

A Comparative Pollen Study of Two Early Wisconsin Bogs in Indiana

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The reconstruction of past vegetation involves, as does any type of research on pre-historical material, numerous sources of error and omission. Yet an attempt at the reconstruction is necessary if we are to understand the changing environment of the past or to interpret the modern vegetation. Inference, as far as possible, should be made by investigating the direct evidence in the form of organic remains whose sequence and identity can be resolved. By the means of pollen studies it is possible to venture estimates of the changes in the ecological conditions that occurred between the various glacial periods.

For the past three decades, pollen analysis has been the dominant method of investigation of late Quaternary vegetational and climatic development. Weaver and Clements (12) state that the climax community is the product of the climate and controlled by it. The climax is not merely the response to a particular climate, but it is at the same time an expression of it. The vegetation integrates the climatic factors and expresses them in terms of life forms.

Because Indiana has both glaciated and unglaciated regions, this state is of special interest in tracing the possible climatic conditions which prevailed since the retreat of the continental ice sheets. According to Malott (6) approximately 30,100 square miles of Indiana have been subjected to glaciation, while only about 6,250 square miles have not been covered by the ice. The unglaciated area is in the middlewestern portion of the southern third of the state and is frequently spoken of as the driftless area, as opposed to the glaciated area. Four major glacial periods are recognized in Indiana: the Kansan, the Illinoian, the Early Wisconsin (Tazewell), and the Late Wisconsin (Cary). Since neither of the successively later ice sheets extended as far south as the one that preceded it, there is a wide belt of the three latter periods. The Illinoian deposits overlapped the Kansan drift in Indiana (11). The border line between the Illinoian and Early Wisconsin glaciations runs from northern Vigo County in the west to southern Franklin County in the east.

Location and Description of Bogs

The two bogs that are discussed in this paper are in the area of the Early Wisconsin glaciation. These sites are: the Fox Prairie Bog, 3 miles north of Noblesville in Hamilton County; and Bacon's Swamp, on the north side of Indianapolis in Marion County. Both bogs have been previously studied during the late 1930's by students of Dr. John E. Potzger. Now, by improved methods, the bogs have been reanalyzed using smaller intervals, and to a greater depth than had been reached before.

The Fox Prairie Bog (Fig. 1) is located in an old valley or glacial channel on the west side of the West Fork of White River (5). The surrounding country varies from a relatively level till plain to an undulating somewhat hilly topography. The area of the bog is approximately 150

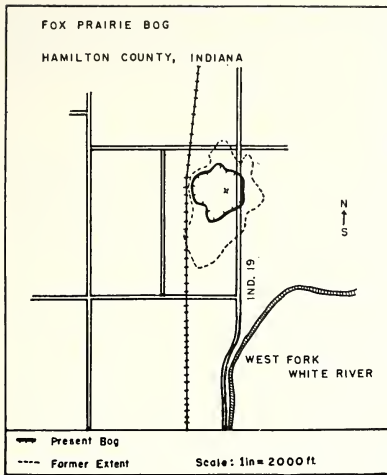


Fig. 1

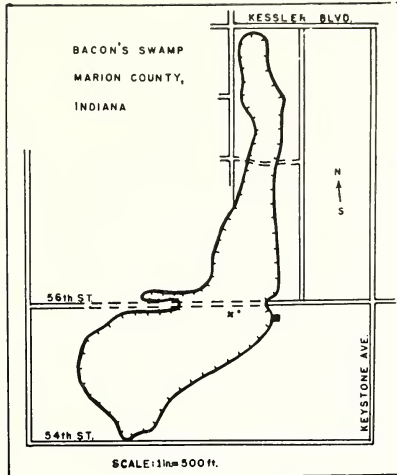


Fig. 2

Figure 1. Fox Prairie Bog, Hamilton County, Indiana adapted from U. S. G. S. Noblesville quadrangle map, 1953.

