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A RADIOCARBON-DATED POLLEN PROFILE FROM SUNBEAM PRAIRIE BOG, DARKE COUNTY, OHIO

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ABSTRACT. A pollen diagram is presented from Sunbeam Prairie bog in Darke County, west central Ohio. The bog formed since the Tazewell stade of the Wisconsin glaciation and is at the outer margin of the Bloomington moraine in a broad meltwater valley. The pollen sequence is dominated by spruce, except in the youngest sediments, and is similar to several previously described pollen diagrams from Indiana bogs. Radiocarbon dates are reported from spruce wood found at 39 inches (L550C, 11,700 ± 250 B.P.) and from peat (14 to 16 inches) deposited during the transition from spruce forest to hardwoods (L550B, 10,600 ± 200 B.P.). Another date from shells in the sandy marl at 85 to 90 inches (L550A, 8600 ± 500 B.P.) is anomalous; the young age indicates probable ground water contamination.

The radiocarbon dates enable us to identify the Two Creeks interstadial interval in the pollen diagram. The interstadial is characterized by a decline in *Pinus* pollen and the appearance of certain hardwoods. Near the end of the interstadial *Picea* percentages decline sharply, and hardwoods, especially *Quercus* and *Carya*, become prominent. There is little evidence of the climatic cooling of Valders time except for a minor increase in *Pinus*. Comparison of this dated pollen record with other published pollen sequences tends to substantiate Frey's postulation concerning the nature of the Two Creeks interval in Indiana and Ohio pollen records.

INTRODUCTION

Numerous pollen diagrams have been described from Indiana and adjacent states. In some recent analyses attempts have been made to identify the Two Creeks interval (Frey, 1959; Engelhardt, 1960). The time-stratigraphic relationships of most Indiana and Ohio pollen profiles have not been demonstrated by radiocarbon dating, however.

This paper adds another postglacial pollen diagram to the several previously reported for this region. Radiocarbon dates on peat, wood, and shells from Sunbeam Prairie bog, 7½ miles northeast of Richmond, Indiana, enable us to correlate certain vegetational changes with the Two Creeks interval. Comparisons of the Sunbeam Prairie pollen diagram with those from nearby Randolph County, Indiana (Friesner and Potzger, 1946; Griffin, 1950) reveal that there may be considerable differences among pollen profiles from bogs in the same vicinity.

The work reported here is part of an extensive study of the Pleistocene geology and ecology in the Whitewater drainage basin, southeastern Indiana. Gooding (1957, 1963) has described the Pleistocene terraces and Illinoian and Wisconsin stratigraphy in the Whitewater basin. Previously, the authors have described pollen records from Pleistocene interglacial and interstadial sediments in southeastern Indiana (Kapp and Gooding, in press).

ACKNOWLEDGMENTS

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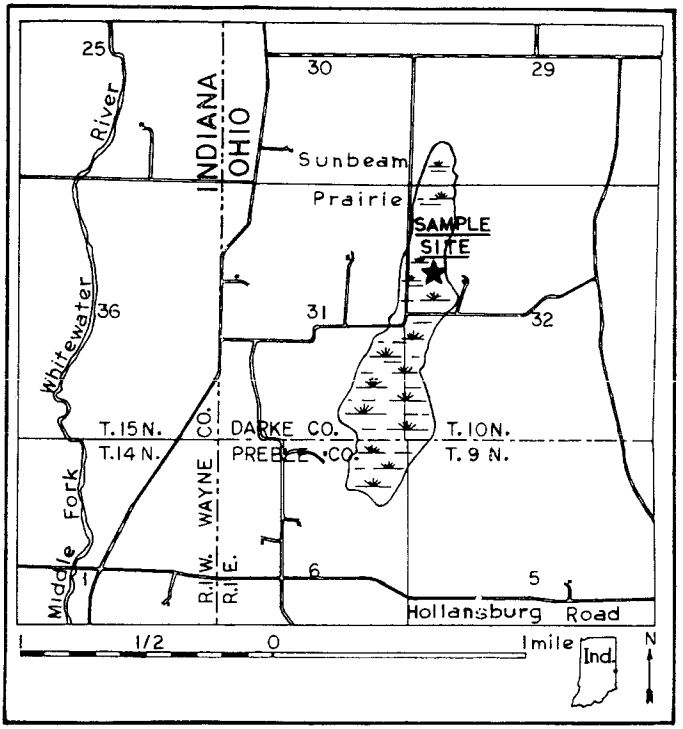

Fig. 1. Location map showing Sunbeam Prairie sample site in SE¼ SW¼ NW¼ sec. 32, T. 10 N., R. 1 E., Darke County, Ohio.

radiocarbon analyses. The aid of Professor David G. Frey of Indiana University, who read and criticized the manuscript, is gratefully acknowledged.

