PLEISTOCENE MOLLUSCA OF THE SUNBEAM PRAIRIE LACUSTRINE DEPOSIT, DARKE CO., OHIO[1]

MARK J. CAMP,[2] Department of Geology, University of Toledo, Toledo, OH 43606
ANNE L. GINDER,[2] U.S. Geological Survey, Woods Hole, MA 02543

Abstract. A study of the molluscan fauna of the Sunbeam Prairie lacustrine deposit of Darke County, OH combined with palynologic data from an earlier study provide an interpretation of the Late Wisconsinan history. Early Sunbeam Prairie Lake had a molluscan fauna dominated by *Gyraulus parvus* and *Valvata lewisi*. *Valvata tricarinata, Fossaria obrussa, Gyraulus parvus,* and *Pisidium casertanum* were dominant members of the diverse molluscan assemblage that existed during marl deposition, suggesting changing littoral conditions. The appearance of amnicolids and scattered terrestrial gastropods in the upper part of the marl section indicates a shallowing of water and an increase in aquatic vegetation. The latest stage of Sunbeam Prairie Lake was characterized by gradual infilling with humic sediments, reduction of the aquatic molluscan fauna, and an increase in the terrestrial gastropod fauna. A comparison of our molluscan data to earlier pollen data for the deposit provides inconclusive support for the recognition of the Two Creeks interval in pollen diagrams of central Indiana and Ohio.

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The glaciated terrain of Ohio, Indiana, and Michigan exhibits numerous lakes that formed during and after the final Wisconsinan ice recessions. Many lakes, especially those located at the southernmost reaches of the ice sheets, have since filled in with sediment and organic debris; some have been completely drained by either natural or manmade outlets; some are now marshes. Sunbeam Prairie is such an area, a former postglacial lake that gradually drained to become a marsh which was converted to rich farmland.

A study of the fauna and flora of a postglacial lake offers an indication of the postglacial history of the region surrounding the lake. Gooding (1957, 1963) conducted stratigraphic studies of Pleistocene sediments in the Whitewater Basin of east central Indiana and west central Ohio, which includes the Sunbeam Prairie area. The initial study of Sunbeam Prairie involved a stratigraphic and palynologic study by Kapp and Gooding (1964a, b). This work established two radiocarbon dates for the succession of sediments. A study of the Pleistocene gastropods by an Earlham College student, Judith Gennett (1971) provided preliminary information on the molluscan fauna and Shane (1976) conducted a palynologic study of a lacustrine deposit at the Carter site, just north of the Union City moraine in northern Darke County, OH.

LOCATION AND GEOLOGIC SETTING

The Sunbeam Prairie lacustrine deposit is located in the SE ¼, SW ¼, NW ¼, sec. 32, T 10 N, R1E in southwestern Darke County, OH, four miles north of New Paris, OH. The samples were taken from a pit excavated along a drainage ditch on the east side of a township road, 0.6 miles south of the intersection with New Garden Road (fig. 1).

The Sunbeam Prairie deposit occurs at the outer edge of the Farmersville moraine of Late Tazewell age in a wide meltwater channel cut by Farmersville (Bloomington) meltwater (Kapp and Gooding 1964a). The Tazewell-Cary boundary has been placed at the outer edge of the Union City moraine to the north of Sunbeam Prairie (Zumberge

[1]Manuscript received March 31, 1977 (#77-33).
[2]Formerly Department of Geology, Earlham College, Richmond, IN 47374.

1960, Wayne and Zumberge 1965, Wayne 1968, Gooding 1963). As the ice sheet retreated from the Farmersville moraine, the channelway was probably abandoned and a lake formed. Kapp and Gooding (1964a) indicated that their pollen record probably begins in Late Tazewell. We feel that our molluscan record also begins at this horizon.

METHODS AND MATERIALS

Since most of the surficial layers of the Sunbeam Prairie deposit are under cultivation, the site had to be chosen carefully to avoid a disturbed section. The extent of the deposit can be readily traced in the spring as the organic-rich sediment stands out in sharp contrast to the sandy clay soil of the surrounding area. The section was taken at the margin of the deposit in order to obtain a more representative molluscan fauna. Changes in abundance of mollusks in vertical section were more pronounced in this part of a lake basin, because fluctuations of water level of several centimeters disrupt shallow littoral communities.

A pit was dug and a 30 square centimeter column of sediment was removed. Samples were taken every 5 cm to a depth of 1.8 m where high water inflow terminated the sampling. Information obtained from Gennett (1971) can be used to extend the section deeper, although her 0.6 m sampling interval is large.

