A fossil pollen analysis of Fox Prairie bog, Hamilton county, Indiana

Robert L. Prettyman
Butler University

Follow this and additional works at: https://digitalcommons.butler.edu/botanical

The Butler University Botanical Studies journal was published by the Botany Department of Butler University, Indianapolis, Indiana, from 1929 to 1964. The scientific journal featured original papers primarily on plant ecology, taxonomy, and microbiology.

Recommended Citation
Retrieved from: https://digitalcommons.butler.edu/botanical/vol4/iss1/4

This Article is brought to you for free and open access by Digital Commons @ Butler University. It has been accepted for inclusion in Butler University Botanical Studies by an authorized editor of Digital Commons @ Butler University. For more information, please contact digitalscholarship@butler.edu.
Butler University Botanical Studies (1929-1964)

Edited by Ray C. Friesner

The Butler University Botanical Studies journal was published by the Botany Department of Butler University, Indianapolis, Indiana, from 1929 to 1964. The scientific journal featured original papers primarily on plant ecology, taxonomy, and microbiology. The papers contain valuable historical studies, especially floristic surveys that document Indiana's vegetation in past decades. Authors were Butler faculty, current and former master's degree students and undergraduates, and other Indiana botanists. The journal was started by Stanley Cain, noted conservation biologist, and edited through most of its years of production by Ray C. Friesner, Butler’s first botanist and founder of the department in 1919. The journal was distributed to learned societies and libraries through exchange.

During the years of the journal’s publication, the Butler University Botany Department had an active program of research and student training. 201 bachelor's degrees and 75 master's degrees in Botany were conferred during this period. Thirty-five of these graduates went on to earn doctorates at other institutions.

The Botany Department attracted many notable faculty members and students. Distinguished faculty, in addition to Cain and Friesner, included John E. Potzger, a forest ecologist and palynologist, William Nelson Clute, co-founder of the American Fern Society, Marion T. Hall, former director of the Morton Arboretum, C. Mervin Palmer, Rex Webster, and John Pelton. Some of the former undergraduate and master's students who made active contributions to the fields of botany and ecology include Dwight W. Billings, Fay Kenoyer Daily, William A. Daily, Rexford Daubenmire, Francis Hueber, Frank McCormick, Scott McCoy, Robert Petty, Potzger, Helene Starcs, and Theodore Sperry. Cain, Daubenmire, Potzger, and Billings served as Presidents of the Ecological Society of America.

Requests for use of materials, especially figures and tables for use in ecology textbooks, from the Butler University Botanical Studies continue to be granted. For more information, visit www.butler.edu/
FOSSIL POLLEN ANALYSIS OF FOX PRAIRIE BOG, HAMILTON COUNTY, INDIANA

By ROBERT L. PRETTYMAN

The study of post-Pleistocene vegetations and migration of forests by means of fossil pollen in peat is a comparatively recent addition to the study of paleobotany and plant geography in America and is certainly in its pioneer stage in Indiana; yet that state offers a rich field to the botanist interested in the postglacial migration of vegetation. In the northern part of the state, numerous bogs in various stages of development, ranging from the open lake stage to those completely covered by meadow or forest, are readily accessible for study. In central Indiana, bogs are less numerous, but all the more interesting, because they mark the southernmost extension of glacial bogs in Indiana.

Indiana occupies a unique position in the glaciated section of the United States. It marks the southern terminus of both the older Illinoian and the more recent Wisconsin ice sheets. The former extended all the way to the southern boundary of the state, with an unglaciated triangle (Malott, 8) from northern Monroe and Brown counties at its northern apex to Posey and Clark counties in the south. The Wisconsin glacier had its southern terminus at a line crossing from the northwest corner of Jennings county to central western Parke county.

