A comparative pollen analysis of two bogs within the boundaries of the late Wisconsin glaciation in Indiana

Byron W. Moss
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
Moss, Byron W. (1940) "A comparative pollen analysis of two bogs within the boundaries of the late Wisconsin glaciation in Indiana," Butler University Botanical Studies: Vol. 4 , Article 17.
Retrieved from: https://digitalcommons.butler.edu/botanical/vol4/iss1/17

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, Willard 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 text books, from the Butler University Botanical Studies continue to be granted. For more information, visit www.butler.edu/
A COMPARATIVE POLLEN ANALYSIS OF TWO BOGS WITHIN BOUNDARIES OF THE LATE WISCONSIN GLACIATION IN INDIANA

By Byron W. Moss

The study of the migration and succession of forest types by means of fossil pollen analysis is very significant in determining the climatic conditions which have existed since Pleistocene times. Vegetation in its largest aspect is controlled by climate, any gradations of climate are then indicated by the succession of plant types. Pollen spectra derived from analyses of peat are some of the best concrete evidence of vegetational and climatic changes since Pleistocene times.

Loon Lake bog is located approximately four miles west of the town of Silver Lake, in the southwest corner of Kosciusko county. Altona bog is located two miles northwest of Altona in the southwest corner of Dekalb county. The two bogs are separated by about 40 miles in an east-west direction and 20 miles in a north-south direction.

METHODS

Peat samples from both bogs were obtained during the winter of 1936-7. The peat borer used was of the cylindrical type as described in former pollen studies by Prettyman (8). Samples of peat were taken at each foot-level from the surface to the bottom of the bog. The staining technique approximated that developed by Geisler (4), but the method of mounting the stained material was different throughout. A small amount of the solution was evenly distributed on a clean slide over an area of about 20 mm square. The slides were placed on a level surface and permitted to dry. After the alcohol had evaporated thoroughly the material was covered with a thin coat of sirtillac (12). No cover glass is necessary since sirtillac dries in 24 to 48 hours forming a smooth, hard, transparent surface. Slides made with this medium are permanent and will not discolor with age. To make observations more readily limited to the 20 mm square area, each slide was lined with a razor blade on all four sides to indicate the boundary of the material covered by sirtillac.

This is a portion of a thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts in Butler University.
These lines are as easy to detect under the microscope as the edge of a cover glass. Pollen grains mounted by this method all occur in the same plane thus very little change in focus of the microscope is necessary to locate all grains and the possibility of overlooking pollen grains which are located at various levels in a medium such as glycerine-jelly is eliminated.

Two hundred grains were counted for each foot-level, except at the surface, the 1-foot layer and the bottom marl levels, where only 100 grains were counted because of low pollen frequency. Barkely (1) concluded that little or no increase in validity accrues from counting above 200 pollen grains per foot-level. At least two slides were used in counting each foot-level, but more were necessary in some cases.

OBSERVATIONS

The results of the analysis of the Altona bog are presented by stippled bars in figure 1. The bottom level, the only marl level in the Altona bog is characterized by Abies and Pinus, the former genus being dominant for the marl level only and going out of the spectrum very early. Pinus dominated the 22-foot level only but extended to the surface in low percentages. Picea did not occur in the marl layer but came into the 22-foot level very strongly and diminished rapidly with a few grains still present near the surface layer. Acer shared the dominance of the 17-, 18-, and 19-foot levels with Quercus but from there to the surface the latter genus controlled the spectrum by more than 60% per foot-level. Carya held a secondary dominance extending from the 14-foot level to the surface. Salix, Tilia, Juglans and Betula were persistent in low percentages throughout the spectrum, however none of the broad-leaved genera were found in the marl level.

The results of the analysis of the Loon Lake bog are shown by solid bars in figure 1. The deposits in the lower 5 feet are composed of coarse marl, the remaining levels being made largely of disintegrated sphagnum. Two layers of peat so dilute that samples could not be taken occurred in the bog, one at the 8-foot level; the other at the 17-20-foot level. Loon Lake bog had 5 feet of marl compared to 1 foot in the Altona bog.

The lowest 6 feet of Loon Lake bog were characterized by Abies and Picea which dominated all other species. Abies was the dominant genus for the lowest 6 feet but disappeared abruptly at the 33-
scope as the edge of the polarization medium such as glass or quartz.