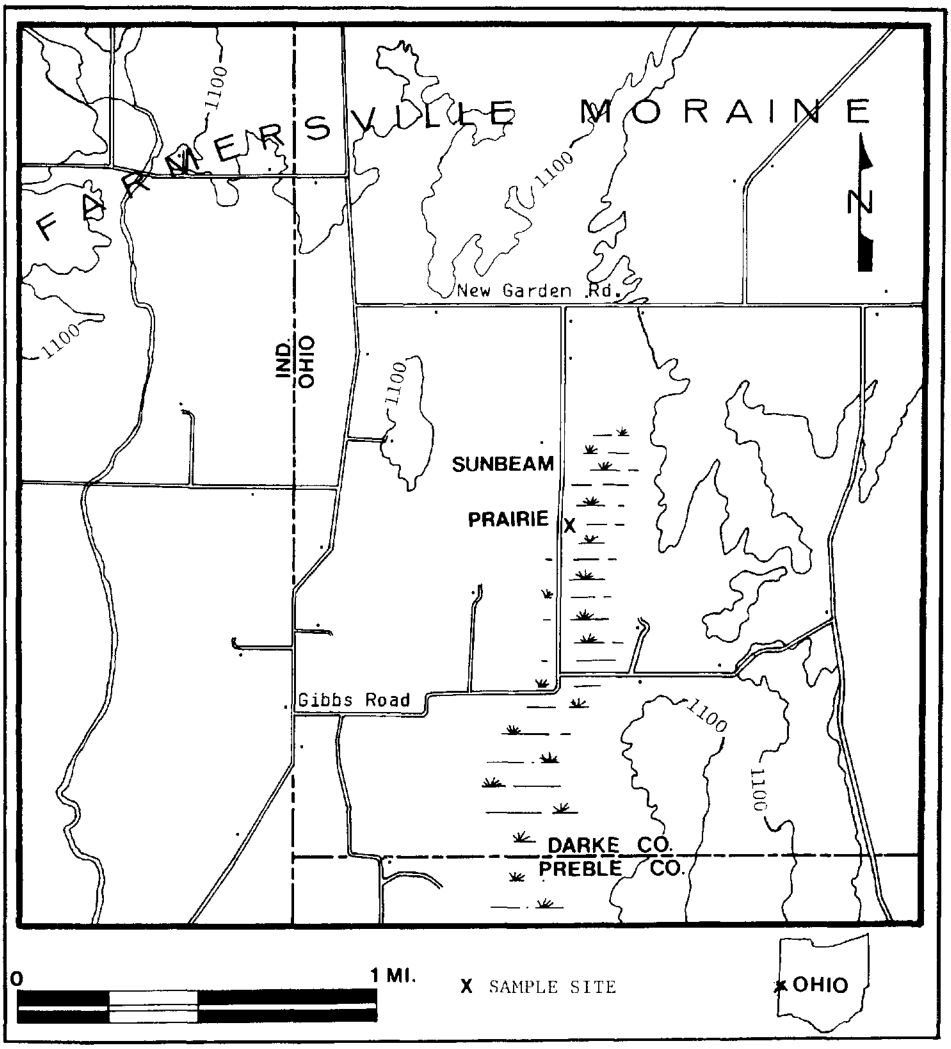

FIGURE 1. Location map showing Sunbeam Prairie sample site, Darke County, Ohio.

Gennett took samples to a depth of 3.9 m, along the same ditch shortly after it had been dredged.

Samples were treated in dispersant and washed through 10, 20, and 40 mesh sieves to remove the fossil material. One thousand shells were picked from each sample after it had been reduced to a fraction containing nearly 1000 shells by repeated halving. The resulting data were used to calculate percentage abundance for each species found in a collection (table 1). The relative abundance of mollusks in each original sample was estimated from the volume of sediment picked to obtain 1000 shells. This permitted a comparison of the abundance of species within one sample and of the changes in abundance of a species from collection to collection in the stratigraphic section.