GEOLOGIC SETTING

The Sunbeam Prairie sample site is near the center of the NW cor., SE¼ SW¼ NW¼ sec. 32, T. 10 N., R. 1 E. in southwestern Darke County, Ohio, 7½ miles northeast of Richmond, Indiana (fig. 1). The Sunbeam Prairie bog occurs at the outer margin of the late Tazewell Bloomington moraine in a poorly drained area at the head of a broad channel cut by Bloomington meltwater (Gooding, 1957). The meltwater channel was abandoned after Bloomington ice melted back a short distance, and bog formation probably began at this time. The beginning of the Sunbeam Prairie pollen record therefore probably dates from late Tazewell time.

METHODS

Samples for pollen analysis were collected in the summer of 1957 by means of a Livingstone sampler. The sediments were peaty to a depth of 27 inches with shell marl extending down to 80 inches. Samples for pollen analysis were taken at one to six inch intervals below a depth of ten inches. The site was revisited in 1959 when samples were taken for radiocarbon dating as well as for additional pollen analysis. A pit was dug for the second sampling so that

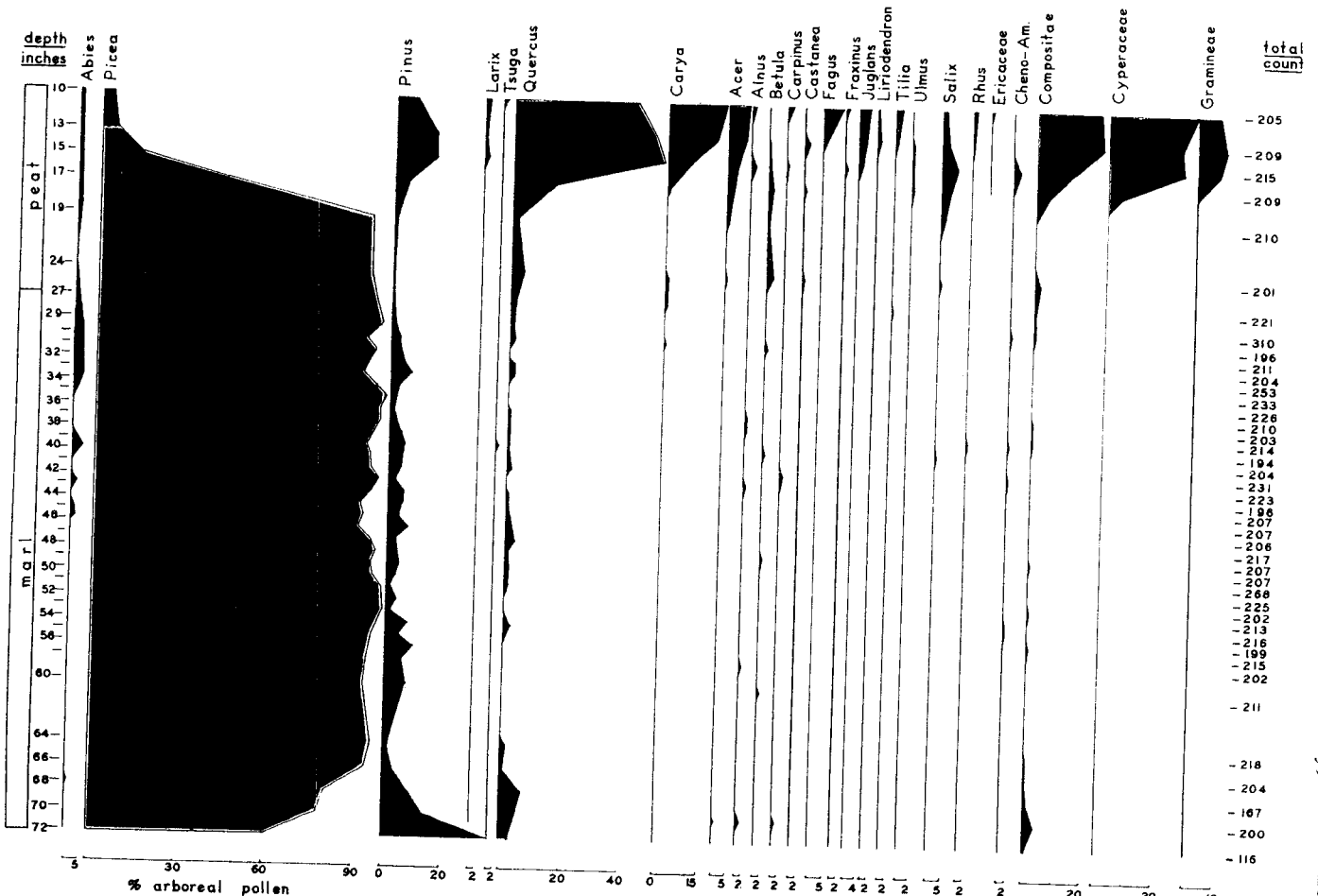

Fig. 2. Pollen profile from Sunbeam Prairie bog (collection made in 1957). Pollen of aquatic vascular plants, ferns, and undetermined types are not plotted here but are shown in table 1.

large samples of peat for radiocarbon dating could be retrieved. In a boring taken in July, 1959, peat extended to 20 inches and marl to a depth of 50 inches. Samples of sandy marl were taken at a depth of 85 to 90 inches from a deeper part of the basin in an attempt to recover a sample for radiocarbon analysis that would date the abandonment of the channel by Bloomington meltwater and the beginning of deposition at the site.

Chemical processing of the samples for pollen analysis included boiling of peaty material in KOH and treating calcareous samples with HCl. The standard acetolysis procedure was followed, and the samples were mounted in glycerin jelly for microscopic examination.

Slides were examined with a Leitz binocular microscope at magnifications of 450 and 1000 diameters. The pollen and spores which were encountered in the systematic traverses of the slides were recorded until about 200 grains had been tabulated.

Pollen spectra from sediments at each stratigraphic level were calculated as percentages of the total tree pollen (total AP). This method of calculating pollen percentages permits direct comparison with previously published palynological investigations from this region.

