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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.

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A FOSSIL POLLEN STUDY OF TWO NORTHERN INDIANA BOGS

By FRANK A. HAMP

Bogs are very common in the northern part of the United States and Canada and are found as far south as Florida and Louisiana. Indiana, however, is the southern limit of extensive bog formations and is doubly significant and interesting since it has within its borders the remains of limits of southern extensions of three glacial invasions whose depositions have "shingled" the state as three great overlapping topographic features showing bogs in all stages of formation, ranging from open lakes in the northern Late Wisconsin deposition to the complete or filled-in "dead bogs" whose chapter is closed, in the depositions of Early Wisconsin glaciations. The glaciers, particularly those of the Wisconsin glaciation, formed what is commonly termed the "kettle-hole" type of bog in Indiana, and it is in the northern tiers of counties where these bogs are most numerous.

Indiana holds an important position for the study of plant migration as Friesner (4) has so well pointed out, calling it a critical botanical area, for it marks within its boundaries the northern limits of southern species and the southern limits for northern species, thus showing the unusual opportunities offered to study plant migration since Pleistocene times.

The two bogs with which this study deals are: (1) Lakeville bog, located in the north half of section 3 (35 north, 2 east), Union Township, St. Joseph County, and (2) Round Lake bog, located in the east half of section 8 (32 north, 2 west), California Township, Starke County, Indiana. A list of the present-day plants growing in the vicinity of these two bogs may be had upon request to the Botany Department of Butler University.

METHODS

At both the Round Lake and Lakeville bogs several borings were made, but only the deepest ones at both bogs were analyzed as to pollen representation. The boring used at Round Lake was made in the boggy margin on the west side of the lake. It is recorded as boring "B" and had a depth of 32 feet. The boring at Lakeville bog is
on the records as boring "A." It was 30 feet in depth. It was near
the center of the bog which is north of the gravel road running west
from U. S. Road 31 at the railroad crossing on the southern edge of
the town of Lakeville 0.3 mile west of Road 31.

Samples of peat were taken at each foot-level. The borer was the
same one described previously by workers in the Butler laboratories.
Geisler's (5) method of separation of pollen from the peat again
proved satisfactory. Staining was with aqueous gentian violet. The
amount of stain required for good results varied with layers of marl
and peat. In some instances 8 drops had to be added to give suf­
cient stain to the pollen grains. A drop of the finely divided
material was placed on a slide and the alcohol was left to evaporate.
After it had dried, a coating of sirrillac* was made over the top of it.
Sirrillac does not fog even when 95% alcohol is still present; it
clears well and forms a hard, smooth cover which makes the slide
permanent without a cover glass. With a razor blade, the surface
was scratched in the form of a square cover glass. This aided the
investigator in recognizing the edges of the mount.

For all levels, except the lowest two in each bog, 200 pollen grains
were counted. In these lowest two levels only 100 grains were
counted because of the low frequency in the marl deposits.

*Sirrillac is a new mounting marketed by the Microtechnique Shop, Route 16, Box 698,
Indianapolis, Indiana.

OBSERVATIONS

Of the 32 feet of deposit in Round Lake bog, the 13-, 14-, 16-,
17-, 18-, 20-, 21-, and 22-foot levels were too unconsolidated to per­
mit the opening of the borer and cutting of samples. The lowest
two foot-levels were fairly compact marl and these were overlain by
three feet of marly ooze. In the Lakeville bog, samples were taken
at every level except the 21-foot level. This bog had only one foot
of marl and the total depth was 30 feet.

In the Lakeville bog the lowest two foot-levels showed a Picea-
Abies climax, Abies being present in 67% and 71% and Picea in
33% and 29% respectively (solid lines in figure 1). An abrupt
change occurred in the 28-foot level. Abies and Picea declined and
Pinus took over the control, while Quercus and Betula assumed some
importance and Tsuga made its appearance. Abies continued to de­
cline rapidly from 19% in the 28-foot level to 0.5% in the 27-foot
level; Picea declined to 9.5% in the 27-foot level but persisted in
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small percentages to the surface layer; and Pinus declined from the 26-foot to the 27-foot level, but it likewise persisted to the top layer, where it was still represented by 11.5%. Quercus gained prominence in the 27-foot level with 63.5% frequency, and Carya and Acer made their appearance. Quercus retained a uniform high percentage to the surface layer.

The Betulaceae were represented only about halfway up in this bog. Alnus was present up to the 15-foot level, Corylus to the 17-foot level, and Betula to the 13-foot level with 2 pollen grains present in the 8-foot level. The percentage frequencies were low for all three genera. Salix appeared in the 25-foot level, and continued to the top of the bog, reaching a maximum frequency of 8.5% in the 10- and 13-foot levels, and a minimum of 5% in the 22-foot level. Juglans pollen was deposited in the bog from the 24-foot level to the surface with percentages never exceeding 2 for any one level. Liquidambar was found only at the 23-foot level. Larix showed sparse representation. Small percentages of Ulmus were present from the 28-foot level to the 8-foot level with the exception of the 9- and 26-foot levels. Tilia was represented in all levels from the 23-foot level to the surface excepting 7, 8, 9, 15, and 20.

