

# Pollen Study of Sediments from Douglas Lake, Cheboygan County and Middle Fish Lake, Montmorency County, Michigan

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The two lakes occupy a somewhat central position in the upper part of the lower peninsula of Michigan. Douglas Lake has been made famous by the Biological Station of the University of Michigan located on its shores. It is perhaps one of the most extensively studied lakes in North America. It is about 15 miles south of the Straits of Mackinac. Middle Fish Lake, one of a group of three lakes in Montmorency County, is 45 miles south and 28 miles east of Douglas Lake. At both locations the original forest consisted of pine and northern hardwoods in disjunct distribution, determined by the nature of the soil. Pine occupied primarily sandy areas and hardwoods the better loam and clay soils. When civilized man first settled in these counties the boreal forest (spruce, fir, tamarack) was reduced to relic colonies in bogs and along wet river valleys. For a detailed description of these remnants of northern forests in the Douglas Lake region we refer to Gates (1942). The original distribution of these various forest cover types in the Douglas Lake area is shown by Gates (1926) in an excellent map of the region. Agriculture was limited to soils originally covered by northern hardwoods, and it was always a poorly rewarded enterprise. During the early days of pioneer settlements, the farmer depended primarily upon lumbering for an adequate income.

The samples analyzed for this study represent only a part of a series of cores taken at both lakes to study configuration of the lake bottom and the nature of the sediments.

## Characteristics of the Lakes and Fringing Vegetation

Douglas Lake was and still is of great depth and considerable surface area. Wave action has prevented formation of a bog mat along the periphery except in beach pools and in protected bays and coves (Gates, 1942). Both pine and northern hardwoods stands flanked the shores, their location being determined by the soil (Gates, 1926). Lowlands and depressions along streams supported forests controlled by Thuja, Larix, Picea and Abies (Gates, 1926, 1942; Gates and Ehlers, 1924). "Boring 4" was made in the deepest part of what is known as East Fish Tail Bay (depth of water 69 feet). This bay receives considerable protection against prevailing winds from Grapevine Point. The original basin had a depth of 125 feet. From the 102- to the 110-foot levels the sediments consisted of hard-packed reddish clay which embodied considerable sand at the 103-foot level. Abundant organic matter first

<sup>1</sup>This is contribution 142 from the Botanical Laboratories of Butler University.

appeared at the 101-foot level. No samples were taken from the 104- to the 109-foot levels.

The Fish lakes occupy depressions in the main moraine of the Port Huron morainic system. Sandy drift is abundant in the neighborhood of these lakes.

Middle Fish Lake is rapidly nearing extinction, 93.76 percent of the basin is filled. The greater part of the original water surface is occupied by a bog mat, leaving only a shallow central pond (depth of water five feet) of 2.49 acres. The deepest boring (No. 1) penetrated to a depth of 56 feet. From the 43-foot level downward the sediment consisted of comparatively coarse sand (size of particles similar to those along the shore), in which small fragments of wood and very few pollen grains (only two pollen grains to ten slides) were embedded. No representative pollen count was attempted for these levels. Very fine sand constituted the sediments from the 43- to the 38-foot levels (Fig. 1) in which pollen became very abundant at the 38-foot level.

Residents of the region about Fish Lake described the forest as having been pine and hardwoods, but principally pine. While *Pinus banksiana*, *P. strobus* and *P. resinosa* were represented in the forest complex, *P. strobus* was most abundant. Among the broad-leaved species mentioned were *Acer saccharum*, *A. rubrum* and *Quercus velutina*. Specific mention was made of the infrequent occurrence of *Tsuga*. Along the edge of the lake the typical bog species (*Thuja*, *Picea*, *Larix*, *Abies*) constituted the fringing forest.