Figure 2. Bacon's Swamp, Marion County, Indiana, adapted from W. J. Wayne map of Bacon's Swamp.

acres, as determined from the Noblesville quadrangle map. This bog is believed to be one of the deepest in Indiana. Prettyman (8) attained a depth of 41 feet near the center of the bog in the winter of 1936-37. The boring made by a class from Indiana University in February 1957 reached a depth of 13.02 meters, or about 42.7 feet, at a position slightly east of the center of the present bog. The fact that this bog is over 40 feet deep is striking, as the surrounding area would not suggest the presence of a lake that deep. Fox Prairie bog is one of the so-called kettle holes that was created by the ablation of a former mass of glacier ice that was wholly or partly buried in the drift. Most kettles are less than 8 meters deep, but some exceed 45 meters (2). The lakes thus formed by the melting ice are rather deep, but are usually not extensive bodies of water.

Bacon's Swamp (Fig. 2) is the name given to an area that is actually a peat bog of the kettle hole type, and is not a true swamp. According to Potzger (9), "A swamp is a feature of the topography where the water table is above the surface and the soil is inorganic or of a humus nature." A bog is, however, "a feature of the topography where the water table is at or near the surface and the soil is of organic origin formed *in situ*." Therefore, Bacon's Swamp is, according to this definition, a true bog. It is located in a unique position for this study in that it is on the southern limits of the Early Wisconsin bog area in Indiana. The area of the bog is approximately 30 acres and it is at present covered with water. In the winter of 1936 the students of J. E. Potzger made their deepest boring, 32 feet. This boring was made at a point about 250 feet from the east

shore and 100 feet south of the old roadbed of Fifty-sixth Street (7). In April, 1959, students under the direction of D. G. Frey made a boring in about the same position and attained a depth of 11.92 meters or about 39.6 feet. At this level coarse unsorted sand was found.

Methods

A 13.02 meter core from the Fox Prairie Bog was collected in meter long segments by means of a Livingstone piston sampler. From the surface of the sediment to the 7.15 meter level, peat of varying composition was found. The core from this level to the final depth was composed of lake sediments of gyttja, silt, clay, and sand.

The core from Bacon's Swamp was also collected in meter long segments by the means of the Livingstone piston sampler down to a depth of 10 meters; from this point a Hiller borer was used to the total depth of 11.92 meters. Samples were taken every 50 cm. until coarse unsorted sand was reached. From the surface to the 6.80 meter level, peat of varying composition was encountered, and from this point to the final depth, lake sediments of gyttja, silt, clay, and sand were found. No marl was found in the lower levels as was reported by Prettyman (8) and Otto (7).

Samples, approximately 1 cc in volume, were taken from the center of the peat sections of the cores and placed in 250 ml. beakers with 10% KOH and then heated with constant agitation by the means of a mechanical stirrer until the sediment was completely deflocculated (ca. 8-10 min.). Next, the samples were centrifuged and washed with water, followed by screening with a 70 mesh screen (208 micron openings) to remove the larger particles. The material was then mounted in glycerine jelly stained with basic fuchsin. The samples taken from the lake sediment sections of the cores were first treated with 10% HCl to test for the presence of carbonates. There was little or no CO₂ evolved. The samples were then centrifuged and washed with distilled water and treated with 10% KOH until completely deflocculated, after which they were centrifuged and washed with distilled water. In the lower levels analyzed which contained a considerable amount of silt, clay, and sand, the bromoform-acetone method of differential flotation (3) was employed to concentrate the pollen grains. From the Fox Prairie Bog, 72 levels were analyzed; 65 levels were analyzed from Bacon's Swamp.

The slides were examined systematically and all the pollen and spores encountered were identified and tabulated until at least 200 tree pollens were recorded. The actual number of grains per sample ranged from 182 to 332 for the Fox Prairie Bog, and 151, in the lowermost level, to 444 for Bacon's Swamp. The non-arboreal pollens and spores were not identified as to genera for the diagrams, but were placed in botanical family categories such as Graminae, Compositae, Chenopodiaceae, etc.

In the pollen diagrams all trees and shrubs are included in the pollen sum, and the other plants are expressed as percentages of this sum at each level studied.