STRATIGRAPHY

Unit	Description	Depth (cm)
1	humus, compact, noncalcareous, brownish-black (no collections)	0–61
2	marl, fine, gray, fossiliferous, increase in algal strands between 101 and 106 cm, wood fragments at 106 cm (collections 1–24)	61–181
From Gennett (1971)		
2 Lower	marl, fine, gray, fossiliferous, sandy in lowermost collections	181–310
3	sand and gravel, gray, fossiliferous	310–390

MOLLUSCAN PALEOECOLOGY

Indigenous species are those species that lived in the environment where the sediment in which they are preserved was deposited. They are found throughout a sedimentary unit representing that environment, often in large numbers. Intruders are defined as species that were foreign to the area where they are preserved. They are often scattered throughout the section and are usually less abundant than the indigenous species. Lacustrine deposits are typically thanatocoenoses, that is, mixtures of both indigenous species and intruders that have been deposited together after death. The abundance of a species at any time is partly a result of the availability of its specific ecologic requirements and the effective population of its competitors and predators, but the abundance of a fossil species may be biased by hydrodynamic sorting of waves, currents, selective leaching, and abrasion.

Twenty-nine species of mollusks were identified from the marl of Unit 2, and sand-gravel of Unit 3 including 5 ctenobranchs, 9 aquatic pulmonates, 11 terrestrial pulmonates, and 4 sphaeriids. *Fossaria obrussa*, *Gyraulus parvus*, and *Pisidium casertanum* were abundant throughout the section and are considered significant indigenous species. *Valvata tricarinata* occurred in all the collections, but was most abundant in collections 1–14. It was considered a significant indigenous species in collections 1–20. *Amnicola limosa* and *A. lustrica* were considered indigenous species in collections 1–9, but were never obtained in great abundance. *Valvata lewisi* and *V. sincera* were characteristic of collections 15–24 and were considered significant indigenous species for this part of the section. *Helisoma anceps* occurred at scattered intervals throughout the section, but was considered indigenous only for collections 1–10. It was commonly a significant member of the assemblage because of its large shell size. *Helisoma campanulatum* was found scattered throughout the upper thirteen collections and although it was not as common as *H.* anceps, was probably still indigenous (Camp 1973, 1974). *H. campanulatum* was considered significant because of shell size in collections 5, 8, and 10. *Sphaerium rhomboideum* and *Triodopsis albolabris* were considered significant intruders because of large shell size. *Armiger crista*, *Physa gyrina*, *Promenetus exacuous*, *Pisidium compressum*, and *Sphaerium occidentale* were considered indigenous species because of their common association with the aforementioned significant indigenous species. All terrestrial pulmonates were classed as intruders.

HISTORY OF SUNBEAM PRAIRIE LAKE

UNIT 3

Gennett (1971) described a lower horizon of sand and gravel in her 3.9 m section. This unit was sampled by bulk sampling techniques because of water inflow, and the molluscan data were of limited use in paleontologic analysis. It showed that the original substratum of Sunbeam Prairie Lake was reworked glacial outwash, probably forming a

TABLE 1

Percentage abundance of Pleistocene molluscan species in Sunbeam Prairie lacustrine deposit (Unit 2).