The pollen spectrum is characterized by the presence of specific pollen types that can indicate the vegetation and climate of the past. In the case of the bog in question, the spectrum shows a shift in dominance from Abies to Pinus around the 33-foot level, with a gradual decrease in Pinus abundance towards the surface. Quercus and Acer also show shifts in dominance, with Acer being more abundant in the lower levels and Quercus in the upper levels.

DISCUSSION

SIGNIFICANCE OF POLLEN STUDY

In spite of the valuable concrete information gained from records of pollen deposits, there are certainly great dangers of reading too much or too little into some of the percentages obtained. The differences in the amount of pollen produced by various genera, the variability in preservation of pollen, the present difficulty of separating the pollens into species, especially in the case of Quercus and Acer, the lack of absolute knowledge as to the history of the formation of the physical constituents of the various bogs, i.e., whether the age of the two bogs in the same general geographical location is the same, all add difficulties to the interpretation. Yet in its gross features, a pollen spectrum is one of the most important visible proofs of vegetational changes especially as far as shifts in formations are concerned. In its gross features the vegetation of a given area is the expression of the climatic factors which exist in the area. Changes in genera in a pollen profile of a bog thus, give evidence of the climatic changes which have occurred during the formation of the successive layers of the bog. Clements (3) has shown that plants are the most immediately responsive to climatic influences and constitute the best indication of climatic changes.

However, a pollen spectrum cannot well indicate how much of the vegetational shifting was due to changes in macroclimate and how much was induced by microclimate or by changes in topography. This, no doubt, accounts for the apparent non-correlation between several bogs where pine dominated while the other shows pine of
while soilds. 

ance b. 

ite, soil tec. 

lits an 

of a soil 

in clim 

change 

area p 

success 

by max. 

profile 

when 

is dom 

be exp 

change 

one fa 

one of 

would 

extend 

and gr 

success 

from a 

range 

omitted
secondary importance. Soil types and soil moisture select forest types, e.g. in our north-central states pine controls in sandy soil while Fagus-Acer or Quercus-Carya dominate in areas with better soils. Kell (6) reports for Itasca Park, Minnesota that “water-balance becomes a critical factor in determining the distribution of the major forest types.” This water balance is seriously affected by soil texture. Thus, one is no doubt justified to assume that the pine dominance in the 34-, 33-, 32-foot levels in the Loon Lake bog and its absence in every level of the Altona bog is evidently an indication of a soil difference rather than of a difference in macroclimate.

Succession of vegetation may not only be the result of changes in climate, but also in physiographic conditions of an area. Climatic changes cause the greatest variation in vegetation, but within a given area physiographic differences may support more than one type of dominant vegetation. Succession as defined by Weaver and Clements (15) is only a series of progressive reactions by which communities are selected out in such a way that only one survives which is in entire harmony with the climate. Reaction is thus the keynote to all succession, for it furnishes the explanation of all the orderly progression by stages and the increasing stabilization which produces a climax. Succession of dominant forest types as indicated by a pollen profile gives evidence of a northward migration of vegetation. The coniferous forest which dominated all other vegetation in Indiana when the lowermost levels of all Indiana bogs were forming, now is dominating the forests of northern Canada. The complete change from a coniferous climax forest to a deciduous climax forest can be explained by only one factor, viz. climate. Temperature has changed in Indiana from one which favored a coniferous forest, to one favoring the deciduous climax forest now present.

Of significant importance in a study of this kind is the depth to which borings are made. It is perfectly obvious that a spectrum would be incomplete if the boring were incomplete, i.e. if it did not extend to the original lake bottom. In Indiana this is always a sand and gravel layer. If a spectrum is incomplete, the inferences as to succession are naturally incorrect. In all Indiana bogs the transition from a coniferous to a deciduous forest is sudden, i.e. within the range of one foot-level. (See figure 1: Loon Lake bog, levels 37 to 36 and Altona bog, levels 23 to 22.) If a single foot-level were omitted at a critical depth, the impression would be gained that Quercus, Betula and other broad-leaved species constituted a part of the
forest complex from the very beginning of deposition. Such an error seems to be indicated in Houdek’s (5) paper on a bog from Steuben County, which is only 20 miles north of the Altona bog. He shows no Abies or Abies-Picea climax with absence of all broad-leaved genera which is so characteristic for all Indiana bogs studied in our laboratory. It is quite evident that here in Indiana the boring must be made into and through the hard marl layer if a true picture of forest succession is to be gained. Houdek reports an ooze bottom layer similar to that usually found directly above marl and with pine as the dominant genus and Quercus in high percentages.