RESULTS OF ANALYSES

Fox Prairie Bog

The lowermost levels of the Fox Prairie Bog (Fig. 3) are characterized by a high percentage of *Picea* with a small percentage of *Abies*

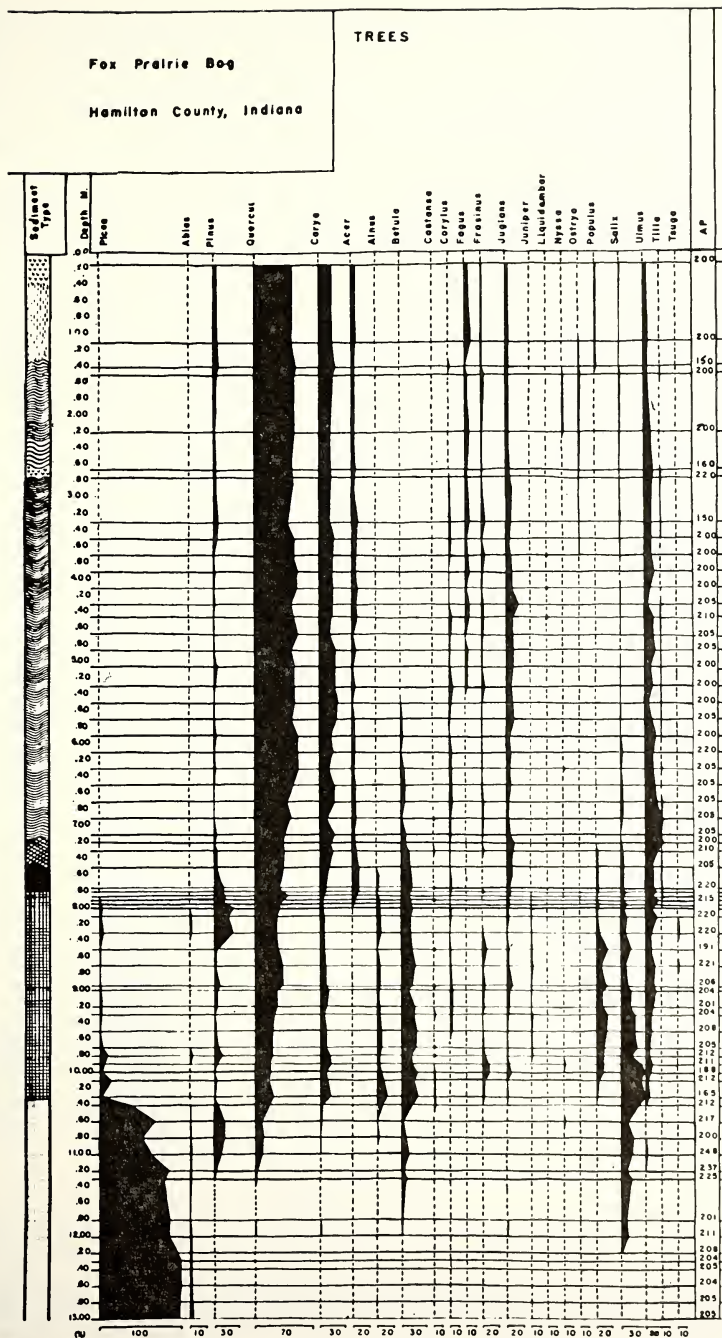


Figure 3. Pollen Spectrum from Fox Prairie Bog, Hamilton County, Indiana

and the total absence of other arboreal genera. *Picea* reached a maximum of 98% at the 12.6 and 12.3 m levels. From this maximum *Picea* declined steadily to 37.5% at the 10.4 m level, and then suddenly dropped to 1.3% at 10.3 m. The percentage rose to 12% at 10.1 m and then declined to low percentages (less than 2%) until the 8.3 m level, where it increased to 3.6%. It then decreased in percentage and disappeared from the spectrum at 7.8 m.

Abies occurred in low percentages in conjunction with *Picea* and disappeared from the spectrum at the 10.3 m level, which coincided with the sudden drop in *Picea*. *Abies* reappeared briefly at the 9.8, 8.3, and 8.1 m levels, and then was no longer found in the spectrum.

