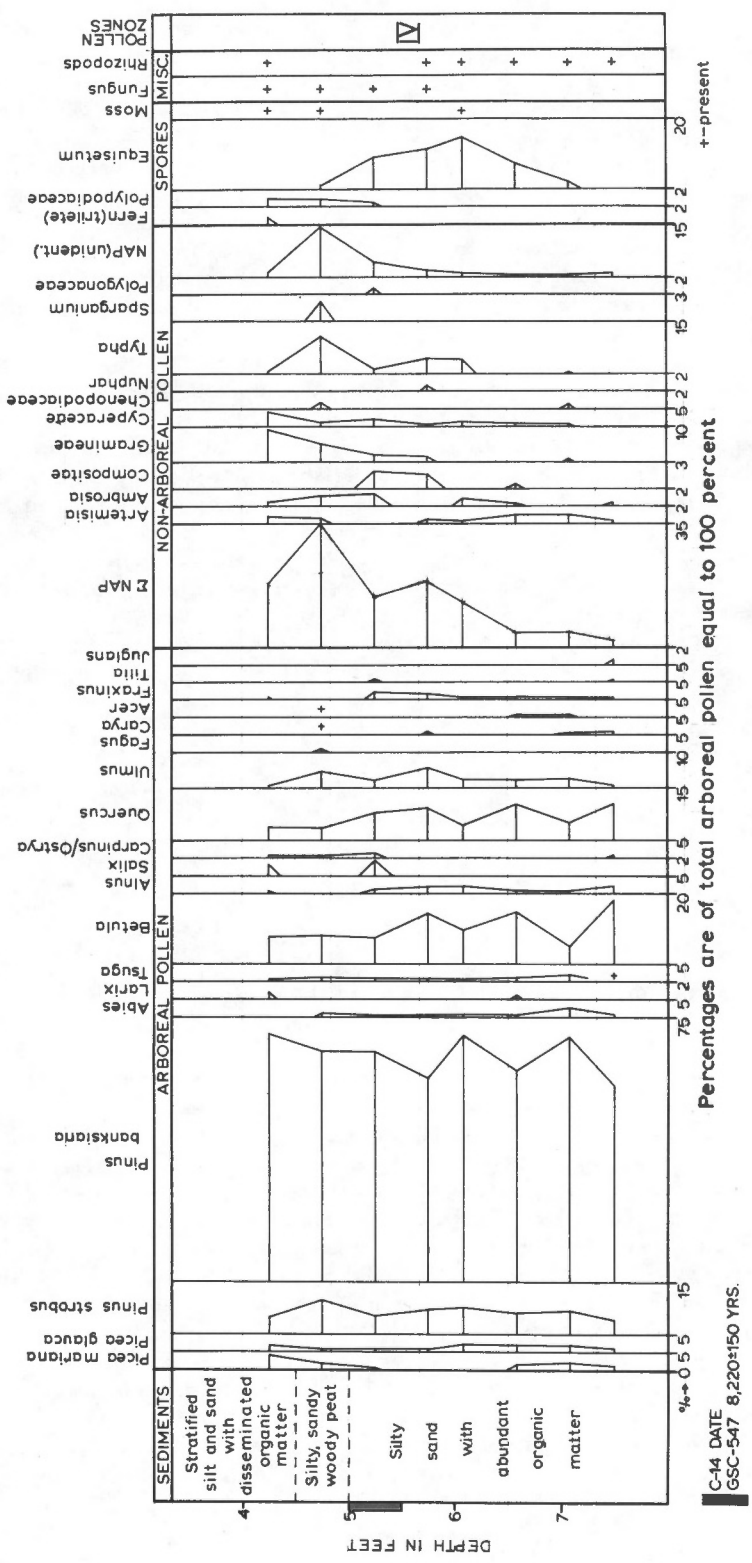


Figure 7. Site 6 *Sy Quersing at Birchumka - Ballandene*

C-14 DATE
GSC-547 8,220±150 YRS.

base up, Q-1 to Q-5. Terasmae (1960), in diagrams from the St. Lawrence Lowlands, subdivided Potzgers zone Q-3 thus establishing six zones which he numbered I to VI, from the top down. The latter system is followed here.