	Collection Number																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
A. limosa	2.2	2.3	3.0	1.0	2.9	3.9	2.9	3.8	4.1	0.8	0.3	1.1	0.6	0.2	0.1	0.2	—	—	—	0.1	—	—	—	—
A. lustrica	4.8	3.1	3.5	5.3	3.4	2.9	1.6	1.9	2.7	0.9	1.1	0.4	0.1	—	0.2	0.4	—	0.1	—	—	—	0.2	0.4	0.7
V. lewisi	—*	—	0.1	0.8	0.9	0.8	0.8	0.4	1.3	1.3	1.7	1.8	0.8	1.4	3.1	3.0	2.4	3.9	2.9	3.8	6.1	6.2	5.4	3.9
V. sincera	—	—	0.3	1.2	1.0	0.7	0.7	1.0	1.7	2.1	1.1	1.2	1.2	1.2	2.0	1.8	1.1	3.3	2.2	7.0	9.3	7.4	8.9	7.4
V. tricarinata	20.4	8.9	12.2	20.5	20.5	14.1	14.2	18.7	16.5	19.9	10.5	10.1	7.7	10.3	7.2	7.2	4.2	5.1	4.3	5.4	3.2	1.7	2.1	3.5
A. crista	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
F. obrussa	8.8	4.6	4.9	9.5	10.2	11.9	7.9	8.0	8.7	16.1	8.7	9.7	9.0	9.6	9.3	8.2	11.6	20.4	24.4	31.8	27.9	31.6	29.4	26.7
G. parvus	28.3	14.9	24.4	24.6	21.5	20.2	21.6	22.8	24.3	29.8	30.7	30.0	27.2	31.4	34.1	34.3	19.1	21.5	23.2	26.5	32.3	25.6	26.9	27.2
H. anceps	2.1	0.8	0.6	1.1	1.8	1.7	1.6	1.6	2.1	1.6	0.6	0.8	0.5	—	—	—	0.4	0.1	—	—	—	0.1	0.2	0.3
H. campanulatum	0.1	—	—	—	0.2	0.1	0.8	0.2	0.2	0.2	0.1	0.1	0.1	—	—	—	—	—	—	—	—	—	—	—
P. gyrina	0.3	0.2	0.7	1.4	1.7	1.2	1.8	2.2	1.3	0.5	0.2	0.4	—	—	—	—	—	0.1	—	—	—	—	—	—
P. exacuous	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
S. palustris	—	—	—	—	—	0.1	0.2	—	—	0.2	—	—	0.1	—	0.2	—	—	—	0.1	0.3	0.2	0.5	1.3	2.8
P. casertanum	32.5	65.1	49.5	33.8	36.2	41.6	45.4	37.9	36.1	25.8	43.8	43.5	51.6	45.6	43.8	44.8	60.8	45.3	42.8	25.1	20.8	26.7	25.3	27.2
P. compressum	—	—	0.5	0.5	0.5	0.5	0.4	1.1	1.2	0.8	1.0	0.8	1.1	0.3	0.1	0.1	0.3	0.2	—	—	0.2	—	—	0.2
S. occidentale	0.1	—	0.1	—	0.1	0.1	—	0.3	0.1	—	—	0.1	—	—	—	—	0.1	0.1	—	—	—	—	—	—
S. rhomboideum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1	—
Carychium exiguum	—	—	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
G. contracta	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
G. tappaniana	—	—	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gastrocopta sp.	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
H. minuscula	0.1	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O. retusa	0.3	—	—	—	—	—	0.1	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	0.1
S. leai	—	—	—	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
S. ovalis	—	—	—	—	—	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—
T. albolabris	—	—	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V. ovata	—	—	—	—	0.1	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Z. arboreus	—	—	—	—	—	0.1	—	—	—	—	—	0.1	—	—	—	—	—	—	—	—	—	—	—	—
Total No. **	1000	1005	1000	1000	1010	1000	1000	1002	1005	1000	1000	1001	1000	1000	1001	1000	1000	1000	1000	1000	1000	1000	1000	1000
Estimated No.**	5500	5500	10^4	10^4	5000	10^4	10^4	10^4	10^4	5000	5000	5000	3000	3000	3000	3000	5000	5000	5000	4000	3000	3000	8000	8000

*Dash indicates species not found.

**Total number of mollusks picked and calculated number of mollusks in sample.

coarse substrate in shallow wave-washed areas and mud in quiet areas perhaps below wave-base.

Gyraulus parvus and *Valvata lewisi* were reported as the dominant species in the lower 60 cm. *G. parvus* was a particularly hardy species and commonly inhibited water depths of 0.3 to 1.2 m (La Rocque 1968). *V. lewisi* was the only valvatid reported by Gennett in the lower 60 cm, but *V. sincera* occurred in upper Unit 3. This may have been a case of misidentification for *V. sincera* typically inhabits cooler, deeper water than *V. lewisi* (La Rocque 1968). The presence of *V. sincera* suggests much cooler lake temperatures during the deposition of lower Unit 3 (fig. 2).

Gennett also reported *Fossaria obrussa, Stagnicola palustris,* and *S. umbrosa* from Unit 3. We have erected these species from several lymnaeid species listed in her study. *F. obrussa* was abundant and certainly indigenous; *S. palustris* and *S. umbrosa* may have been intruders. The presence of these species suggests nearness of shoreline, for all typically thrive in areas of muddy bottoms and emergent vegetation (La Rocque 1968, Harman and Berg 1971).