Pinus appeared at the 11.2 m level and reached a minor peak of 12.1% at the 10.8 m level. It then declined, with minor fluctuations, followed by a rise to a peak of 24.7% at 8 m. The percentage then decreased but remained, in negligible amounts, in the spectrum up to the surface of the bog.

Tsuga appeared in low percentages in only three levels, 8.7, 8.3, and 8.1 m, which coincided with the *Pinus* maximum and the increase in *Picea* and the reappearance of *Abies*.

Quercus appeared at the 12 m level and rapidly increased to 21.9% at 10.3 m, where the sudden drop in coniferous pollen occurred. It then increased to a maximum of 60.4% at the 6.3 m level and proceeded to decline, with minor fluctuations, to 48% at the surface.

Other genera, namely, *Alnus*, *Betula*, *Carya*, *Fraxinus*, *Juglans*, *Populus*, *Salix*, and *Ulmus*, appeared between the 12 and 10 m levels, in the interval between the decline of the *Picea-Abies* maximum and the *Pinus* maximum. The pollen grains of *Quercus*, *Carya*, *Juglans*, *Ulmus*, and *Salix* comprise the major percentage of the deciduous pollens encountered. *Acer* does not appear in the spectrum until after the decline of the *Pinus* maximum, and *Fagus* appears late in the spectrum, at the 5.3 m level, and continues to the surface of the bog.

Altogether there were 22 arboreal genera identified in the deposits of Fox Prairie Bog.

The nonarboreal pollens (NAP) were counted and placed in their proper botanical families. Of the 13 families encountered, 5 belonged to families of aquatic plants. Spores of lycopods and polypodiaceous ferns were distributed in small percentages throughout the entire spectrum.

The grains identified as *Equisetum* occurred almost continuously in the spectrum. This large grain had a distinct two-layered cell wall, a diagnostic feature which distinguishes it from the superficially similar pollen of *Larix*. It is significant that no grains of *Larix* were positively identified in this study, although Prettyman (8) had previously reported a maximum of 28% *Larix* from the Fox Prairie Bog.

Bacon's Swamp

In the lower levels of Bacon's Swamp (Fig. 4), as in the Fox Prairie Bog, *Picea* was the dominant arboreal genus, with low percentages of *Abies* and *Pinus* also being present. *Picea* attained a maximum of 95.6% at the 10.7 m level and then underwent a steady decrease in the percentage, with minor fluctuations, to 41.8% at 6.9 m. At this level *Picea* suddenly