RESULTS

Pollen analysis.—The pollen diagram from Sunbeam Prairie bog (sediments collected in 1957) is presented in figure 2. High percentages of *Picea* (spruce), with varying percentages of *Pinus* (pine), characterize most of the pollen record. Hardwoods are almost completely absent during the Picea period, and non-tree pollen (NAP) is not abundant in these deeper sediments.

The sparseness of pollen in the deepest sediments and the lower spruce percentages near the bottom of the pollen profile may indicate that forests were just becoming established near the site when the lake marl started to accumulate. High percentages of NAP, which are expected in recently deglaciated sites, are not encountered in the deepest sediments sampled at Sunbeam Prairie bog.

Abies (fir) is present in very low percentages throughout the record while *Larix* (tamarack) and *Tsuga* (hemlock) do not appear until the hardwood period near the top of the profile. Low percentages of *Alnus* (alder), *Betula* (birch), and *Quercus* (oak) are found throughout the *Picea* period.

Interestingly, very high percentages (72 percent) of one type of pollen grain, assigned to the Umbelliferae, were recovered at the 47 inch depth. Apparently the extreme abundance of this pollen type at only one level is due to the presence of an inflorescence or anthers in the sediments at this location.

Near the end of the *Picea* period, between 17 inches and 30 inches, there apparently was a significant change in the ecological conditions. A decline in *Pinus* is noted in this interval as well as minor increases in *Quercus* and *Betula*. Certain hardwood trees such as *Carya* (hickory), *Acer* (maple), *Castanea* (chestnut), and *Tilia* (basswood) appear for the first time at this level in the pollen record.

Above the 19 inch level the percentage of *Picea* drops off quickly and *Pinus*, *Larix*, *Quercus*, *Carya*, and other hardwood trees increase significantly.

Pollen of herbaceous plants becomes very abundant near the top of the profile; dominant are sedges (Cyperaceae), grasses (Gramineae), ferns (several types), and members of the aster family (Compositae). The great abundance of grass, sedge, and composite pollen may indicate that a prairie-like area developed at the site. The local name of the area, "Sunbeam Prairie", may indicate that such a prairie opening existed here at the time of settlement.