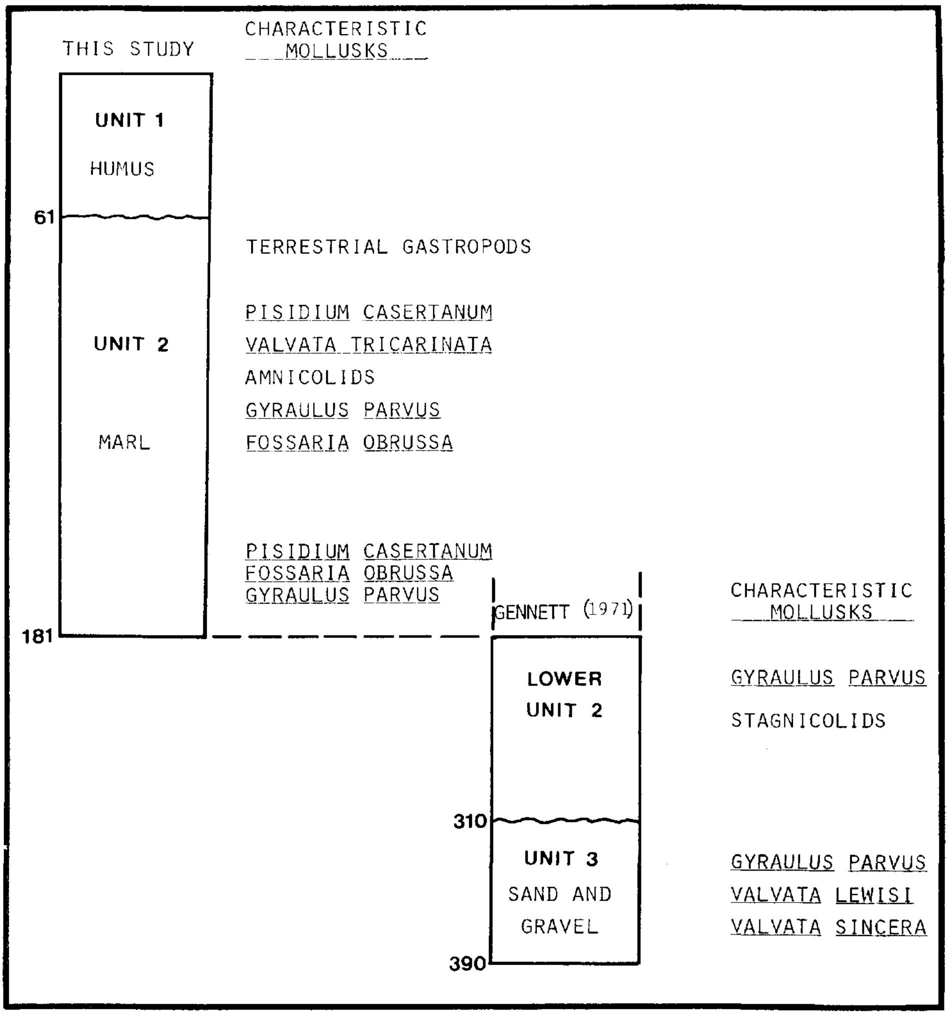

FIGURE 2. Stratigraphic section of Sunbeam Prairie lacustrine deposit with characteristic mollusk species. Depth in centimeters is shown by numbers to the left.

Sunbeam Prairie Lake's linear extent suggests that it formed in a depression between the Farmersville moraine and outwash plain or was created by a damming of meltwater by outwash. The lake basin must have filled sometime after the Wisconsinan readvance to the Farmersville-Reesville morainic system dated at 17,200±400 years B.P. in Madison County, OH (Dreimanis and Goldthwait 1973).

UNIT 2

Unit 2 is marked by the beginning of marl deposition. Lime leached from the surrounding glacial sediments began to precipitate as the water temperature increased and calcareous algae became more abundant (Kindle 1927, Deevey 1953). The marl probably formed a submerged shelf around the perimeter of the lake as is the case in many marl lakes (Deevey 1953). Marl precipitation must have been quite intense during this time for the lower collections contain a high percentage of calcareous algal stems and oogonia probably assignable to *Chara* or *Nitella*.

The lower half of Unit 2 including collections 18–24 and the 7' and 9' collections of Gennett (1971) showed a dominance of *Valvata lewisi*, and *V. sincera*, *Fossaria obrussa*, *Gyraulus parvus*, and *Pisidium casertanum*. The abundance of *V. sincera* was suggestive of cool water temperatures because the presence of *F. obrussa*, *G. parvus*, and *Stagnicola palustris*, all shallow water species (less than 1.2 m), negate deeper water, a typical habitat of *V. sincera* (Zimmerman 1960, La Rocque 1968). *V. lewisi* must have preceded *V. tricarinata* in colonizing Sunbeam Prairie Lake for it apparently has similar ecologic requirements as *V. tricarinata*. *V. tricarinata* is the more aggressive of the two species, and once it became introduced into the lake probably began to suppress the population of *V. lewisi* as shown by the inverse relationship of percentage abundance figures. The reduction of *V. sincera* upward in the section was probably a result of the combined effect of intraspecific competition and shallowing, warming lake waters.