**Altona Bog and Climatic Changes**

In the Altona bog a coniferous forest of Abies, Pinus and Picea dominated the bottom two layers but suddenly disappeared and dominance was assumed by Quercus which continued to the surface in high percentages. According to Sears (11) a coniferous forest of this type is an indication of a cool moist climate. The transition from that climate was quite abrupt since Quercus with more than 70% dominates all other genera in the third foot-level from the bottom.

Comparing the spectrum of this bog with that of other Indiana bogs, an unusual feature is the high percentage of Acer pollen in the 16-, 17-, 18-, 19-foot levels which, when present in other bogs, occurs much closer to the surface. If one takes into account the limited amount of pollen produced by Acer as compared with Quercus, the percentages of Acer pollen in the Altona bog indicate that the abundance of this genus in the forest complex must have been even more significant than the percentage figures indicate. Acer has some species which indicate mesophytism, but if Acer saccharinum, A. rubrum or A. spicatum were involved it could indicate a more hydrophytic habitat which might well be only a sub-climax in a Quercus-Carya climatic climax.

The climate of the area must have changed from a cool moist, when the coniferous forest was dominant, to a warm moist, when Acer and Quercus occurred in about equal percentages, to a warm dry which supported a Quercus-Carya climax forest such as we have at present. Betula, Juglans, Salix and Tilia may be considered as trees which indicate physiographic changes within a Quercus-Carya association. The climatic conditions are not necessarily different from those which are required to support a Quercus-Carya climax; rather, the moist forest from topograpic records. Such a situation is high.

Abies and 17-18-foot levels of deposit of Abies, Pinus and Picea their decline and dominance by Quercus was observed. A coniferous forest is generally considered to be a cool moist climate type. In the Altona bog the transition from cool moist to warm moist to warm dry climate is evidenced by the pollen spectrum. Acer is an important genus in cool moist climates, but in warm moist climates it is usually absent. In the Altona bog, Acer is represented in the 16-, 17-, 18-, 19-foot levels. This suggests that the climate in the Altona bog was cool moist during the formation of the lower two layers and warm moist during the formation of the third foot-level.

The two bogs, Altona and Steuben, represent different climates. During the formation of the Altona bog, the climate changed from cool moist to warm moist to warm dry. During the formation of the Steuben bog, the climate changed from cool moist to warm moist. The pollen spectrum of the Altona bog indicates a vegetation change from coniferous to deciduous forest, which is typical of a climate change from cool moist to warm moist to warm dry.
position. Such an error in a bog from Steuben Altona bog. He shows the loss of all broad-leaved genera in our Altona the boring must be a true picture of what once bottom we have and with pine percentages.

Changes

Abies, Pinus and Picea disappeared and dominated to the surface in a coniferous forest of climate. The transition to a forests with more than 80 foot-level from the that of other Indiana sites of Acer pollen in the near other bogs, occurs to account the limited area with Quercus, the indicate that the abundance-Volume may be even more late. Acer has some Acer saccharum, A. indicate a more hydro-b-climax in a Quercus-Carya climate. This change from Abies-Picea to a deciduous forest is generally abrupt in the Illinois bogs, and the present study shows the same feature present in bogs of northern Indiana. If the successive layers of thickness of the peat deposits is a safe indicator of varying elapses of time, we must conclude that conifers controlled for a comparatively short period, in most cases 10% or less of the total time since the retreat of the ice. Acer, Betula, Juglans and Salix which were present in low percentages in nearly all levels except the marl levels, may be regarded as natural invaders in a Quercus-Carya climax forest in places where the moisture content is high.

Comparison of the two bogs

The two bogs are similar in the rapid decline of Picea-Abies and Pinus forests and the subsequent rapid ascendency and persistence of Quercus dominance but they do not agree closely regarding the time of these changes. Maple played a very important role in the Altona bog (19-15-foot levels) but it was less prominent in the Loon Lake bog. This is a variation in the deciduous forest complex which might be controlled by local soil moisture conditions.
Carya was a representative component of the forest at both places while Fagus was absent at Altona and played a minor role at Loon Lake. The secondary genera Tilia, Ulmus, Salix, Juglans and Betula were sparsely represented at both stations. In the upper two-thirds of the two bogs there is a uniformity in the genera and percentages of their pollen. In the Altona bog Picea was absent in the lowermost level, this was compensated partly by a higher percentage of Abies, and this is not uncommon in a number of Indiana bogs studied. In the Altona bog Pinus made a prominent showing in the lowest level (27%) while it did not appear in the spectrum of the Loon Lake bog until the 4th foot-level from the bottom and did not reach a comparable percentage until the 8th foot-level. Quercus assumed dominance very much earlier in the Altona bog than in the Loon Lake bog.