Pollen of aquatic plants in the Nympheaceae and Alismataceae in the top sample indicates that there was still open water in the basin near the end of the period of peat deposition. A table of pollen of the aquatics, ferns, and undetermined types is presented below.

TABLE 1

Pollen of aquatic plants, ferns, and undetermined sporomorphs from Sunbeam Prairie bog, to accompany figure 2 (expressed as percent of total tree pollen)

Depth inches	Sediment	Aquatics			Ferns	Undetermined
		Nymphaeac.	*Sagittaria*	*Typha*		
10		9.3%	3.0%	0.5%	11.0%	10.0%
13	peat	1.5	1.0	0.5	12.0	3.3
15		—	0.5	—	11.5	3.3
17		—	0.7	0.4	1.4	1.0
19		—	—	—	0.5	—
24		—	—	—	8.4	0.5
27		—	—	—	2.3	—
29		—	—	—	—	0.3
31		—	—	—	1.0	—
38		—	—	—	0.5	—
41		—	—	—	0.4	—
43		—	—	—	—	0.5
44	marl	—	—	—	—	0.5
45		—	—	—	—	0.9
47		(Umbelliferae — 71.5%)			0.9	—
48		—	—	—	1.5	—
60		—	—	—	—	1.0
66		—	—	—	—	0.5
68		0.6	—	—	—	2.5
70		0.5	—	—	1.0	2.0
72		—	—	—	—	0.9

A radiocarbon-dated pollen diagram from sediments taken in 1959 is shown in figure 3. This pollen diagram was prepared to facilitate correlation of the radiocarbon dates with the more complete pollen record (fig. 2). The two pollen diagrams are very similar; figure 3 shows dominance of *Picea* at the bottom followed by a decline above 21 inches. The decline in pine, which was noted above (fig. 2), is found again between 15 and 39 inches. *Quercus, Carya, Tilia, Fraxinus* (ash), *Juglans* (walnut), *Ulmus* (elm), and other hardwoods increase at 15 inches and above; this hardwood period again is accompanied by a striking increase in non-tree pollen (NAP). At the 12 inch level (fig. 3) a great over-abundance of ferns and *Sphagnum* (peat moss) spores was observed (200 percent and 370 percent of total AP, respectively).