The glacial bogs in Indiana are all in the Wisconsin deposits. While the surface records of boreal plant relics are almost obliterated by the activities of civilized man, i.e., fires, draining and grazing, the records of the great migrations of forest types and climaxes are still neatly stored away unmolested in the peat of our deep bogs, open to the inspection of the botanist who is ready and willing to spend physical labor to collect the peat and who has the patience necessary for microscopic analysis.

During the past year the Butler University Botanical Laboratory has undertaken an extensive and intensive study of Indiana bogs; records of surface vegetation are being gathered, and other pertinent data are being collected from the oldest settlers of the region in question, which in most cases covers a period of seventy-five years. One of the deeper bogs in the group studied at present is the Fox Prairie bog, in Hamilton county, Indiana. Data on this bog are here reported.

*This paper is a portion of a thesis in partial fulfillment of the requirements for the degree of Master of Arts in Butler University.*
GEOGRAPHICAL LOCATION AND DESCRIPTION

The Fox Prairie bog is located three miles north of Noblesville in Hamilton county, which is situated slightly north of the geographic center of Indiana. The bog is located in an old valley or glacial channel on the west side of the West Fork of White river (6). This surrounding country varies from a level till plain to an undulating and somewhat hilly topography. The area is characterized by a beech-maple climax with an oak-hickory subclimax on the drier uplands.

PLANT ASSOCIATIONS

The bog covers approximately three-fourths of a square mile. Those areas which are not too wet are under cultivation and the black soil reveals its organic origin. The old lake shore is marked by encircling sandy ridges. The central and larger portion of the bog is occupied by an extensive Calamagrostis meadow. Populus tremuloides is by far the most abundant tree and is found in patches and small groves. The trees are all young, probably none exceeding fifteen years in age. Acer rubrum and A. saccharinum are represented by scattered trees. Salix nigra is common in the more moist locations, along the drainage ditches and around the margins of the open water. Ilex verticillata is the most abundant shrub. Rhus verniciflua is also present though not in great abundance. Osmunda cinnamomea, O. regalis spectabilis, Dryopteris thelypteris pubescens, and D. cristatum are the most prominent ferns. The absence of any significant boreal relics may be due to the age of the bog, together with the destruction by fires and pasturing.

METHODS

In the winter of 1936-37, two borings were made approximately 400 feet apart near the center of the bog, and samples taken at one-foot intervals. These borings, hereafter referred to as Spectra A and B, were 40 and 41 feet deep respectively. The boring was done with a borer of the cylindrical type, having a movable sleeve. The cylinder was thoroughly washed between samples to avoid contamination. The samples were always taken from the center of the core and placed into a clean vial, corked and labelled. The lower 11 feet in each boring were composed of a bluish-gray marl, indicating that an open lake stage had existed over a rather extensive period. In both borings the marl was
The ground was underlain by a coarse, hard-packed sand which the boring apparatus would not penetrate.

The fact that the bog was 41 feet deep was rather striking, as the surrounding terrain would not suggest the existence of so deep a lake. Cleland (2) states that such lakes and ponds, the so-called kettle holes, probably have as their origin huge blocks of ice which had been buried in the glacial drift and melted to form rather deep but not extensive bodies of water.

The procedure followed for the preparation of the peat for microscopic analysis approximated that used by Geisler (4). This method worked quite satisfactorily, yielding a large number of grains per slide at levels where pollen was abundant. Basic fuchsin (1 per cent aqueous) was used to stain the grains in the marl. This stain worked much better than either methylene blue or gentian violet. In the peat, aqueous gentian violet (1 per cent) gave excellent results. It was found that when used to stain the pollen grains in the marl, gentian violet gave little or no results. This was probably due to the alkaline nature of the marl, since the grains in slightly acid peat took the stain readily. The amount of peat to be used in the preparation of slides for a given level depended largely upon the abundance of pollen. This was determined by a preliminary examination of the mounts. If this examination revealed the pollen to be abundant, a lump of peat about the size of the thumbnail was separated in about 15 cc. of alcohol. If the frequency was low, a still larger lump was used. The amount of gentian violet used for staining was inversely proportionate to the degree of acidity of the peat. Grains in peat approaching neutrality were found to require more stain than those in the upper or more acid levels.