The following zone descriptions apply in general to all the sites studied. The oldest zone present at any of the sites investigated in this study was Terasmae's zone IV. It is characterized by a relatively high percentage of jack pine with smaller amounts of white pine, birch and oak. Spruce pollen content is low as is the non-arboreal pollen (NAP) content.

In zone III, the next highest zone, jack pine content has decreased considerably and white pine pollen has become dominant. Oak and birch show increases but percentages of pollen for hemlock and other deciduous species, and for non-arboreal pollen, remain low.

An abrupt increase in hemlock pollen marks the beginning of zone II, and hemlock and beech reach maximum abundance. Oak, elm and pollen of other broadleaf genera also show increases. White pine pollen has decreased considerably in abundance compared with zone III but it is still well represented. Spruce percentages are still very low and jack pine shows little change. Non-arboreal pollen percentages do not show any consistent changes.

A decrease in abundance of hemlock, beech and white pine pollen and an increase in spruce, birch, and other broadleaf genera characterize zone I. Near the top of zone I a sharp increase in non-arboreal pollen is a prominent feature.

Of the six diagrams presented, the one for Mer Bleue (Fig. 2) is the most complete, with zones I through IV represented. The Site 2 diagram for Dows Lake Bog (Fig. 3) also has four zones but the top of zone I is truncated and zone III is poorly represented. In the diagrams for Sites 3, 4 and 5 (Figs. 4, 5 and 6) zone I is missing because the upper disturbed layers of peat were not sampled. Assemblages from the Site 6 (Fig. 7) represent only a short time interval in zone IV.

DISCUSSION

(See respective pollen diagrams for exact organic intervals dated.)

Radiocarbon dates from Mer Bleue (Site 1), $7,650 \pm 210$ years (GSC-681); Site 3, $7,870 \pm 160$ years (GSC-628); and Site 6, $8,220 \pm 150$ years (GSC-547), (Lowdon *et al.*, 1967), all fall within pollen zone IV and agree well with previous estimates for this zone (Terasmae, 1960). The Site 3 date, $8,830 \pm 190$ years (GSC-546; Lowdon *et al.*, 1967) is from the base of zone III immediately above the contact with zone IV. If the palynological interpretations are correct, this date would appear to be about 1,200 years too old. The close proximity of the basal organic material, which was dated, to the Ordovician limestone bedrock (about 6 inches) suggests possible contamination of the organic material by older carbon from the carbonates of the limestone. This 'hard-water' effect can cause errors up to the half-life of C^{14} in the dating of plants that carry out photosynthesis under water (Shotton, 1967; Broecker and Walton, 1959; Deevey *et al.*, 1954).

According to current interpretation of the postglacial history of the area, organic accumulation could not have begun at any of the sites included in this study until the Champlain Sea had retreated from the area and the ancestral Ottawa River had first eroded and then abandoned these channels. However, in the surrounding higher areas, when the ice retreated plants were

able to enter the area as quickly as their migration rates would allow. Pollen diagrams from adjacent regions (Pötzger, 1953; Pötzger and Courtemanche, 1956 a and b; Terasmae, 1960; and Terasmae and LaSalle, 1968) go farther back in time and show two older pollen zones.

A good example is the Kazabazua Bog, about forty miles north of Ottawa, where the pollen record begins with zone Q-1 (Pötzger and Courtemanche, 1956a) or VI (Terasmae, 1960). This zone is low in spruce pollen and high in pine (mainly jack pine), birch and non-arboreal pollen. A radiocarbon age determination on basal organic sediment gave a date of $9,910 \pm 200$ years (GSC-680; Lowdon and Blake, 1968) for this zone or for the boundary between this and the next higher zone. The second zone, designated Q-2 (or V), is characterized by a maximum in spruce and birch, with less pine and non-arboreal pollen.

