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Chronology and Molluscan Paleontology of Two Post-Woodfordian Bogs in Northeastern Illinois

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CHRONOLOGY AND MOLLUSCAN PALEONTOLOGY OF TWO POST-WOODFORDIAN BOGS IN NORTHEASTERN ILLINOIS

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ABSTRACT

Hand-auger borings in two post-Woodfordian basic bogs, one northeast of Strawn in Livingston County and one west-southwest of Batavia, Kane County, Illinois, provided the materials for collections of fossil mollusks from a total of 27 levels. Each collection consisted of approximately 1,000 shells; faunal assemblages varied from 10 to 19 species. In all, 31 species, grouped in 18 genera, were recovered from fine-grained water-laid sediments; sediments and molluscan assemblages from the two bogs were remarkably similar. Each of the bogs—and their remnant lakes—occupies a basin in morainal topography; the lakes are maintained at present by runoff from surrounding slopes and by groundwater inflow. Radiocarbon analyses of carbonaceous materials in the samples range from about 9,000 years B.P. several feet above the bottom of the sediments to about 2,000 years B.P. at the base of the sphagnum matte that essentially terminated the biological activity in the bog lakes. It is estimated that the deposition in the basins began more than 10,000 radiocarbon years B.P.

Six species, *Amnicola gelida*, *A. leightoni*, *Gyraulus altissimus*, *Helisoma antrosa*, *Physa gyrina hildrethiana*, and *Valvata tricarinata*, occur throughout the sediments in both of the bogs; of these, three species are branchiates and all are aquatic. Except for four species of terrestrial habit (three of these represented by single specimens), the entire fauna in the two bogs is aquatic in habitat requirements. Specific data concerning the habitat requirements of these freshwater mollusks are lacking, but a comparison of the fossils with their living counterparts, where available, indicates that the molluscan faunal assemblages in the two bog lakes lived in clear, cool, moderately eutropic waters, basic in reaction, sufficiently supplied with dissolved carbonates to support strong growth of molluscan shells, and characterized by fluctuating levels.

INTRODUCTION

Available evidence points to the end of the Woodfordian Substage of the Wisconsinan Stage of the Pleistocene at about 12,500 radiocarbon years B.P. (Willman and Frye, 1970). Dissipation of the last Woodfordian glaciers in the Lake Michigan Basin left, here and there, isolated masses of glacial ice, which, protected by mantling debris, slowly melted; in closed or poorly drained basins in a morainal topography, these glacial ice blocks formed ponds and lakes of various sizes and shapes. As the climate ameliorated, aquatic plants and animals colonized these small lakes, many of which terminated as peat-covered bogs.

Two such bogs (figs. 1 and 2) are the subject of this study; one of them is situated on the Delmar Ford farm, 1.5 miles north and 4 miles east of the village of Strawn, in the SW$\frac{1}{4}$ SW$\frac{1}{4}$ SE$\frac{1}{4}$ section 32, T. 26 N., R. 8 E., Livingston County, Illinois (Strawn NE Section, localities 135-1, 135-2). The second bog is situated about 85 miles north of the first, and about 2 3/4 miles west-southwest of Batavia, on property of Batavia Soil Builders, Paul Wasser, president. The hand-auger boring that provided the data for the Batavia West Section (locality 136) is on this property in the SE$\frac{1}{4}$ SE$\frac{1}{4}$ section 24, T. 39 N., R. 7 E., Kane County, Illinois. At each of the localities, property owners were graciously cooperative; their assistance is gratefully acknowledged.

Volo Bog, situated northwest of the city of Chicago, in Lake County, Illinois, has been intensively studied (McComas, Kempton, and Hinkley, 1972) geologically and hydrologically. In addition to describing the portion of the bog with a pH in the acid range, the authors (who incorrectly refer to Volo Bog as unique in Illinois because "no other bogs in Illinois have open-water ponds") describe a portion in which *Typha* and sedges produce an alkaline sediment, but they make no reference to fossil shells in these basic deposits. Their study of the time framework of the development of the Volo Bog corresponds well with the available dates for the Strawn NE and Batavia W bogs; especially interesting perhaps is the date they obtained from the base of about 5 feet of peat, 2,100 ± 200 years B.P. (ISGS-49), which is almost identical with the date obtained from a similar peat deposit at Batavia W (1,870 ± 200 B.P., ISGS-134).

Baker (1910) investigated the Skokie Bog with special reference to the molluscan faunas living there at the time; he did not explore the sediments in the bog for fossil mollusks.

STRAWN NORTHEAST LOCALITY

The two hand-auger holes bored at the Strawn Northeast locality (135-1, 135-2, fig. 1) were made at the water's edge of a small lake maintained by a brook that enters the bog from the Paxton Moraine to the east; a colony of beavers regulates the water level of the lake by a dam which these animals keep in good repair. The depression in which the fossiliferous sediments have accumulated (fig. 1) seems to have been occupied by a glacial ice remnant in a morainal topography. The present lake is about 200 by 400 yards, but deposits indicate that the lake was originally at least twice this size. Only a 12 to 18 inch layer of peat covered the bog; this was removed by operations begun in

Fig. 1 - Excerpt from Sibley, Illinois, 15-minute quadrangle map, contour interval 10 feet, showing the location of the Strawn NE bog, and the position of the two hand-auger borings, localities 135-1 and 135-2. The high ground to the east of the bog lake is the front of the Paxton Moraine. A canal provides drainage for the basin, but a colony of beavers maintains a dam that regulates the level of the lake.

1934 to recover fossilferous, highly organic marl for use as a substitute for agricultural lime and fertilizer. These operations have been virtually suspended.

The cuttings from the two auger holes provided the samples upon which the measured section is based and from which the molluscan faunas were recovered. Auger hole 131-1, according to judgments based upon local topography, is near the southern shore of the original basin; here glacial outwash and/or till was encountered at a depth of 14 feet. Auger hole 135-2 was bored about 200 yards north, on the opposite shoreline of the present lake; it is judged to be near the center of the original basin. Sediments were penetrated to a depth of 20 feet, at which depth sidewall collapse prevented further augering; till was not encountered but the paucity of molluscan fossils, increase in percentage of clay, and occurrence of pebbles indicated the nearness of the base of the bog deposits.

Strawn Northeast Section

Strawn NE Section, measured in auger holes in the SW¼SW¼SE¼ sec. 32, T. 28 N., R. 8 E., Livingston County, Illinois.