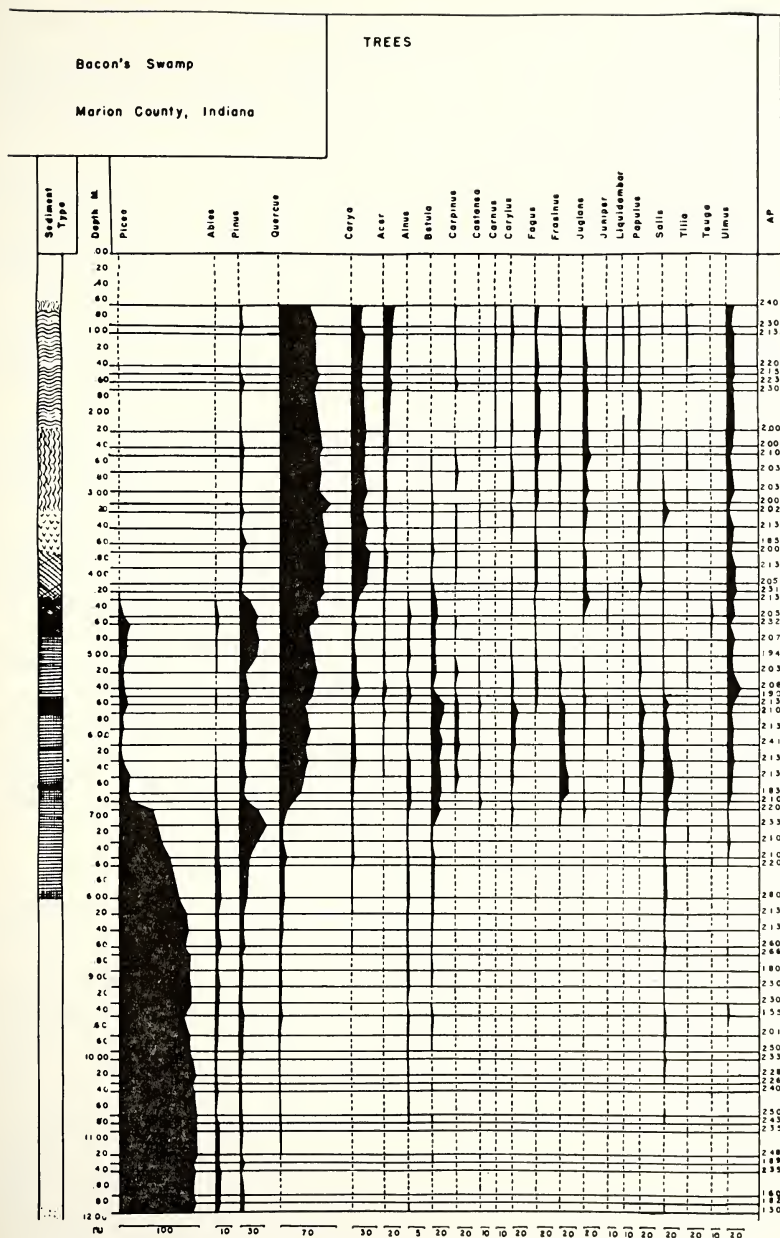


Figure 4. Pollen Spectrum from Bacon's Swamp, Marion County, Indiana.

declined to 15.2%, and then continued to decrease to less than 1% at 6.1 m. *Picea* remained in the spectrum in low percentages until it rose to a

secondary peak of 13.4% at 4.6 m; from this point it declined rapidly and was absent from the spectrum above 4.1 m.

Abies never attained a dominant position in the spectrum, but remained in the spectrum in low percentages (5% maximum) until the 6.3 m level, where it disappeared. *Abies* reappeared at 5.2 m and rose to 1.9% before it dropped from the spectrum.

Pinus was present continuously in the spectrum and attained two maxima. The first occurred at 7.1 m (33.6%) in conjunction with the decline of the *Picea* maximum. The second peak of 23.1% coincided with the increase of *Picea* and the reappearance of *Abies* at the 4.8 m level. The percentage of *Pinus* then decreased, but remained in the spectrum to the surface of the bog.

Tsuga appeared, but in low percentages, in four levels only. The first level at 7.5 m, where the first *Pinus* maximum occurred, and the other three levels, 4.8, 4.6, and 4.5 m, which coincided with the coniferous pollen increase as it did in the Fox Prairie Bog.

Quercus appeared at the 11.2 m level and remained in low percentages to the 6.8 m level, where it increased rapidly as the first *Pinus* maximum decreased. *Quercus* reached a maximum of 59.4% at the 3.6 m level and then declined, with minor fluctuations, to 39.2% at the surface.

As in the case of the Fox Prairie Bog, the other eight major deciduous genera appeared at the decline of the *Picea-Abies* maximum and a *Pinus* maximum. *Acer* appeared at the 6.5 m level and increased to 14.1% at the surface.

There were 22 arboreal genera identified in the deposits from Bacon's Swamp.

The types and percentages of nonarboreal pollens and spores were similar to those found in the Fox Prairie Bog. Furthermore, *Equisetum* spores were detected in similar percentages and depths as in the previously described bog. No grains of *Larix* were positively identified in the deposits as was reported by Otto (7).

Discussion

The results obtained from the analysis of the two bogs exhibit a striking resemblance, even though the Fox Prairie Bog is more than 25 miles north of Bacon's Swamp.