**PEAT ACIDITY**

The hydrogen-ion concentration of samples taken from Spectrum A was determined by the Youden hydrogen-ion concentration apparatus. Three readings were made of each sample. The active acidities of these were averaged, and from this the pH values were obtained. The peat was most acid (pH 5.7) near the surface, with a steady decrease in acidity as depth increased. At the 29-foot level, or in the first foot of marl, the reaction was neutral, and from here to the 41-foot level there was an increasing alkalinity.
EXAMINATION AND IDENTIFICATION

A binocular microscope equipped with 15X oculars, 43X objective, graduated mechanical stage and condenser, was used for identification and examination of the pollen. The grains were identified by comparing them with prepared slides of modern pollens. The works of Wodehouse (16), Sears (12) and Lewis and Cocke (7) were also helpful in identification. Examination of the upper 12 feet of peat in both borings revealed a marked absence of pollen. For the most part, 200 grains were counted in each level, with the exception of those in which the pollen frequency was so low as to prohibit it. This was true of the 13-, 14-, 15- and 16-foot levels of Spectrum A, and the 38-, 39-, 40- and 41-foot levels of Spectrum B. In all instances the unknown grains were included in the total number of grains counted for each level.

OBSERVATIONS

The results of the microscopic analysis of Spectrum A are presented in Figure 1. Those of Spectrum B are not here shown, but will be supplied to anyone wishing them by the Botany Department of Butler University. The percentages were derived from the total number of grains counted for each level. In general, the two spectra are similar. The lower levels are characterized by high percentages of Abies and Picea grains and the total absence of any other genera. This is followed by increasing percentages of Larix and Pinus pollen, with a decrease in Abies and Picea. Grains of Larix and Pinus extend well into the upper levels, but only in small percentages. Such genera as Juglans, Corylus, Betula and Alnus tend to appear early in the lower levels, but in no great abundance throughout the spectra. The grains of Quercus, Salix, Carya and Ulmus comprise the bulk of the pollen of the broad-leaved forms. In several levels, Quercus comprises over 50 per cent of the total number of grains counted. The grains of the unknown genera tend to increase toward the upper levels. The most striking difference between the two spectra is in the percentages of Abies and Picea in the lower levels. In Spectrum A these two genera are rather equally divided, while in Spectrum B Abies reaches a maximum of 86 per cent.

Figure 1 shows graphically the percentages of the more important genera found in Spectrum A. Abies and Picea exhibit a rather gradual decline up to the 31-foot level, in which both species almost disappear. This is followed by a small increase, finally to disappear in the 23- and
Objective, ication

Parin revealed frequency
16-foot Specimen total

presented the super Uni- grains. The Picea fragment by rese in the upper Corylus, in no Salix, leaved the total tend to between the lower biod, while important gradual appear. 23- and

FIGURE 1
24-foot levels. Larix reaches a striking maximum in the 28-foot level. In general, most of the broad-leaved genera are characterized by a steady increase after making their appearance. However, in the 27- and 38-foot levels all these genera are subject to a definite and, in some instances, an abrupt decrease. Quercus is the most outstanding of the broad-leaved genera, attaining a maximum of over 50 per cent in the 18-foot level.

**DISCUSSION**

One of the most striking features of the bog was the absence of pollen in the upper levels of the peat. Analysis revealed the pollen frequency so low that counting was prohibited. Fern spores and sporangia were abundant throughout these levels and gave evidence of a rather densely covered bog mat having its vegetation above the water level. Davis (3) believes that this dead vegetation when exposed to the air and sun created a poor medium for the preservation of the pollen. A bog similar to Fox Prairie bog, in that the upper 12 feet had pollen frequencies too low to permit counting, is recorded by Voss (14) for the Bald Eagle bog of northern Minnesota.