	Thickness (feet)
5. Black, highly fossiliferous organic muck, partially exposed in wave-cut bank; contains some silt and very fine sand. Radiocarbon date from near base of bed, 2640 ± 75 B.P. (ISGS-161)	2.0
4. Black organic muck; fine sand, silt, clay, much organic debris, and abundant molluscan fossils. Radiocarbon dates from near base of interval, 2330 ± 75 B.P. (ISGS-162A) and 2370 ± 100 B.P. (ISGS-162B)	4.0
3. Dark gray marl (lighter gray near base of unit); fine sand, silt, clay, much organic debris, and many molluscan fossils. Radiocarbon date from near base of interval, 7760 ± 84 B.P. (ISGS-164). .	4.0
2. Gray marl; fine to medium sand, silt, and clay; plastic when wet; contains a few pebbles to ½ inch diameter; abundant plant remains and fossil mollusks declining in abundance toward base of unit. Radiocarbon date from near base of interval, 8940 ± 80 B.P. (ISGS-167) (Coleman, 1974)	4.0
1. Gray sand; silt and clay mixed with numerous pebbles; contains a few mollusks and plant remains in upper part; sterile toward base in glacial till and/or consolidated outwash. Organic materials too sparse for radiocarbon date	3.0
Total	17.0

BATAVIA WEST LOCALITY

The Batavia West Section is also described from a hand-auger boring; the boring is situated along the northwest border of a depression that extends for more than a mile in a southwesterly-northeasterly direction. All of the depression is a peat-covered bog, except for Nelson Lake, which occupies part of the

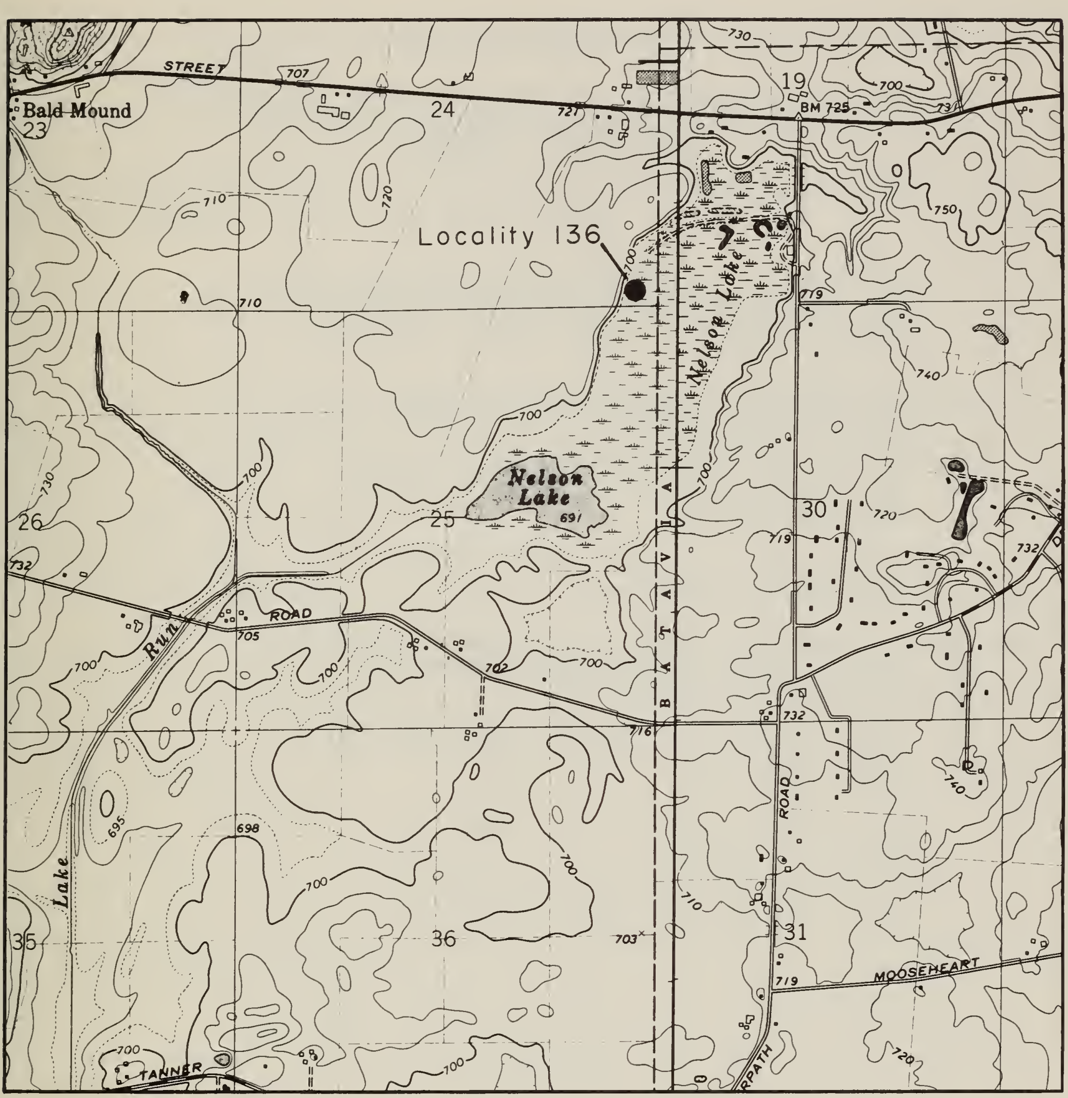

Fig. 2 - Excerpts from Aurora North and Sugar Grove, Illinois, 7.5-minute quadrangle maps, contour interval 10 feet with dotted 5-foot contour, showing the Batavia W bog and the location of the hand-auger boring, locality 136. The basin is situated in a re-entrant of the St. Charles Moraine; it is partially drained by a channelized brook, "Lake Run."

southern end of the depression (fig. 2). The bog, at least in the northern part, bears a layer of peat to a thickness of 4 to 5 feet; this is being harvested commercially by Batavia Soil Builders as soil conditioner. The hand-auger boring penetrated nearly 5 feet of peat; the hole terminated in nonfossiliferous, unctious clay, where it had to be abandoned because of sidewall collapse.

Batavia West Section

Batavia W Section, measured in auger hole situated in the SE¼SE¼ sec. 24, T. 39 N., R. 7 E., about 2.75 miles WSW Batavia, Kane County, Illinois.