The lower levels of the Fox Prairie Bog and Bacon's Swamp are characterized by a high percentage of *Picea* and a low percentage of *Abies*. The *Picea-Abies* climax in the lower levels of the bogs has been found in most of the bogs studied in Indiana (10). The period of cool, moist climate which continued for a time after the Early Wisconsin glacial retreat, which occurred about 20,000 years B.P. (Before Present) in this area, was evidently responsible for the dominance of the *Picea-Abies* forest. This cool, moist period must have continued longer than the interval of the retreat of the Early Wisconsin glacier. However, this cooler climate must have extended to the period following the retreat of the Late Wisconsin glacier (about 12,500 years B. P.), because there is no evidence of a warm period between the two glacial advances. If there had been a change in the climate in this interval between the two glacial advances it is probable that a deciduous forest would have appeared.

Moreover, it is postulated that this deciduous forest would have been superseded by a coniferous forest, due to the periglacial effects caused by the advance of the Late Wisconsin substage (about 13,600 years B. P.) to within 30 miles of the present site of the Fox Prairie Bog. Following the northerly retreat of the Late Wisconsin glacier, the climate became warmer and drier and the *Picea-Abies* climax suddenly declined in the pollen profile.

In both bogs *Pinus* reached a peak during the decline of the *Picea-Abies* climax. The *Pinus* then decreased in the transitional period, which is characterized by the appearance of the deciduous forest genera, especially by the rapid increase of *Quercus*. This appearance of a deciduous forest would seem to indicate a somewhat warmer, drier climate. In this interval there is almost the complete elimination of *Picea* and *Abies* and a marked decrease in *Pinus* coupled with the marked development of *Betula*, *Salix*, *Fraxinus*, *Populus*, etc.

Pinus, *Picea*, and *Abies* make a notable increase in both bogs after this interval at levels approximately two meters apart. It is at this time that *Tsuga* appeared in both bogs. This coniferous increase points to a change to a cooler, more moist climate such as existed earlier. Frey (4) has recognized what may be the Two Creeks Interval in Indiana pollen diagrams. This interval occurred when the ice retreated into northern Michigan (or beyond) about 11,500 years B.P. If the interval between the two *Pinus* maxima, where there is a distinct development of *Quercus*, *Betula*, and the *Salix-Populus* group, is interpreted as the Two Creeks Interval, then the increase of the coniferous trees may be due to a cooler, more moist climate caused by the Valders advance about 10,000 years B. P. Since the Valders advance did not reach Indiana, the effect of the readvance of glaciation would probably have only a minor effect on the bogs in the southern half of the state, as is indicated by the short period of coniferous increase. With the retreat of this glacial advance, the Midwest was not again covered by ice.

Following the period of cool, moist climate caused by the readvance of the ice, there was a change to a warm, drier climate in which the deciduous forest increased rapidly. *Quercus* attained a dominant position in association with *Carya*. This *Quercus-Carya* climax has existed in the pollen profile to the surface of both bogs. There is an indication, however, of a change to a warmer, more moist climate, because in both bogs *Acer* and *Fagus* have increased and the *Quercus-Carya* maximum has decreased slightly.

Summary

To summarize this study, it may be stated that the results obtained from the analysis of the Fox Prairie Bog and Bacon's Swamp exhibit a striking resemblance. The lower levels are characterized by a *Picea-Abies* climax with a *Pinus* maximum at the decline of this climax. In the following interval, which may be interpreted as the Two Creeks Interval, there is a rapid and distinctive increase of the deciduous forest genera. The second *Pinus* maximum, in conjunction with *Picea*, *Abies*, and *Tsuga*, then occurs to close this interval. This coniferous increase may be due to the climatic effect of the Valders advance. After the decline of the conifers, *Quercus* and *Carya* become dominant and continue to the surface as

the climax association. *Acer* and *Fagus* increase near the surface indicating another possible climatic change.

The post-glacial forest succession of *Picea-Abies* to *Pinus* to the deciduous forest complex to *Pinus-Picea-Abies* to *Quercus-Carya* to *Acer-Fagus* suggests the following climatic periods: cool moist to cool drier to warmer drier, changing to cool moist again, and then to warm drier and finally to warm more moist.

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