Prevailing climates inferred from the pollen assemblages of the various zones have been suggested by Pötzger (1953) and Terasmae (1959). An initial relatively warm period following deglaciation was postulated by Pötzger for zone Q-1 (VI) mainly because of the high pine and non-arboreal pollen content and low spruce pollen content. The high frequency of pine, however, may be explained also by over-representation at a time of generally low local pollen production. This episode is followed by a change to a colder and moister climate, according to Pötzger, as indicated by the marked increase of spruce (zone Q-2 or V). Zone Q-3 (IV), with its higher jack pine and lower spruce pollen content, marks the beginning of a warming trend with drier conditions that continued up into zone Q-3 (III), a zone of abundant white pine pollen.

A decline in the amount of pine pollen and an increase in the beech and hemlock pollen (zone Q-4 or II) indicate a warm climate also, but with an increase in moisture. Decreases of hemlock pollen, further decreases of pine and increases of spruce pollen in zone Q-5 (I) indicate a return to a colder, moister climate.

Near the top of Terasmae's zone I, the advent of lumbering and agriculture is clearly indicated by the abrupt decline in white pine pollen and the increase in birch, grass and other non-arboreal pollen.

In order to see to what extent the regional forest types are reflected in the pollen record, Terasmae and Mott (1964) collected surface samples from two peat bogs and three lakes near Ottawa. They found that recent pollen assemblages were characteristic of the Great Lakes - St. Lawrence forest region of Rowe (1959). Moreover, local vegetation at and near the sampling sites was also reflected in the pollen counts. The recent pollen assemblages obtained from atmospheric pollen, surface peat and bog water samples taken at Mer Bleue (Site 1) compare well with the results of the uppermost samples recorded in the pollen diagram (Fig. 2). Almost all general trends indicated in the top part of this pollen diagram appear to have continued to the present despite alteration of the original forest cover by man (Camfield, 1969).

Although the fossil pollen in the deposits studied reflects the vegetation of the area, there are some anomalies. For example, poplar pollen is found neither in the recent samples nor in the samples recorded in the diagrams, yet poplar grows near Mer Bleue and probably grew there in the past. Poplar pollen does not preserve well. The same is true of tamarack and white cedar pollen (Sangster and Dale, 1961 and 1964). Maple appears to be under-represented and pines in particular are greatly over-represented. These anomalies must be kept in mind when drawing conclusions from pollen records about the past vegetation of the area.

The six sections described here were taken within a radius of 8 miles. One would expect the distribution of tree pollen over such a small area to be very similar from one site to the next, yet there are certain local variations. Jack pine in zone III at Site 2 and in zone II at Site 4 appears to have been locally abundant during certain periods. This local abundance may be explained by a local phenomenon such as a sandy ridge near the sampling site or a fire in the area that may have created favourable conditions.

White pine pollen graphs also show local variations. Whereas at most sites throughout zone II white pine is decreasing, at Mer Bleue there is a sharp increase at the top of the zone.

Hemlock pollen was found to present a very constant regional picture in all sections, although it will be noted that at Mer Bleue and the Dows Lake Bog (Site 2), two maxima appear in the curves in contrast to the smooth curves in the other diagrams.

Beech, assumed to be a good indicator of a relatively warm, moist climate, is present all through Sites 1, 2 and 5 but only sporadically at the other sections. This indicates that the local environmental conditions may have been different at the latter sites and that beech did not grow in the immediate area.

The birch curves reveal that birches tend to be of local rather than regional importance. Whereas there were pronounced maxima in zone III for Sites 3, 4 and 5, these were not found in the other sections. There appears to be an inverse relationship between the birch and jack pine curves in many parts of all sections except that at Site 4. Possibly jack pine and birch may have been in competition for available open ground.

A certain amount of information about local conditions at some of the sites can be gathered from the non-arboreal pollen counts. Thus, at Site 6 the presence of Typha and grasses may indicate an open, marshy environment, at the time this ancient river channel was abandoned.

The high counts of Polypodiaceae (ferns) found in zone II at Sites 2, 3 and 5, may suggest that these sites were overgrown forest swamps at the time. Mer Bleue (Site 1), on the other hand, was never thickly overgrown with trees. This is evident from the persistent presence of ericaceous pollen, Ledum in particular, from the beginning of zone III to the present day. Periodic fires may explain this particular condition.

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