		Thickness (feet)
8.	Dark brown peat; no fossil shells except in lower few inches. Radiocarbon date from lowermost 2 inches of interval, 1750 ± 100 B.P. (ISGS-131) (Coleman, 1974)	4.5
7.	Gray-tan silt, clay, and marl; contains abundant fossil mollusks	0.5
6.	Gray-tan marl with abundant fossil mollusks and plant remains	2.8
5.	Gray-tan marl and clay; plastic and wet; abundantly fossiliferous	2.5
4.	Dark gray marl and silt, some undecayed peat; fossiliferous, very wet, almost semifluid	2.1
3.	Dark gray fossiliferous silt, with small amount of plant material; contains small masses of sterile gray clay	3.3
2.	Dark gray, sandy, nonfossiliferous clay; plastic and very wet	1.6
1.	Base in sterile gray clay, no pebbles	0.6
	Total	17.9

Generalities

Augering was done with a sandspoon because of the almost semifluid condition of the bog sediments. Samples were removed from the spoon and collected in plastic bags, each of which was labeled with appropriate data. The collected samples were subsequently washed over wire screens; the residue was dried and the fossil shells were sorted from the residue. Although no attempt was made to collect samples of uniform size, most of them contained about 1,000 shells. A few fossil seeds were recovered; all the samples, except the sterile clay and sand at the base of the borings, contained many ostracods and even more diatoms.

It is judged that most of the fossil shells at each of the two localities collected on the bottom of a quiet lake; evidence for this includes the apparent lack of sorting of fine sediments and the fact that in all borings and at nearly all levels many small pelecypods were recovered with the two valves still united, despite the operations of boring and the later treatment of the samples. However, as discussed below, there is evidence that some shells reached the deposit from outside the lakes.

The original basins in which the two bogs developed are judged to be as old as 10,000 to 12,000 years, inasmuch as the lowermost finite date of about 9,000 radiocarbon years B.P. (Coleman, 1974) is approximately 5 feet above the base of the bog sediments. A reasonable extrapolation based on the rate of dated sedimentation produces this approximation.

SYSTEMATIC ACCOUNT OF MOLLUSCAN SPECIES

The molluscan fauna is listed here in systematic order, and reference is made to the original description of each taxon, to a standard work using the present name combination, and to a description and illustration of each kind of shell.

Class Pelecypoda
Order Prionodesmacea
Family Unionidae

Fragments recognizable as those of unionid mussel shells were recovered from time to time in auger samples from each of the three holes augered, but none of these was large enough to do more than relate them to the pelecypod family. No hinge teeth were recovered.

Order Teleodesmacea
Family Sphaeriidae
Genus *Sphaerium* Scopoli 1777

H. B. Herrington, in his revision of the North American Sphaeriidae (1962), recognized 35 kinds of these animals, 31 of them native to North America and 4 kinds judged to have been introduced from Europe. The sphaeriids were distributed by Herrington among 3 genera— *Sphaerium*, having 12 recognized species; *Pisidium*, having 22 species; and the New World genus *Eupera*, which is represented in North America by the single species *cubensis*. Burch (1972), in his illustrated key to the Sphaeriidae of North America, added 4 species of *Pisidium* to the list recognized by Herrington.

Sphaerium securis (Prime) 1851

Cyclas securis Prime 1851, Boston Soc. Nat. Hist. Proc., v. 4, p. 160.
Sphaerium securis Prime 1865, Monogr. Amer. Corbiculidae, p. 49.
Sphaerium securis (Prime), Herrington 1962, Revision Sphaeriidae North America, p. 26, pl. 1, fig. 2.

The shell of *S. securis* is small for the genus, usually not more than 8 mm in length; the beak is usually, but not invariably, calyculate. The species occurs in seven of the faunal assemblages; it is distributed through various levels and at each of the three localities (fig. 3). In no assemblage were the shells numerous; in fact they should be categorized as rare since numbers of valves ranged from 1 to 7 in any particular assemblage.

LOCALITIES AND LEVELS OF SAMPLES / MOLLUSCAN SPECIES	STRAWN NE, No. 135-1 (intervals in feet)						
	0 - 2	2 - 4	4 - 6	6 - 8	8 - 10	10 - 12	12 - 14
Amnicola gelida F. C. Baker	●	●	●	●	●	●	●
Amnicola leightoni F. C. Baker	●	●	●	●	●	●	●
Gyraulus altissimus (F. C. Baker)	●	●	●	●	●	●	●
Helisoma antrosa (Conrad)	●	●	●	●	●	●	●
Physa gyrina hildrethiana Lea	●	●	●	●	●	●	●
Valvata tricarinata (Say)	●	●	●	●	●	●	●
Promenetus umbilicatellus (Cockerell)	●	●	●	●	●	●	●
Pisidium nitidum Jenyns	●		●	●	●	●	●
Promenetus exacuous (Say)	●	●	●	●	●	●	
Pisidium compressum Prime				●	●	●	●
Sphaerium simile (Say)					●		●
Ferrissia parallela (Haldeman)	●					●	
Lymnaea (Fossaria) parva Lea	●		●			●	
Lymnaea (Fossaria) obrussa Say							
Helisoma campanulatum (Say)	●						
Valvata lewisi Currier				●	●		●
Sphaerium securis (Prime)	●	●					
Lymnaea (Stagnicola) lanceata Gould	●				●		
Helisoma trivolvis (Say)	●	●					
Lymnaea (Fossaria) dalli F. C. Baker	●	●					
Armiger exigua Leonard							●
Planorbula armigera (Say)	●				●		
Succinea (Oxyloma) retusa Lea	●	●			●		
Aplexa hypnorum (Linné)					●		
Carychium exile Lea							●
Helicodiscus parallelus (Say)					●		
Lymnaea (Stagnicola) caperata Say	●						
Lymnaea (Stagnicola) palustris (Müller)							
Pseudosuccinea columella (Say)						●	
Sphaerium fabale (Prime)							
Vertigo modesta (Say)							
Total number of species	19	12	10	11	17	13	13

Fig. 3 - Chart showing occurrence and distribution of 31 species at three localities, 135-1, 135-2, Strawn NE, Livingston

STRAWN NE, No. 135-2 (intervals in inches)													BATAVIA W, No. 136 (intervals in inches)						
0 - 18	18 - 28	28 - 44	44 - 52	52 - 64	64 - 95	95 - 136	136 - 142	142 - 152	152 - 165	165 - 195	195 - 219	219 - 240	54 - 60	60 - 84	84 - 90	90 - 112	112 - 144	144 - 184	184 - 204
●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●
●	●	●	●	●	●	●	●	●	●					●	●	●	●	●	●
			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
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			●	●	●	●	●	●		●	●			●				●	
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12	14	9	14	13	12	11	13	13	12	12	15	11	13	15	13	16	16	16	15

of mollusks obtained from hand-auger cuttings from 27 levels
County, and 136, Batavia W, Kane County, Illinois.