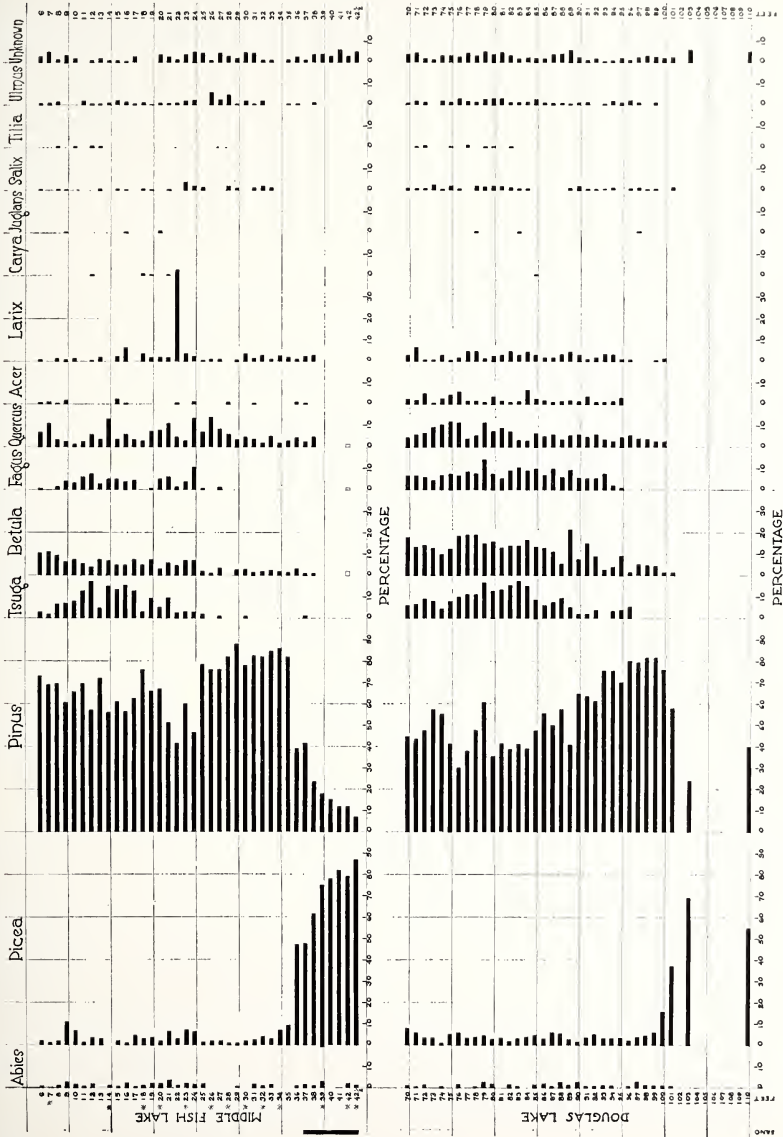
### Methods

Collecting of samples was carried out with the Wilson sampler. This instrument was described by Wilson (1941) and in the pollen study of Minnesota lakes by Wilson and Potzger (1942). The Geisler (1935) method was followed in the preparation of the slides. At Douglas Lake 200 pollen grains of tree genera were counted for each foot-level except in the lower part where pollen was poorly represented. A count of 200 grains began at the 101-foot level. At Middle Fish Lake counts of 100 and 200 were alternated except when critical changes in the forest cover was in evidence. The difference in percentage representation between a count of 100 and 200 pollen grains was so small that practically nothing was contributed to the story by the additional count of 100 grains, especially when forest cover type was more or less the same for a long period. Levels represented by 100 pollen grains are starred in Figure 1. Pollen of shrubby and herbaceous genera was tabulated but they have been omitted from the figure because their small representation apparently added nothing of significance as far as vegetational succession was concerned. One per cent aqueous solution of gentian violet was used for staining.<sup>2</sup>

### Results

Both profiles begin with a decided spruce period, but pine was represented from the very beginning. It was especially prominent in the lowest level of Douglas Lake (Fig. 1). At both stations the spruce period was succeeded by a spruce-pine association which yielded abruptly to a

decided pine dominance, and this was later depressed by the invading broad-leaved genera associated with hemlock to less than 50 per cent representation in the pollen spectrum. At this stage importance of certain genera differed somewhat at the two stations. At Douglas Lake pine seldom exceeded 50 per cent of total tree pollen after its depression