Boring B, Round Lake, presents a somewhat different spectrum. Here the lowest level had not only Abies and Picea, as in the Lakeville bog, but also Pinus and 2% Quercus. In the Abies-Picea climax, Abies had more than a three to one dominance over Picea in the lowest three levels. Pinus was represented by a 5% frequency in the 32-foot level, and continued to the surface of the bog never reaching more than a 6.5% frequency.

Quercus increased from 2% in the 32-foot level, to 11, 2, 16.5, and 59.5% in the 31-, 30-, 29-, and 28-foot levels, respectively, and continued to the surface with a marked high frequency. It was dominant over all other genera above the 28-foot level with percentages running as high as 77, in the 3-foot level, and 76.5 in the 9- and 12-foot levels.

Although Abies persisted only to the 25-foot level, Picea continued to the top of the bog, but was no longer a vital factor in the climax above the 29-foot level. The 29-foot level shows a definite climatic change, for here Larix, Acer, Betula, Carya, Juglans, and Salix made their appearance, though in very low percentages. Alnus was found in small percentages from the 28- to the 2-foot level, Betula to the 3-, and Corylus to the 10-foot levels, with all percent-ages for the entire fauna.

The dominance of these genera at the present levels agrees with findings at Round Lake, presented by McCulloch (7), who also found the same climatic change from a cold, moist climate except that Pinus did not control the lowest levels. Only one Larix, at the 25-foot level at Round Lake, contained a significant percentage of pollen, 6.5%. The other genera were found in all levels from the 23-foot level to the surface, with percentages never exceeding 2 for any one level. Liquidambar was found at the 23-foot level, and Quercus showed a uniform high percentage to the surface of the bog. Ulmus was represented by 2% in the 32-foot level, and continued to the surface with a marked high frequency. It was dominant over all other genera above the 28-foot level, with percentages running as high as 77, in the 3-foot level, and 76.5 in the 9- and 12-foot levels.

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IUUS declined from the 2-foot level to the surface. They remained prominent in Acer and Carya, which both continued to the top layer. The pollen frequency ran considerably higher than that for Acer. Ulmus was found in the 6-, 11-, 12-, 15-, 23-, 25-, and 26-foot levels, but never running higher than 1.5%. The pollen frequency of this genus was considerably lower here than in the Lakeville bog spectrum.

Figure I represents a graphic presentation of the pollen frequency percentages of the two bogs, the Lakeville bog being shown by the solid line and Round Lake bog by the stippled line.

**DISCUSSION**

**Lakeville Bog**

The dominance of these, Abies and Picea, in the lowermost two levels agrees with findings of Sears (14), Potzger (11), Voss (17), McCulloch (7), who worked in various North-Central states, and other investigators who worked peat deposits here in Indiana. Auer (1) found the same condition existing in peat bogs of southeastern Canada.

The loss of dominance by Abies and Picea and the appearance of such genera as Tsuga, Ulmus, Corylus, and Alnus indicate a definite change from a cold, moist climate to one that was somewhat warmer. The appearance of such new genera as Acer and Carya in the pollen spectrum at the 27-foot level, indicate that the climate continued to become warmer, and decrease of Acer in all levels from 16 indicates increasing dryness. Especially significant is the increase of Quercus from 19 to 63.5%, while Pinus, Ficea, and Abies declined strikingly to insignificance. While Pinus and Picea both continue to the surface of the bog, Quercus is the dominant to the top layer of the spectrum, with percentages as high as 70. Similarly high percentages of Quercus pollen were found by Potzger (10) in Winona Lake, Indiana deposits. Pinus reached its maximum frequency of 27.5% in the 26-foot level. In a way Pinus and Quercus represent similar climate except that Pinus indicates a more sandy soil. Apparently Pinus did not control very long anywhere in Indiana. Otto (8)
found Pinus the dominant genus in the 12-foot level of boring IV, Bacon's Swamp, Marion county, Indiana, while Smith (16) reported finding Pinus the dominant genus from the 26- to the 22-foot levels of Lake Cicott bog, Cass county, Indiana. Pinus was never dominant in other Indiana bogs so far studied (2, 6, 9, 12). In most sections of Indiana the soil adjacent to bogs was of the better clay type and so moderating climate gave Quercus a chance to displace Pinus. While Pinus is recorded in every bog, and is represented uniformly to the topmost layer, it is not consistent in its frequency. At some places it may control while one or several foot-levels were being deposited, while at others it may be represented in the spectrum only by low percentages. A similar correlation is shown between Lakeville bog, and the findings of Sears (15) in an Ohio bog in that there was a definite period when Pinus increased immediately following the disappearance of Abies and Picea, and preceding the rapid increase of Quercus and Carya.