Summing up the various features we would say that the apparent early dominance of Quercus, the comparatively high percentage of Pinus pollen in the lowest level, the appearance of large numbers of broad-leaved genera in the second foot-level, the sudden decline of Abies in the second foot-level and of Picea in the third foot-level in the Altona bog indicate some difference in formation of the two bogs. Loon Lake bog is of the kettle hole type while the one at Altona is of the river valley type, this may mean that the first had abundant water from its very beginning while the Altona bog was a river and by subsequent damming, either by animals, or physical forces, filled in to lake dimensions after a period during which about 7 or 8 feet of marl and peat had accumulated in the Loon Lake bog.

The record of successional changes from boreal to deciduous forest formations is, of course, the same in both bogs, only the time element is poorly correlated in the two depositions. The succession at Altona is Abies-Pinus (23-22), to Picea-Pinus-Quercus (22-21), to Quercus (20), to Quercus-Acer (19-14), to Quercus-Carya (13-1). At Loon Lake bog the succession was Abies-Picea (41-35), to Abies-Picea-Pinus (34), to Picea-Pinus (33), to Pinus-Quercus (32-31), to Quercus-Carya (30-1), with Acer as possible co-dominant at the 25-, 23-, and 4-foot levels.

SUMMARY

1. This study involves a pollen analysis of Loon Lake bog (Kosciusko county) and Altona bog (Dekalb county).
forest at both places
a very minor role at
Salix, Juglans and
In wildflower genera and per-
the lower tiers of Indiana bogs
higher percentage of
the spectrum of the
bottom and did not
a higher percentage of
That the apparent
large numbers of
the sudden decline of
third foot-level in
formation of the two
while the one at
that the first had
the Altona bog was
animals, or physical
period during which
in the Loon Lake
boreal to deciduous
bogs, only the time
The succession
Quercus (22-21),
Quercus-Carya
Abies-Picea (41-35),
possible co-domin-

2. Both bogs are located within the boundaries of the Steuben
Morainal Lake region (Late Wisconsin glaciation) and are separated
in an east-west direction by approximately 40 miles.
3. Loon Lake bog is of the kettle hole type; Altona bog is of
the valley type.
4. Both bogs recorded control by a boreal forest during the time
the lower levels of deposits accumulated.
5. The large phases of forest succession correlate well in both
bogs, but the time indicated for control by conifers was much shorter
in the Altona than Loon Lake bog.
6. This difference in time when conifers controlled the forest
in these areas is probably due to a later lake formation or to a slower
deposition of marl in the Altona valley area.
7. The upper two-thirds of both bogs were more or less comparable
in genera present and in their pollen percentages. The most
important dominants were Quercus and Carya.
8. In the Loon Lake area a period of Pinus dominance preceded
the Quercus-Carya-Acer period while this phase was absent in the
Altona area. This was probably due to soil differences.
9. Fagus apparently was not an important component of the for-
est in the areas concerned here.
10. The order of succession of the Altona bog was: Abies-
Pinus, Picea-Pinus-Quercus, Quercus, Quercus-Acer and Quercus-
Carya.
11. The order of succession of the Loon Lake bog was: Abies-
Picea, Abies-Picea-Pinus, Pinus-Quercus and Quercus-Carya.

ACKNOWLEDGEMENT

The writer expresses his sincere appreciation to Dr. J. E. Potzger
for suggestions and supervision of this research, and the critical
reading of the manuscript; to Dr. R. C. Friesner for the description
and collection records of both bogs; and to the members of the
Botany Department of Butler University for collecting the peat
samples.

LITERATURE CITED
1. Barkley, Fred A. The statistical theory of pollen analysis. Ecol. 15:283-
289, 1934.
2. Barnett, Jean. Pollen study of Cranberry pond, near Emporia, Madison

215