Sphaerium simile (Say) 1816

Cyclas similis Say 1816, Nicholson's Encyc., v. 2, pl. 1, fig. 9.
Sphaerium simile (Say), Burch 1972, Biota Freshwater Ecosystems, Washington, p. 6, 10, fig. 5b.

The specific name of this common sphaeriid mussel has long been a matter of controversy; the problem was discussed in some detail by F. C. Baker (1928, p. 316). Herrington considered the problem and indicated that *simile* is not a synonym of *sulcatum*. However, Burch (1972), who worked with Herrington, does not recognize *sulcatum*, but uses Herrington's figure of *sulcatum* to illustrate *simile*. Since the species is widely distributed in North America, it probably is a native element of the sphaeriid complex, distinct from *sulcatum*.

The large shell of *S. simile* occurs in 12 of the 27 faunal assemblages considered (fig. 3), but in none are the valves numerous. They vary from fragments to eight complete valves. At localities 135-1 and 135-2, *simile* does not occur in the uppermost 5 to 6 feet of the deposits, but at the Batavia locality, 136, *simile* ranges throughout the section.

Sphaerium fabale (Prime) 1851

Cyclas fabalis Prime 1851, Boston Soc. Nat. Hist. Proc., v. 4, p. 159.
Sphaerium fabale (Prime), Herrington 1962, Revision Sphaeriidae N. America, p. 18, pl. 2, fig. 3.

A single valve recovered from the 12-foot level of locality 136 is the only evidence of this species in the bogs under study. It seems unlikely that the animal lived in the lake itself, at least where the auger boring was made. This valve is somewhat smaller than those described by Herrington, but it seems to be a mature shell.

S. fabale is distributed in North America from Vermont to the Mississippi River; it has been reported in Canada from southern Ontario.

Genus *Pisidium* Pfeiffer 1821

The shells of the genus *Pisidium* are small, rounded or ovoid to cuneiform, seldom much over 6 mm in length. They differ from those of *Sphaerium* inasmuch as the beaks are posterior. The species recognized in North America are divided arbitrarily into two groups: four "large" species and 21 "small" species. The two species of *Pisidium* considered here belong to the "small" group.

Pisidium compressum Prime 1851

Pisidium compressum Prime 1851, Boston Soc. Nat. Hist. Proc., v. 4, p. 164.
Pisidium compressum Prime, Herrington 1962, Revision Sphaeriidae N. America, p. 35, pl. 5, fig. 2; pl. 7, fig. 14.

The shell of *P. compressum* is 3.5 to 4.0 mm long, robust for its size, and characteristically trianguloid in shape. In our collections, it occurs in 21 of the 27 faunal assemblages and is numerous in every occurrence; it is absent from the uppermost 4 to 6 feet of the auger samples at localities 135-1 and 135-2, but occurs abundantly throughout the several levels of locality 136 (fig. 3). A few united pairs of valves were observed at each of the localities studied.

P. compressum is distributed widely in North America, from northern Canada to California and Mexico.

Pisidium nitidum Jenyns 1832

Pisidium nitidum Jenyns 1832, Cambridge Philos. Soc., v. 4, p. 304, pl. 20, figs. 7-8.
Pisidium nitidum Jenyns, Herrington 1962, Revision Sphaeriidae N. America, p. 45, pl. 5, fig. 6, pl. 7, fig. 17.

Pisidium nitidum is a small pelecypod, usually less than 3 mm in length; it has a generally rounded form, inconspicuous beaks, and very fine striations on the shell. It is distributed widely in Europe as well as in North America.

It occurs in 24 of the 27 faunal assemblages studied (fig. 3), but at none of them were the valves numerous. In many of the assemblages, pairs of valves occurred intact, indicating that the species is indigenous to the deposits even though not abundant in them. Some of the shells possess the characters referred to as the "form *pauperculum*," which does not seem to be a valid taxonomic entity.

Class Gastropoda
  Subclass Streptoneura
    Order Ctenobranchiata
      Family Valvatidae
        Genus *Valvata* Müller 1774

The genus *Valvata* encompasses a few species of small, spiral, turbinate gastropods that carry on gaseous exchange by means of gills; they therefore require permanent water, reasonably free of silt. There are probably no more than three or four species of this genus, which is unique to North America, but many "forms" of little or no taxonomic value have been described (Baker, 1928, p. 7-32; La Rocque, 1968, p. 358-368).

Valvata lewisi Currier 1868

Valvata lewisi Currier 1868, Kent Sci. Inst. Misc. Pub. No. 1, p. 9.
Valvata lewisi Currier, La Rocque 1968, Ohio Div. Geol. Surv. Bull. 62, pt. 3, p. 360, fig. 211.

Valvata lewisi is a small gastropod with a spiral, turbinate shell bearing regular striae that have been compared to the winding of a thread on a spool. The shells are about 4.5 mm in diameter, and are 3 or more mm high. In this study, *V. lewisi* occurred in only 8 of the 27 faunal assemblages, and in these the species was represented by no more than 1 to 4 shells. Occurrences were limited to the deeper levels of localities 135-1 and 135-2; no shells were found in the abundant faunal assemblages at locality 136 (fig. 3).

This species is distributed across Canada and the northern part of the United States; it has been reported living in La Salle County, Illinois (Baker, 1928, p. 28).

Valvata tricarinata (Say) 1817

Cyclostoma tricarinata Say 1817, Acad. Nat. Sci. Philadelphia Jour., v. 1, p. 13.
Valvata tricarinata (Say), F. C. Baker 1928, Freshwater Moll. Wisconsin, pt. 1, p. 11, pl. 1, figs. 1-3.