**Round Lake Bog**

The lower layers of the Round Lake bog differed from those of the Lakeville bog in that Pinus and Quercus appeared in low percentages in the lowest level, but the climax association was again Picea-Abies. Abies pollen was represented with a frequency of 72% in comparison to 21% of Picea, or more than a 3:1 ratio. In this bog Pinus never reached more than 6.5% but was found in all levels, while Abies was not represented after the 25-foot level, with the initial decrease being between the 29- and 28-foot levels where a marked drop from 49% in the former level to 4% in the latter was recorded. This extreme decrease marks again a definite climatic change accompanied by a change from the coniferous to the broad-leaved forest, for in this 29-foot level Quercus increases to 16% and Acer, Betula, Carya, Juglans, and Salix enter in very low percentages. In this same level, also, the only Larix pollen grain was found. The low frequency is probably due to the fragile and delicate nature of the exine prohibiting a high or normal preservation percentage. In the 28-foot level two other members of the Betulaceae appeared, viz. Corylus and Alnus, and all other genera increased in percentage excepting the genera which had constituted the climax, i.e. Abies and Picea which continued to decrease. Quercus again shows a marked increase, reaching 59.5% and remained high in percentage of pollen present and the dominant genus throughout the remainder of the bog, in this bog. While Carya and Quercus pollen were present in the lowest levels, Borys (12) noted that after the migration of Pinus to the bottom of the bog, one would expect it to be present in the lowest levels, appearing at highest percentages of the pollen. Sears (15) found that after the migration of Pinus to the bottom of the bog, one would expect it to be present in the lowest levels, appearing at highest percentages of the pollen. Sears (15) found that after the migration of Pinus to the bottom of the bog, one would expect it to be present in the lowest levels, appearing at highest percentages of the pollen.
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bog, in this way being comparable to Quercus in the Lakeville
bog. While carya came in at the 29-foot level it did not show
important percentages until the upper third of the bog, and there could
possibly have constituted with Quercus a weak Quercus-carya cli-
max. Tilia was found only in the 23-foot level, and Ulmus and
Tsuga were present in extremely low frequencies in several
foot-levels.

**Comparison of the Two Bogs**

While both bogs exhibited a Picea-Abies forest climax in the
lowest levels, Round Lake bog showed pollen of Pinus and Quercus
in the lowermost level. Since this bog had several feet of marl in
the bottom as compared to only slightly over one foot in the Lakeville
bog, one would hardly be justified to assume Round Lake bog was
not bored deeply enough to show the disappearance of Pinus and
Quercus. Smith (16), Barnett (2), Otto (8), Howell (6), Richards
(12), McCulloch (7), and other investigators found Pinus pollen in
lowest levels, while Prettyman (9), and Sears (14) found this genus
appearing at higher levels. This may be explained in part by assum-
ing that after the last glaciation there was a differential northward
migration of plants, the migration occurring more rapidly in some
localities depending on controlling edaphic and physiographic factors.
The earliest period immediately following glaciation was much colder,
and deposition within the open lake stage of the bog was slow due
to the absence of plants characteristic of our bogs today. These
lowermost marl or Picea-Abies levels represent many more years
deposition than those of higher levels.

Both Round Lake, and Lakeville bogs show the incoming of the
deciduous genera at approximately the same levels. This is definite
evidence of the aforementioned change in climate, a change from a
cold moist to a warmer and somewhat drier climate. While a Quer-
cus-carya climax was dominant throughout the greater part of the
bogs above the Picea-Abies climax, such sub-dominant genera as
Salix, Juglans, Acer, and Picea, which were found in every foot-level
after making their appearances in the lower levels, show the type of
forest indicative of temperatures and forests approaching ours of
today.

In Lakeville bog Tilia was found in 16 levels while at Round
Lake bog only two pollen grains were found. Perhaps the edaphic
factors in the neighborhood of Round Lake were not suitable for
growth of Tilia, and some pollen grains were blown from some ad-
joining or nearby suitable habitat area, thus giving a low percentage
frequency. Ulmus pollen was also found in lesser amounts in Round
Lake, showing again the probability of difference in edaphic or other
factors. In both bogs Larix was sparsely represented, but this may
be attributed to the poor preservation qualities of this pollen.

SUMMARY
1. The paper deals with pollen analyses of Lakeville and Round
Lake bogs in deposits of Late Wisconsin glaciation in Indiana.
2. Both bogs have about the same successional record.
3. Succession in the Lakeville bog was: Abies-Picea (29-30);
Abies-Pinus-Quercus (28); Quercus-Carya (26-17); Quercus-
Carya-Acer (16); Quercus-Carya (15-1).
4. Succession in the Round Lake bog was: Abies-Picea
(32-30); Abies-Picea-Quercus (29); Quercus (28); Quercus-Carya
(27); Quercus-Carya-Acer (26-23); Quercus-Carya (19-1).
5. Significant climatic changes from cool-moist to warm-dry
are indicated by a striking decrease in Abies and Picea and appear-
ance of numerous deciduous genera.
6. The Lakeville bog showed a brief Pinus dominance in the
28-foot level.
7. Picea and Pinus persisted to the top foot-level in both bogs.
8. From the 27-foot level in the Round Lake bog and 26-foot
level in the Lakeville bog, the forest dominance was essentially Quer-
cus-Carya with a weaker co-dominance of Acer indicated in several
levels.
9. Quercus is by far the most important genus in both bogs.
10. Tsuga appeared at some levels in very low percentages in
both bogs.

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