**THE SUCCESSION OF FOREST TYPES**

The forest types and their succession are best seen in Spectrum A. Figure 1. The high percentages of Abies and Picea in the lower levels indicate a coniferous forest dominated by these two genera. No broadleaf nor unknown species were recorded from the lower levels of marl, indicating that this forest was for a period relatively stable. Abies and Picea disappear gradually and are replaced by Pinus, Larix and several broad-leaved genera, such as Salix, Quercus, Ulmus, Betula, Corylus, Carya and Alnus. Pinus and Larix finally give way to the broad-leaved forest, which in the upper levels appears to be essentially oak-hickory. As to what the upper twelve feet might have shown had the pollen been preserved, one can only infer from other records. Jean P. Barnett, a fellow investigator at the Butler University Botany Department, working on a bog near Emporia, Madison county, found a strong tendency toward a beech-maple climax in the upper eight feet of the Emporia bog. This seems to be true in the Fox Prairie bog, too, as indicated by the decline of Quercus and the appearance of Acer in the 15-, 14- and 13-foot levels. On the other hand, one must consider the question of whether or not the pollen grains which fell into the bog at this period were characteristic of large areas of the surrounding forest. The regions adjacent
to the bog were an old sandy shore line and an area of wet lowlands. The former probably supported primarily oak-hickory and the latter was no doubt dominated by an elm-walnut subclimax forest, while the bog itself was probably covered by a Thuja-Larix relic vegetation, as were most of the remaining bogs in Indiana when civilized man moved in. This, of course, is only conjecture. One must, however, always bear in mind that the deciduous forest is heterogeneous and forest types are determined by local environmental conditions, and depositions in a bog are under control of this limited local environment.

The Forest Types and Their Significance as Climatic Indicators

The forest type which a given area will support is determined by climatic, edaphic and topographic factors. If these factors undergo change, the existing forest type will be replaced by one better fitted to meet the conditions of the changed environment. With the retreat of the Wisconsin glacier, there was initiated a change in the factors which control forest types. Conifers, such as Abies, Picea, Pinus and Larix, which had been pushed southward by the advance of the ice, were among the first trees to advance over the barren drifts left by the glacier. As the huge ice masses retreated farther northward, the climate in a given region changed and the conifers were forced farther northward by climatic factors and by new forest types crowding in from the south.

The climate which existed during the dominance of Abies and Picea in the Fox Prairie area was apparently the same as that of the region in which the northern conifers are now found, i.e., the so-called boreal forest. The northern boundary of this area runs from the Mackenzie delta to the east of Great Bear and Great Slave lakes to Port Churchill on Hudson bay; it then swings around the bay to the northeast, but reaches the coast only near Newfoundland. From Cook inlet in Alaska the southern boundary trends southeastward to Saskatchewan, eastward to Lake Winnipeg and thence to northern New Brunswick (15).

No sudden change from one forest type to another was revealed in either spectrum. The change from coniferous to broad-leaved forest (36- to 22-foot levels) was a very gradual one in which Larix and Pinus reach their maxima and slowly decrease. The earlier part of this transitional period is characterized by the appearance of genera comprising the broad-leaved forest and especially the rather rapid increase of Quercus (36- to 29-foot levels). This would seem to indicate a somewhat drier...
and warmer climate than when the conifers were dominant. This is followed by a rather sudden decrease in the broad-leaved forest, which is revealed in all the genera (28- to 27-foot levels). At this time, Abies and Picea, which had almost disappeared (29-foot level), make a notable increase, and Larix reaches its maximum (28-foot level). This points toward a return to the cooler and more moist climate which existed earlier.