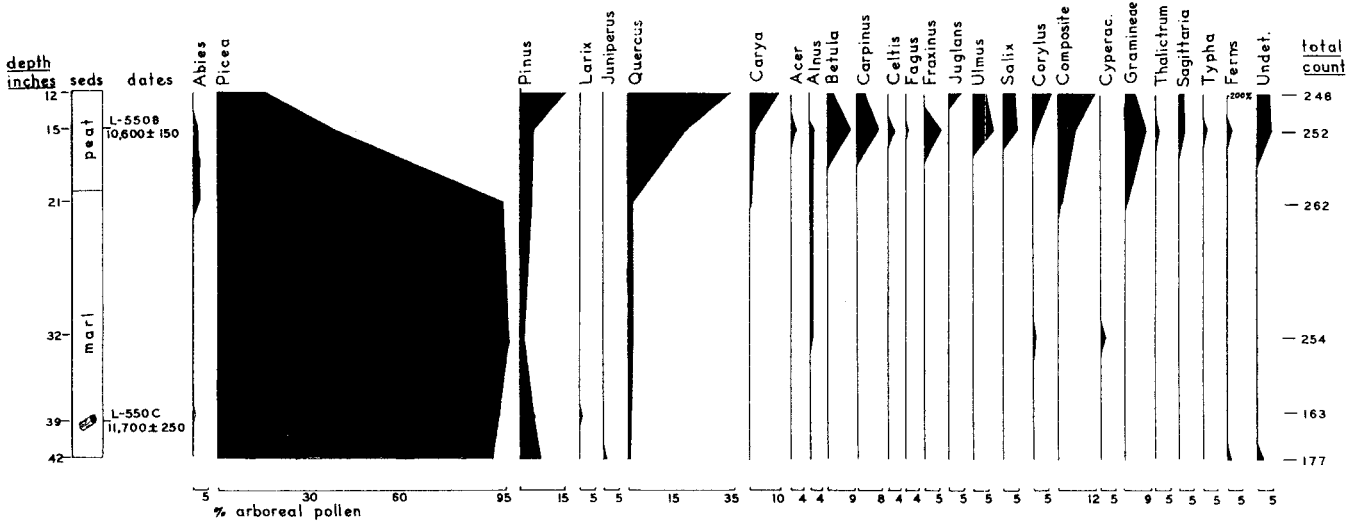

Fig. 3. Radiocarbon-dated pollen profile from sediments at the 12 to 42 inch levels at Sunbeam Prairie bog (collection made in 1959). *Sphagnum* spores were abundant (370 percent) at the 12 inch level but are not plotted in this figure.

Remains of *Pediastram* and *Botryococcus* were never observed in the analysis, and pollen of submergent aquatic plants was almost entirely absent.

The similarity of the two profiles (fig. 2 and fig. 3) enables us to correlate the pollen sequences and the radiocarbon dates.

Radiocarbon dating.—Three samples collected in 1959 were radiocarbon dated by the Lamont Geological Observatory. Peat at 14 to 16 inches, formed from the remains of grasses, sedges, peat moss, and emergent aquatics, has yielded a radiocarbon date of 10,600 ± 150 years B.P. (L550B). Humic acid isolated from the same sample gave an age of 9900 ± 200 years B.P. (Olson and Broecker, 1961, p. 143). Wood collected at 39 to 40 inches has been dated at 11,700 ± 250 years B.P. (L550C). These two dates are especially significant because they bracket the Two Creeks interval which has an average date of 11,400 years B.P. (Thwaites and Bertrand, 1957; Frye and Willman, 1960).

A sample of basal marl sediments augered from a depth of 81 to 85 inches has yielded an anomalous date of 8600 ± 500 years B.P. (L550A; Olson and Broecker, 1961, p. 143). It was hoped that we could obtain a date which would give the maximum age of the sediments and possibly establish the approximate age of the Bloomington ice stand in the area. According to Olson and Broecker (1961, p. 143), the young age from the basal marl "indicates ground water contamination, not an unexpected situation in view of water seepage encountered in digging of bog pit". This date is inaccurate and of no value in the interpretation of the age of this deposit.

DISCUSSION

In general outline the pollen profile from Sunbeam Prairie bog is similar to several published earlier by Potzger and his co-workers and recently by Engelhardt (1960). Most of the pollen record is characterized by a high percentage of *Picea* and low percentages of *Pinus*, *Abies*, and *Quercus*. The possible significance of a high percentage of *Pinus* at the beginning of the record (fig. 2) is not known.

Near the end of the Picea period there was a significant decline in the amount of *Pinus* pollen. During this phase there was a minor, but possibly significant, increase in hardwood pollen. Certain trees, such as *Acer*, *Carya*, *Castanea*, and *Tilia*, appear for the first time in the record. At the 24 inch level *Quercus* and *Betula* become slightly more prominent. The radiocarbon dates indicate that this period of declining *Pinus* and increasing hardwoods is the Two Creeks interval. The persistance of high percentages of *Picea* throughout most of this period indicates that spruce trees remained locally abundant in the region of Sunbeam Prairie bog during Two Creeks interstadial time. Leopold (1958) discussed the importance of spruce in interpretations of late-glacial climate. She summarizes the pollen content of sediments thought to be of the Two Creeks interstadial. Such sediments from the Two Creeks site in Wisconsin and from sites in southern Michigan contain from 75 to 95 percent *Picea* pollen. At Sunbeam Prairie bog, located 150 miles south of the Michigan sites, *Picea* accounts for more than 90 percent of the tree pollen during Two Creeks time.

Frey (1959) has discussed the vegetational changes during the Two Creeks interval in Indiana pollen diagrams. At Myers Lake in northern Indiana (Marshall County) he reports a decline in *Picea* during the Two Creeks interval followed by a strong peak during the subsequent Valders glacial readvance. Frey states that "any pronounced notch in the coniferous curves in late-glacial time may indicate the Two Creeks Interval" (Frey, 1959, p. 138). Furthermore, he suggests that *Quercus, Betula, Populus* (poplar), and *Salix* (willow) could be expected to increase, and NAP to decrease, during Two Creeks time.