<sup>2</sup> We express our thanks to Miss Jane Goodlet for the lettering on figure 1.

at the 89-foot level. At middle Fish Lake pine recovered much of its pre-depression importance and retained this to the topmost level. The broad-leaved complex consisted primarily of *Fagus*, *Betula* and *Quercus* with *Tsuga* as associate. Abundance of these various genera fluctuated at different levels, while pine maintained a striking uniform representation. *Tsuga* decreased appreciably towards the topmost levels at both stations. This may perhaps be interpreted as a result of less favorable moisture conditions. Broad-leaved genera never attained the importance at Middle Fish Lake which they held at Douglas Lake. If the percentages of pollen of *Quercus*, *Betula*, *Fagus*, *Acer* and *Tsuga* are totaled the difference in importance of the hardwoods at the two locations is accentuated. At Douglas Lake these genera constitute from one-third to one-half of the total pollen after depression of the pine period (92- to 70-foot levels), while at Middle Fish Lake their representation for the northern hardwoods period (24- to 6-foot levels) fluctuated between one-fifth and one-third of the total pollen count.

An unusual temporary abundance of *Larix* is shown at the 22-foot level in Middle Fish Lake, which was not approximated again after that period.

#### Discussion

In the early forest succession there is little difference between the Michigan stations and those of Wisconsin (Potzger, 1942; Potzger and Richards, 1942), Minnesota (Wilson and Potzger, 1942), New Jersey (Potzger and Otto, 1942). At all these places *Pinus* was associated with *Picea* from the beginning stages of forest invasion. This differs, however, from early succession in Indiana and the southern part of lower Michigan (Otto, 1938; Potzger and Wilson, 1941) where the initial forest consisted entirely of *Picea* and *Abies*. Retardation of a decided control by *Quercus*, on the other hand, resembles the behavior of the genus at stations in northern Michigan and Wisconsin (Potzger, 1942; Potzger and Richards, 1942). Decline of *Pinus* with the invasion of deciduous genera associated with *Tsuga* resembles greatly the succession in the Gillen Nature Reserve (Potzger, 1942) except that *Fagus* is absent in the complex of the deciduous forest in that part of Wisconsin.

*Acer*, again, presents a problem for the interpretation of the constitution of the deciduous forest because its low pollen representation does not reflect the true importance of this genus in the forest cover. This was pointed out by Potzger (1942) for the forests about the bogs in the Gillen Nature Reserve. It also fails to reflect the true importance of this genus in the hardwoods complex represented by the two Michigan stations, as one of us knows from the acquaintance with the forest in Presque Isle and Montmorency counties; and as Gleason (1924), Potzger (1941), Gates (1926, 1942) show in field studies from these northern counties. Gates (1924) describes *Acer saccharum* as "one of the most abundant trees of the region." It is also interesting how the brief statements in the annotated list by Gates and Ehlers (1924) correlate with representation of the same genera in the pollen spectrum. *Tilia*, "not very abundant." *Ulmus*, "a few old trees in wetter parts of beech-maple

woods." *Betula lutea*, "most abundant in the beech-maple woods." *Quercus velutina*, "infrequent in the jack pine plains."

The incorrect representation of *Acer* in the spectrum may introduce the possibility of a two-fold distortion of the interpretation of a pollen profile, viz. the underestimation of importance of *Acer* and overestimation of importance of *Pinus*. If *Acer* constituted the major part of the broad-leaved forest its absence in the pollen record would give pine a too prominent place; it will certainly give the impression that *Betula* and *Fagus* as well as *Tsuga* had greater representation in the northern hardwoods than they really did have. However, pine occupied a prominent place in the forest cover of Montmorency county, and the hardwoods was scattered in disjunct areas, so the distortion in the pollen spectrum may not be so great even though *Acer* is not represented in proportion to its actual abundance in the forest. The general description of the forest cover given by the residents at the Montmorency county station also supports the pollen record showing greater importance of *Pinus* at Middle Fish Lake than at Douglas Lake.