Valvata tricarinata possesses a shell shaped much like that of *V. lewisi*, but the whorls are tricarinate, although the development of the carinae varies greatly. This variation has led to the publication of many trinomial names, which are essentially meaningless since many variations of the shell ornamentation occur in the same population of the species. Furthermore, there is no correlation between variation in shell carinae and internal anatomy. If writers feel constrained to refer to the variations in the development of the carinae, La Rocque has suggested a means of doing this (1968, p. 368) which certainly is better than trinomial designations.

V. tricarinata forms a conspicuous element of each of the faunal assemblages studied; it occurs in each of the 27 assemblages, and is in every one of them the most numerously represented. It is present in the bottom samples at each locality and was therefore one of the first species to colonize these bogs as the original glacial lakes formed by meltwaters and by runoff from the surrounding moraines.

The species is widely distributed in North America east of the Rocky Mountains, and was a conspicuous animal in Pleistocene fossil assemblages on the Great Plains; it no longer lives there south of the Sand Hills area in Nebraska.

Family Amnicolidae
Genus *Amnicola* Gould and Haldeman 1841

The genus *Amnicola* is composed of small branchiate gastropods having tightly coiled spiral shells; the height of the shells is rarely more than 6 mm and in most species is less. Although the genus is distributed primarily in northeastern North America, living species extend as far southwest as eastern Kansas. However, members of the genus thrive best in clear, cold waters. Several genera are recognized in the family Amnicolidae (Berry, 1943), but only one of them occurs in the bog faunas studied here.

Amnicola gelida F. C. Baker 1921

Amnicola lustrica gelida F. C. Baker 1921, Nautilus, v. 35, p. 22.
Amnicola gelida F. C. Baker 1928, Freshwater Moll. Wisconsin, pt. 1, p. 110, pl. 6, figs. 19-23.

Although not as numerous as *V. tricarinata* in these collections, *Amnicola gelida* occurs abundantly in every one of the faunal assemblages studied. *A. gelida* is known only as a fossil that has been reported in Ohio and in Illinois. The shells are high spiraled. Sexual dimorphism seems apparent among them; the shells presumed to have contained male animals possess a much broader ultimate whorl than do the presumptive females. This is a common phenomenon among amnicolids, produced by the necessity of accommodating the large male intromittent organ (verge). *A. gelida* was also an early colonizer of the glacial lakes; the shells occur in the lowermost samples that contain any fossils at all.

Amnicola leightoni F. C. Baker 1920

Amnicola winkleyi leightoni F. C. Baker 1920, Nautilus, v. 33, p. 125.
Amnicola leightoni F. C. Baker 1921, Nautilus, v. 35, p. 23.
Amnicola leightoni F. C. Baker 1928, Freshwater Moll. Wisconsin, pt. 1, p. 120, pl. 6, figs. 34-39.

The shells of this species have a characteristic bulbous shape produced by the large ultimate whorl, which differs little between the sexes. The shells are spiral, turbinate, and relatively small, the height being no more than 5 mm in adult specimens. Like *A. gelida*, *A. leightoni* is presumed to be an extinct species, which has been reported from Pleistocene marl deposits in Illinois, Ohio, Indiana, and elsewhere in nearby states.

Amnicola leightoni occurs in every one of the 27 faunal assemblages studied and forms abundant populations in each of them. It was one of the earliest colonizers of these bogs, and occurs in the lowermost fossiliferous samples at each locality.

Subclass Euthyneura
Order Pulmonata
Suborder Basommatophora
Family Lymnaeidae
Genus *Lymnaea* Lamarck 1799

The lymnaeids are pulmonate aquatic gastropods, widely distributed over the world, especially in the northern hemisphere. The animals are extremely sensitive to local environmental conditions and to fluctuations in them, which has led to great taxonomic confusion and needless proliferation of names. Baker (1911) subdivided the genus *Lymnaea* into several genera; this subdivision has been widely, although not universally, accepted. The lymnaeids seem rather to be represented worldwide as a small number of highly variable species, as pointed out and so ably defended by Hubendick (1951).

In this work all taxa of lymnaeids are listed in the genus *Lymnaea*, as seems proper, especially in the case of fossil shells, but the names of the Bakerian genera are inserted as subgenera in order to reflect wide usage among students of the family Lymnaeidae.

Aquatic pulmonate gastropods possess no gills; they mediate gaseous exchange through a pocket in the mantle, or through the general body surface. Active lymnaeids have been found at great depths, indicating their independence of free gaseous oxygen.

Although several taxa of lymnaeids occur in the two bogs under investigation, the shells are nowhere numerous and should be classed everywhere in these bogs as rare.

Lymnaea (*Stagnicola*) *caperata* Say 1829

Lymneus caperatus Say 1829, New Harmony Disseminator, v. 2, p. 230.
Stagnicola caperata (Say), F. C. Baker 1928, Freshwater Moll. Wisconsin, pt. 1, p. 260, pl. 18, figs. 43-47.

L. caperata is represented in these collections by a single example (fig. 3), which was probably transported into the bog from small brooks that flowed into it. It cannot be said to have recognizable significance in this study.

Lymnaea (*Stagnicola*) *lanceata* Gould 1848

Limnaea lanceata Gould 1848, Boston Soc. Nat. Hist. Proc., v. 3, p. 64.
Stagnicola lanceata (Gould), F. C. Baker 1928, Freshwater Moll. Wisconsin, pt. 1, p. 228, pl. 14, figs. 12-15.

L. lanceata occurs in only 6 of the 21 faunal assemblages, and in each of these is represented by only one to three shells. The occurrence of the species in the two bogs (fig. 3) seems to have no correlation with the depth of the sample. The shell is elongate-cylindrical and may vary in length from 20 to 30 mm. However, the few shells collected in these deposits are either immature or broken, and are much smaller than the typical dimensions. *L. lanceata* has been reported from southern Ontario to Ohio and Wisconsin.

L. lanceata, sparsely and erratically distributed in the Strawn and Batavia bogs, certainly cannot be considered a significant element of the faunal assemblages.

Lymnaea (*Stagnicola*) *palustris* (Müller) 1774

Buccinum palustre Müller 1774, Verm. Terr. et Fluv. Hist., p. 131.
Stagnicola palustris (Müller), La Rocque 1968, Ohio Div. Geol. Surv. Bull. 62, pt. 3, p. 443, fig. 294.

A single shell of *L. palustris* was taken from the uppermost sample at locality 135-2 (fig. 3). The species is one adapted for living in a small lake habitat, but the single shell makes it doubtful that established populations inhabited the lake at the Strawn locality. *L. palustris* has an elongate spiral shell usually more than 20 mm high.