F. obrussa, *G. parvus*, and *Pisidium casertanum* showed no significant fluctuations in abundance throughout Unit 2. These are extremely tolerant species and are to be expected in most marl lake environments of this area.

An increase in molluscan diversity in the upper collections of Unit 2 was probably the result of warming shallowing water. A wide marl shelf may have been present at this time, leading to littoral habitats. New species may have been introduced into the lake by various modes of dispersal, or by the changing littoral conditions.

Amnicola limosa, *A. lustrica*, *Helisoma anceps*, *H. campanulatum*, *Physa gyrina*, *Pisidium compressum*, and *Sphaerium occidentale* became fairly consistent members of the fauna in the upper collections (4–17) of Unit 2. Abundance of these species suggests a shallowing of water level and an increase in aquatic vegetation (La Rocque 1967, 1968, Harman and Berg 1971). The amnicolids are typically found in a periphytic niche (Zimmerman 1960, La Rocque 1968).

In collections 1–12 a few terrestrial pulmonates were found, obviously washed in or dropped by flying or swimming organisms. By this time, a terrestrial pulmonate population must have been well established on the shore of the lake. The presence of *Triodopsis albolabris* in collection 8 suggests the growth of forests nearby (La Rocque 1970). Terrestrial pulmonates were strikingly absent in the lower part of Unit 2, suggesting that land gastropod populations were slow in developing near the lake, possibly because of cooler temperatures.

Picea was the dominant arboreal pollen preserved in Sunbeam Prairie sediments of Unit 2 (Kapp and Gooding 1964a). Pollen data are not available for Unit 3 but a decrease in *Picea* and an increase in *Pinus* and *Quercus* was indicated in the lower two collections of the pollen section (183 cm depth). This change in arboreal pollen has been suggested by Kapp and Gooding (1964b) as possibly marking the Two Creeks Interstadial. If so, Kapp and Gooding suggest that Sunbeam Prairie Lake formed at a later date than the Late Tazewell date referred to in their earlier study (Kapp and Gooding 1964a, b). We feel that the Late Tazewell age of Sunbeam Prairie Lake could be retained, for there was no indication of the thickness of the sandy marl in the lower part of the Kapp and Gooding pollen section. Gennett's (1971) study provides a section nearly twice the depth of that of Kapp and Gooding. The Gennett section was fossiliferous through the lowest collection and lacustrine sediments probably extended much deeper. Thus, the reduction in *Picea* and increase in *Pinus* at the 72 inch (183 cm) level of Kapp and Gooding (1964a) could mark the Two Creeks Interstadial and still leave a considerable thickness of lacustrine sediment below to represent deposition since the Late Tazewell formation of the basin.

At the latitude of Sunbeam Prairie, it seems logical that during Two Creeks time, pine and oak would have become more abundant, while spruce would have decreased. Farther north in Ohio, Two Creeks time should be represented by an open spruce forest. During Valders readvance the climate cooled enough to reinstitute spruce dominance in the Sunbeam Prairie area. This would have been enhanced if prevailing wind directions were downslope or to the south of the Valders ice-sheet and pollen from spruce forests in northern Ohio and Indiana would have been readily transported into the Sunbeam Prairie area.

UNIT 1

The humic sediments of Unit 1 were not analyzed for molluscan content for they were relatively barren of macrofossils. It was assumed that the humus originally contained terrestrial pulmonates and aquatic pulmonate gastropods, but the fossils were destroyed by postdepositional leaching. During the deposition of Unit 1, Sunbeam Prairie probably was occupied by a shallow eutrophic lake. Sunbeam Prairie Lake underwent the typical process of hydroseric succession after rooted vegetation began to gain control of the marl shelf. Marl deposition essentially ceased because of the reduction of available calcium carbonate and increasing amounts of organic matter. The boundary between Unit 2 and 1 was marked by a transitory horizon of marl and humus.

Kapp and Gooding's (1964a) pollen diagrams show a marked change in vegetation in Unit 1. *Picea* was on the decline while *Pinus*, deciduous trees, and nonarboreal plants were on the rise. A radiocarbon date of 10,600 ± 150 (L–550B) years B.P. was obtained by Kapp and Gooding from Unit 1 sediments. Ogden (1967) postulated a sudden climatic change, occurring about 10,000 years B.P., which he recognized in a large number of pollen diagrams from eastern North America. This reflects a change in prevailing wind directions and a redistribution of pollen from deciduous trees south of Sunbeam Prairie (Ogden 1967).

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