The abundance of *Picea* in the Two Creeks segment of late-glacial pollen profiles seems to be quite variable. *Picea* is nearly absent at Myers Lake in north-central Indiana and at Fox Prairie Bog and Bacon's Swamp in central Indiana (Engelhardt, 1960). In contrast, at Tippecanoe Lake, Kosciusko County, northeastern Indiana (Potzger and Wilson, 1941) *Picea* is prominent during the interstadial, declining only near the end. Deevey (1953) first recognized the vegetational evidence of the Two Creeks interval in the Tippecanoe Lake profile.

Two pollen profiles are available from Randolph County, Indiana, located within 25 miles of the Sunbeam Prairie bog. One of these profiles, from Reed Bog (Griffin, 1950), shows a decline in both *Picea* and *Pinus* during Two Creeks, accompanied by increases in *Quercus, Carya, Salix,* and *Ulmus*. Nearby Cabin Creek Bog (Friesner and Potzger, 1946) provides a pollen record quite similar to that of Sunbeam Prairie. *Picea* was strongly predominant throughout the Two Creeks interval, although a minor decline in *Pinus* is noted near the end of the spruce period. At the end of the Two Creeks interstadial *Picea* declines abruptly, as it does in the Sunbeam Prairie profile.

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DISCUSSIONS

REVISION: SUNBEAM PRAIRIE POLLEN PROFILE

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In a recent paper we presented a pollen diagram (p. 264) from sediments from Sunbeam Prairie bog in Darke County, Ohio (Kapp and Gooding, Am. Jour. Sci., 1964, v. 262, p. 259-266). Radiocarbon dates on wood and peat from the sedimentary core included one date (L550C) of 11,700 ± 250 and another (L550B) of 10,600 ± 150 B.P. Accepting the average date of 11,400 on wood from the Two Creeks forest bed (Thwaites and Bertrand, 1957), certain features of the pollen diagram were interpreted to reflect the climatic changes of the Two Creeks interstadial. Since preparation of this paper a new and more precise average C^{14} date has been published. Broecker and Farrand (1963) established that the radiocarbon age based on lignin and cellulose of the Two Creeks forest is 11,850 ± 100 years B.P. Thus, the climatic cooling which marked the end of the Two Creeks interstadial occurred prior to 11,850; the Valders ice passed over the Two Creeks site at least 450 years earlier than previously assumed.

The newly-established Two Creeks date materially affects the interpretations of the Sunbeam Prairie bog pollen diagram. A segment of the diagram which had been presumed to date from the Two Creeks interstadial is clearly from the Valders stadial. The rather minor decline in *Pinus* and smaller increases in hardwoods that seemed to suggest correlation with the climatic amelioration of Two Creeks now are clearly not from that interstadial period.

Two interpretations emerge as possibilities: (1) The entire period of high *Picea* percentages which dominate the pollen diagrams may date from the Valders stade with only the end of the Two Creeks interstadial represented at the bottom of figure 2 (p. 261). If this is true, *Picea* pollen was less prominent in the interstadial and *Pinus* and *Quercus* more abundant. The pollen record would then begin near the end of the Two Creeks interval, and the pollen sequence would be rather like the Two Creeks-Valders section from pollen diagrams from Myers Lake in northern Indiana (Frey, 1959). This interpretation raises the serious problem of explaining why deposition began so late in this basin. The bog lies on the Bloomington moraine which dates from late Tazewell time, and deposition was expected to have begun earlier in late glacial time than this interpretation allows. Further borings at the site might reveal the nature and age of deposits beneath the marl. (2) A second interpretation of the pollen diagram would assume that marl deposition began soon after the formation of the sedimentary basin in late Tazewell time. Early marl deposition would have been much slower than later deposition (19 inches of marl and 6 inches of peat in 1100 C^{14}

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years). If, indeed, the pollen diagram does represent a period substantially longer than the end of the late glacial and earliest postglacial time (as suggested in the second interpretation), then the minor fluctuations of the pollen diagram do not permit obvious interpretation or correlation with late glacial events. The vegetational changes in southeastern Indiana must then not have been strongly influenced by climatic changes presumed to control movements of the glacial lobes in the upper Great Lakes region.

Other detailed pollen analyses with C^{14} dates are needed from this region to resolve the questions raised by this re-interpretation.

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