Lymnaea (*Fossaria*) *dalli* F. C. Baker 1906

Lymnaea dalli F. C. Baker 1906, Illinois Lab. Nat. Hist. Bull., v. 7, p. 104.
Fossaria dalli (F. C. Baker), F. C. Baker 1928, Freshwater Moll. Wisconsin, pt. 1, p. 288, pl. 16, fig. 11.

L. dalli is a tiny gastropod with a typical lymnaeid shell no more than about 4 mm in length. The living species occurs more often near water than in it, on mud and debris near the water's edge. It is widely distributed in North America, probably more so than records indicate because its small size leads to its being overlooked. It occurs in five of the faunal assemblages (fig. 3), in fair numbers in some collections. In spite of this fact, it is doubtful that the animals lived where the shells were found, because *L. dalli* is rarely if ever found far from shoreline habitats.

Lymnaea (*Fossaria*) *obrussa* Say 1825

Lymneus obrussus Say 1825, Acad. Nat. Sci. Philadelphia Jour., v. 5, p. 123.
Fossaria obrussa (Say), F. C. Baker 1928, Freshwater Moll. Wisconsin, pt. 1, p. 239, pl. 18, figs. 14-24.

L. obrussa is a rather small lymnaeid gastropod, the shells varying from 9 to 11 mm in length; it is larger than *L. parva* and the ultimate whorl is more swollen than it is in *L.parva*. *L. obrussa* was not recovered from any level at locality 135-1. It occurs sparingly in three faunal assemblages at locality 135-2, but is found at every level among the samples from locality 136 (fig. 3). Even at the Batavia bog (136) *L. obrussa* does not occur in abundant numbers, although its regular occurrence would indicate it as a part of the indigenous molluscan population.

Lymnaea (*Fossaria*) *parva* Lea 1841

Lymnaea parva Lea 1841, Amer. Philos. Soc. Proc., v. 2, p. 33.

Fossaria parva (Lea), F. C. Baker 1928, Freshwater Moll. Wisconsin, pt. 1, p. 285, pl. 18, figs. 1-5.

Lymnaea parva is a small gastropod, the shell varying from 4.5 to 9 mm in length. The shell is slender, and the whorls are rounded. Like *L. dalli* it is more often found out of the water than in it; Baker (1928, p. 287) notes that *L. parva* "is more prone to leave the water than any other member of the family." This small gastropod occurs throughout the two bogs studied and is found in 11 of the 27 faunal assemblages; it is slightly more numerous in the assemblages recovered at the Batavia site (locality 136). Although it does not occur at any level in abundance, its distribution throughout the various sampled levels indicates that it was probably a part of the indigenous molluscan fauna.

Genus *Pseudosuccinea* F. C. Baker 1908

Baker removed the species *Lymnaea columella* of Say 1817 from the genus *Lymnaea* and established the genus *Pseudosuccinea* on the basis of the peculiar succineiform shape of the shell and certain anatomical characteristics. This change has not met with universal approval, but most authors have followed Baker.

Pseudosuccinea columella (Say) 1817

Lymnaea columella Say 1817, Acad. Nat. Sci. Philadelphia Jour., v. 1, p. 14.

Pseudosuccinea columella (Say), F. C. Baker 1928, Freshwater Moll. Wisconsin, pt. 1, p. 272, pl. 10, figs. 9-12, 20.

The shell of *P. columella*, as the name suggests, greatly resembles the shells of *Succinea*, except that it has more whorls than the members of the latter genus. Adults are as long as 12 mm, but the single shell recovered in this study, from the 10- to 12-foot level of locality 135-1, is much smaller although it has nearly five whorls. The environment at the bog lake seems appropriate, but the single shell recovered indicates that *P. columella* was not a significant element of the molluscan fauna. *P. columella* is widely distributed in North America. The genus *Pseudosuccinea* extends through Central and South America.

Family Planorbidae

Genus *Gyraulus* Agassiz 1837

The genus *Gyraulus* is composed of small planorbid gastropods which live as aquatic pulmonates, principally on vegetation, in ponds, lakes, or the quiet parts of streams. They are inconspicuous because of their small size and dark color, but may often exist in abundant populations. Species of *Gyraulus* are persistent and often conspicuous elements in fossil molluscan assemblages from water-laid sediments. The genus is worldwide in distribution. La Rocque (1968, p. 483) points out means of distinguishing members of the genus *Gyraulus* from others with which they might be confused.

Gyraulus altissimus (F. C. Baker) 1919

Planorbis altissimus F. C. Baker 1919, Nautilus, v. 32, p. 95, pl. 7, figs. 7-10.

Gyraulus altissimus (F. C. Baker), F. C. Baker 1928, Freshwater Moll. Wisconsin, pt. 1, p. 382, pl. 22, figs. 10-17.

Like many other species of *Gyraulus*, *altissimus* is characterized by 3½ to 4 rapidly increasing whorls and the lack of a distinctive umbilicus. It is recognized by the fact that the periphery of the shell is situated in a ventral position; the ventral whorl is not flattened as in *G. parvus*. *G. altissimus* is the only species of the genus recognized in these faunal assemblages (fig. 3), where it occurs in great numbers at every level studied, but many shells tend toward *G. arcticus* and some tend to approach *parvus*. The dense populations of *G. altissimus* in all faunal assemblages make this species a significant element of the molluscan faunas in these bog lakes.

Genus *Armiger* Hartman 1840

There seems little to justify this genus as distinct from *Gyraulus* except the shell sculpture; the soft anatomy is similar to that of species of *Gyraulus*. Granting validity to the genus, species of *Armiger* are found in North America, Europe, and Asia.

Armiger exigua Leonard 1972

Armiger exigua Leonard 1972, Nautilus, v. 85, p. 81, figs. 1-2 and 1-3.

This tiny gastropod closely resembles *A. crista*, but is much smaller. It has the same number of whorls; the nuclear whorl is granular rather than striate; there is no indication of spiral striation; and the last whorl does not descend toward the aperture, which is roundly oval in shape. It occurs sparingly in five of the faunal assemblages (fig. 3), none of them in the Batavia locality (136). Nothing is known, of course, of the ecological requirements of this minute gastropod beyond that which can be deduced from its associates. The species was described from shells found in Petersburg Silt of early Illinoian age, Henry County, Illinois. It has been found in late Woodfordian sediments in eastern New Mexico.