The later part of the transitional period marks the disappearance of Abies and Picea (24- and 23-foot levels) and the increase of Quercus. The other broad-leaved genera tend to increase generally and Pinus reaches its maximum (25-foot level). This would suggest the tendency toward a drier and warmer climate than existed previously, probably similar to that of the present Lake Forest area (15).

The broad-leaved forest had by this time become well established, and Pinus and Larix apparently existed only as relics (20- to 16-foot levels). The forest type was essentially oak-hickory and was controlled by a climate somewhat similar but perhaps less moist than that of today. This period of a drier climate may be in some way correlated with the eastward extension of the prairie, which is known to have extended farther eastward in earlier times than it does today (13).

The upper levels (15- to 13-foot levels) give evidence of a return to a more moist climate. Quercus decreases rapidly and Acer makes its first appearance. Analysis of the upper 12 feet, had it been possible, would probably have recorded the change from a rather dry, warm climate, supporting oak-hickory, to a moist, warm climate, supporting beech-maple, which exists in the area today.

Comparison of Results and Interpretations with Those of Other Workers

The evidence of a coniferous forest dominated by Abies and Picea in the lower levels of the Fox Prairie bog is typical for the majority of the bogs in Wisconsin, Illinois, Minnesota, Michigan, Ohio and Indiana, that have been investigated by Voss (14), Sears (10), Houdek (5), Artist (1) and Lindsey (9). Sears (11) found evidence to suggest that five or six climatic cycles have occurred in postglacial times. This is in contrast with the findings of Voss (14), whose studies reveal the climate to have been uniform. The present work tends to support the opinion of Sears.

The climatic changes which occurred in the Fox Prairie area during postglacial times apparently were: a cool, moist climate, supporting
Abies and Picea; a drier, warmer climate, during which Abies and Picea decrease, while Pinus, Larix and broadleaf genera make their appearance; a cooler, moist climate, during which Abies and Picea again become conspicuous and the broad-leaved forest is definitely retarded; a dry, warm climate, which witnessed the disappearance of Abies and Picea and the increase of a forest type which was essentially oak-hickory; and lastly, a more moist, warm climate, supporting beech-maple. Such a succession of postglacial climates would tend to agree with the Blytt-Sernander hypothesis (17). This theory holds that there have been two periods of greater humidity in postglacial times. In Europe, where this theory was advanced and a great deal of investigation of postglacial climate has been carried on, workers in general agree with this hypothesis.

Paleobotanists have emphasized the need for a more extensive and exhaustive investigation of peat deposits in North America. Until these have been made, any interpretations or reconstructions of postglacial migration and climate are provisional. It is with this in mind that the writer submits his investigations in hope that they may, in a small way, be a contribution to a more comprehensive knowledge of post-Pleistocene climate and vegetation.

**SUMMARY**

1. The pollen analysis of the Fox Prairie bog reveals that the upper 12 feet of peat were deposited during a period unfavorable to the preservation of pollen grains.
2. Abies and Picea were the dominant genera in the lower levels.
3. The transitional period from coniferous to broad-leaved forest was gradual and was characterized by Pinus and Larix maxima and the general increase of broad-leaved genera.
4. The broad-leaved forest following the transition period was essentially oak-hickory.
5. The uppermost levels (15- to 13-foot) in which pollen was found point towards the decrease in Quercus, the appearance of Acer, and to the present day beech-maple climax.
6. The successive forest types indicate the following fluctuations in climate: cool moist, warm dry, cool moist, warm dry, and warm moist.
7. This succession of climates agrees with the Blytt-Sernander hypothesis.
The writer wishes to express his gratitude to Dr. J. E. Potzger for helpful advice in directing this work, references to literature and critical reading of the manuscript; to Dr. R. C. Friesner for his helpful suggestions and generous assistance; to Paul B. Sears, of the University of Oklahoma, for checking the identification of several pollen grains; and to the members of the Butler University Botanical Department for their aid in boring the bog and their kindly cooperation and interest.

LITERATURE CITED