Both of the lakes are in a latitude where *Quercus* has not exerted much control in the crown cover. It evidently approximates here the status of this genus in the forests of Wisconsin (Pottzger, 1942). Its early appearance in the profiles show that it is not a matter of retarded invasion but rather a depression by some climatic factor which does not influence such genera as *Betula*, *Fagus* and *Acer*. What was said of the lake forest of northern Wisconsin and upper Michigan (Pottzger, 1942) apparently also applies to the forests represented by the two stations. The northern hardwoods appears to be the climatically favored type, and pine maintains itself primarily by aid of edaphic factors which limit the more aggressive broad-leaved genera in their invasion of sandy habitats. This interpretation also echoes the opinion voiced by Gates (1926).

### Summary

1. The paper presents pollen profiles from sediments of Middle Fish Lake, Montmorency County, and Douglas Lake, Cheboygan County, Michigan. Both of the lakes are located in the upper third of the lower peninsula of Michigan.

2. In a general way both profiles show the same succession types, which was from *Picea* to *Picea-Pinus* to *Pinus* to *Pinus-deciduous* forest.

3. *Tsuga* was associated with the deciduous genera *Fagus*, *Betula*, *Acer*.

4. The invasion by deciduous species depressed the importance of *Pinus* to less than 50 per cent of the total pollen. At Middle Fish Lake it recovered some of the lost abundance but at Douglas Lake the *Tsuga-deciduous* complex maintained its controlling influence.

5. The deciduous forest was never so important at the Middle Fish Lake station as at Douglas Lake.

6. *Tsuga* is to all appearances a component of the northern hardwoods and not of the *Pinus* element in the lake forest.

7. *Tsuga* declined in abundance during the time in which the five topmost levels of sediment at both lakes were laid down.

8. The opinion is expressed that the deciduous forest here as in northern Wisconsin is the climatically favored phase of the lake forest, and that pine occupies the position of relic favored by soil factors.

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#### Bibliography

1. Gates, Frank C., 1926. Plant succession about Douglas Lake, Cheboygan County, Michigan. *Bot. Gaz.* **82**:170-182.
2. —————, 1942. The bogs of northern lower Michigan. *Ecol. Mon.* **12**:213-254.
3. ————— and J. H. Ehlers, 1924. An annotated list of the higher plants of the region of Douglas Lake, Michigan. *Papers Mich. Acad. Sci., Arts and Letters* **4**:183-282.
4. Geisler, Florence, 1935. A new method for separation of fossil pollen from peat. *Butler Univ. Bot. Stud.* **3**:141-146.
5. Gleason, H. A., 1924. The structure of the maple-beech association in northern Michigan. *Papers Mich. Acad. Sci., Arts and Letters* **4**:285-296.
6. Otto, James H., 1938. Forest succession in the southern limits of Early Wisconsin glaciation as indicated by a pollen spectrum from Bacons Swamp, Marion County, Indiana. *Butler Univ. Bot. Stud.* **4**:93-116.
7. Potzger, J. E., 1942. Pollen spectra from four bogs on the Gillen Nature Reserve along the Michigan-Wisconsin state line. *Amer. Midl. Nat.* **28**:501-511.
8. Potzger, J. E., 1941. The vegetation of Mackinac Island, Michigan: An ecological survey. *Amer. Midl. Nat.* **25**:298-323.
9. ————— (Ms.), 1942. The phytosociology of the forest primeval in central northern Wisconsin and upper Michigan.
10. ————— and Ruth R. Richards, 1942. Forest succession in the Trout Lake, Vilas County, Wisconsin area: A pollen study. *Butler Univ. Bot. Stud.* **5**:179-189.
11. ————— and Ira T. Wilson, 1941. Post-Pleistocene forest migration as indicated by sediments from three deep lakes. *Amer. Midl. Nat.* **25**(2):270-289.
12. Wilson, Ira T., 1941. A new device for sampling lake sediments. *Jour. Sedimen. Petrol.* **11**(2):73-79.
13. ————— and J. E. Potzger (Ms.), 1942. Pollen records from lakes in Anoka County, Minnesota: A study on methods of sampling.