Genus *Helisoma* Swainson 1840

Species of *Helisoma* are among the large gastropods of the family Planorbidae. Shells are robust, the cross striation is typically coarse, and spiral striation may be conspicuous.

Helisoma antrosa (Conrad) 1834

Planorbis antrosus Conrad 1834, Amer. Jour. Sci., 1st ser., v. 25, p. 343.
Helisoma antrosa (Conrad), F. C. Baker 1928, Freshwater Moll. Wisconsin, pt. 1, p. 317, pl. 19, figs. 8-15.

Helisoma antrosa is another of the six species that occur in every faunal assemblage in the localities studied (fig. 3) although population numbers are lower than those of any other of the persistent species except *Physa gyrina hildrethiana*. Nevertheless, this species forms a conspicuous element of the total molluscan assemblages.

Many, but not all, of the examples collected have the spiral striations that characterize a described form (*striata* F. C. Baker) that supposedly characterizes Pleistocene populations of *H. antrosa*. It seems unlikely that the "*striata*" modification of sculpture has taxonomic significance.

The aperture of many *Helisoma antrosa* specimens is distended in a bell-like form resembling *H. campanulatum*, but the spires of the two species are entirely different; that of *H. antrosa* forms a deep, smooth-sided funnel, while that of *H. campanulatum* is flatly coiled. Living *H. antrosa* is widely distributed in North America, but populations are especially numerous east of the Mississippi River.

Helisoma trivolvis (Say) 1817

Planorbis trivolvis Say 1817, Nicholson's Encyclopedia, Amer. Ed., v. 2, pl. 2, fig. 2 (no pagination).
Helisoma trivolvis (Say), F. C. Baker 1928, Freshwater Moll. Wisconsin, pt. 1, p. 330, pl. 20, figs. 1-13, 22, 23.

The shells of this large pulmonate aquatic gastropod may exceed 30 mm in diameter. It is widespread in North America, except in the western mountains, where it occurs less frequently. In the Pacific area, populations previously referred to *trivolvis* are often given other names. *H. trivolvis* is not common in the collections from the two bogs under study, and those populations that do occur are obviously late colonizers (fig. 3) since shells occur only in the uppermost 4 to 6 feet at localities 135-1 and 135-2. No shells of *H. trivolvis* were recovered at the Batavia bog (locality 136).

Helisoma campanulatum (Say) 1821

Planorbis campanulatus Say 1821, Acad. Nat. Sci. Phila. Jour., v. 2, p. 166.
Helisoma campanulatum (Say), F. C. Baker 1928, Freshwater Moll. Wisconsin, pt. 1, p. 345, pl. 21, figs. 1, 2, 4, 5, 8, 9, 13, 14.

H. campanulatum is about the same size as *H. antrosa*, that is, the shell is 10 to 15 mm in diameter; the aperture is expanded in a bell-like fashion, hence the name. Superficially it resembles *H. antrosa*; its distinguishing characters have been noted.

H. campanulatum occurs infrequently in the assemblages from localities 135-1 and 135-2, but is present in every one of the seven faunal collections from the Batavia bog, locality 136 (fig. 3). The living species is distributed largely in northeastern United States, but records exist for several widely scattered localities in Canada. It does not seem to occur south of Illinois and Ohio.

Genus *Planorbula* Haldeman 1842

The shells of the pulmonate aquatic gastropods of this genus are typically planorbid, the whorls are tightly wound, and the lip is more or less thickened within. The truly characteristic feature of these shells, however, is the persistent set of six dentiform lamellae a short distance back from the aperture. The internal anatomy is similar to that of *Gyraulus*. The genus occurs in North America and in Africa.

Planorbula armigera (Say) 1818

Planorbis armigerus Say 1818, Acad. Nat. Sci. Phila. Jour., v. 2, p. 164
Planorbula armigera (Say), F. C. Baker 1928, Freshwater Moll. Wisconsin, pt. 1, p. 355, pl. 8, figs. 27-30.

Planorbula armigera displays the characters of the genus; the planorbid shell is about 7 mm in diameter. According to Baker (1928, p. 359), it is distributed from New England and Great Slave Lake to Nebraska and south to Georgia and Louisiana. It is widespread as a Pleistocene fossil.

In the bog sediments under study here, it is erratically distributed among five faunal assemblages at the Strawn locality (135-1, 135-2), but is absent from the Batavia assemblages, locality 136 (fig. 3). Even where it does occur in these sediments, it is rarely represented by more than one or two shells.

Genus *Promenetus* F. C. Baker 1935

F. C. Baker erected the genus *Promenetus* (Nautilus, 49:48) using *Planorbis exacuous* Say as the type; later (1945) he recognized five species and several varieties of these—which, of course, he referred to as subspecies—by the form in which the so-called varietal names were used. The shells of species in this genus are lenticular, with rapidly increasing whorls, and often with a carinate periphery.

Promenetus exacuous (Say) 1821

Planorbis exacuous Say 1821, Acad. Nat. Sci. Philadelphia Jour., v. 2, p. 168.

Promenetus exacuous (Say), F. C. Baker 1945, Molluscan Family Planorbidae, p. 182, pl. 41, figs. 1-10.

P. exacuous is distributed in North America east of the Rockies from Canada to the mountains of New Mexico; it is absent from the central and southern High Plains except as a Pleistocene fossil.

Promenetus umbilicatellus (Cockerell) 1887

Planorbis umbilicatellus Cockerell 1887, Conchologist's Exchange, v. 2, p. 68.

Promenetus umbilicatellus (Cockerell), F. C. Baker 1945, Molluscan Family Planorbidae, p. 182, pl. 43, figs. 1-12.

P. umbilicatellus was for many years considered as belonging in the genus *Gyraulus*, but anatomical studies demonstrated its relation to *Promenetus*. This species is almost universally represented in the two bogs under study here, being absent from only two faunal assemblages (fig. 3). Never present in abundant populations, *P. umbilicatellus* is, nevertheless, represented in at least moderate numbers where it occurs. It is, obviously, an indigenous element of the total faunal assemblages of the two bogs.

P. umbilicatellus lives today in northern United States and southern Canada, and in high elevations in the Rockies as far south as New Mexico.

Family Ancylidae

Genus *Ferrissia* Walker 1903

Shells of the gastropods of the genus *Ferrissia* are patelliform, or limpetlike; the animals creep about on leaves, stems of reeds and sedges, abandoned shells of unionids, old bottles, and other smooth surfaces in quiet waters. The shells are extremely simple and do not always reflect complexities that may be present in the organization of the animal itself. The genus is worldwide in distribution, but lacking in many places, such as, for example, Europe and Latin America.

Ferrissia parallela (Haldeman) 1841

Ancylus parallelus Haldeman 1841, Monograph Limniades N. Amer., pt. 2, p. 3.

Ferrissia parallela (Haldeman), La Rocque 1968, Ohio Div. Geol. Surv. Bull. 62, pt. 3, p. 521, fig. 375.

The shells of *F. parallela* are so named because the sides of the patelliform shell are straight and nearly parallel, although they widen somewhat anteriorly; the apex is turned slightly to the right and is situated slightly anterior of center. The shells are thin and delicate and easily broken, but many were recovered from auger cuttings in the study of the two bogs. Although there was some variation in the precise form of the shells recovered, it seems best to refer all of them to *F. parallela*.

This little ancylid, rarely more than 5 mm in length, is distributed somewhat erratically through the faunal assemblages studied; how much the apparent occurrence (or lack of it) depends upon the hazards of collecting such delicate shells is not known. They thrive in a pond environment, especially if large vascular plants such as *Typha* are present.

F. C. Baker (1928, p. 397) quotes Walker as saying that *F. parallela* is a northern species distributed from southern Canada to northern Ohio and Indiana. A few records exist for southern states, however; and it is widely distributed as a Pleistocene fossil in the Great Plains.

Family Physidae

Genus *Physa* Draparnaud 1801

Species of the genus *Physa* are aquatic pulmonates with simple, sinistrally spiral shells. They are quite sensitive to local environmental factors, and thus recognition of biological species is extremely difficult. The result has been proliferation of names ad nauseam. For many years F. C. Baker (1928, p. 408) preferred to recognize the genus *Physella* of Haldeman (1842, Monogr. Limnaides N. America, pt. 8, p. 14, 38) on the basis of the digitations of the mantle, but in the last years of his life Baker abandoned this stand.

Physa gyrina hildrethiana Lea 1841

Physa hildrethiana Lea 1841, Amer. Philos. Soc. Proc., v. 2, p. 32.

Physella gyrina hildrethiana (Lea), F. C. Baker 1928, Freshwater Moll. Wisconsin, pt. 1, p. 453, pl. 27, fig. 36, pl. 28, figs. 2-4, 7-14.

The physid shells that occur throughout the faunal assemblages at the Strawn and Batavia localities (135-1, 135-2, 136; fig. 3) are referred to this name combination with some misgivings, but the shells in question closely resemble those previously referred to as *P. g. hildrethiana*. One of the problems in such an assignation is that *hildrethiana* is described by Baker (1928, p. 454) and others as living in temporary ponds, where few animals ever reach maturity before the pond dries up. The shells recovered in these studies are small as described, but there is no evidence that the ponds were in any sense ephemeral, since they supported throughout their history abundant populations of branchiate mollusks that do not survive drying conditions for very long. Whatever the fact may have been, physid shells occur in moderate numbers in every faunal assemblage studied, and with almost no variation of shell characters. The animals must have formed a significant and persistent element of the total molluscan fauna.

Genus *Aplexa* Fleming 1820

Although the shells of this genus are sinistral like those of *Physa*, animals have been separated from that genus on the basis of mantle and other anatomical characters. The differences are not striking, and the validity of the genus may be questioned on biological grounds. As recognized, however, the genus is Holarctic in distribution.

Aplexa hypnorum (Linné) 1758

Bulla hypnorum Linné 1748, Syst. Nat. Ed. 10, p. 727.
Aplexa hypnorum (Linné), F. C. Baker 1928, Freshwater Moll. Wisconsin, pt. 1, p. 473, pl. 19, figs. 1-4.

Whatever may be the true systematic relations of this species, the shells are readily recognized by their sinistral spirals, polished surface, and narrow, elongate spire. *A. hypnorum* is distributed in northern North America (La Rocque, 1968, p. 552, however, notes a record from Louisiana), northern Europe, and Asia.

In our collections, *A. hypnorum* occurs as a single, immature shell at the 8- to 10-foot level of locality 135-1 (fig. 3). It is assumed that the species is not a part of the indigenous faunal assemblages.

Family Carychiidae
Genus *Carychium* Müller 1774

Species of *Carychium* possess minute elongate spiral shells that bear a superficial resemblance to shells of pupillid gastropods. The animals live in damp situations, often very near water but never in it; they live as terrestrial pulmonates. The validity of the several named "species" in North America has been questioned with considerable reason; the problem has been ably discussed by La Rocque (1970, p. 558).

Carychium exile Lea 1842

Carychium exile H. C. Lea 1842, Amer. Jour. Sci., 1st ser., v. 42, p. 109, pl. 1, fig. 5.
Carychium exile Lea, Pilsbry 1948, Land Moll. N. America, v. 2, pt. 2, p. 1058, figs. 561c, 566a.

Since this gastropod is represented in the two bog collections by a single shell (fig. 3) occurring in the base of locality 135-1, precise identification was not possible, since shells must be dissected to demonstrate the character of the plait that ascends the columella. In any case, the single example of *Carychium* cannot be viewed as significant in the total faunal complex.

Suborder Stylommatophora
Family Endodontidae
Genus *Helicodiscus* Morse 1864

Gastropods of this genus have small discoid shells with tightly wound whorls; the shell may resemble a gyraulid. In fact, Thomas Say described the first species that subsequently was recognized as a member of the genus *Helicodiscus*; the shell that he observed was discovered in a dried-up pond near what is now Council Bluffs, Iowa, and he described it as a species of *Planorbis*. However, the striking parallel striations of *H. parallelus* are entirely different from any of those seen among the planorbids. The species of *Helicodiscus* in North America are found primarily east of the Rockies, although there are exceptions to this generalization.

Helicodiscus parallelus (Say) 1821

Planorbis arellelus Say 1821, Acad. Nat. Sci. Philadelphia Jour., v. 2, p. 164 (corrected to *parallelus* in the index, p. 407).

Helicodiscus parallelus (Say), Pilsbry 1948, Land Moll. N. America, v. 2, pt. 2, p. 625, fig. 339.

This small discoid shell is represented in the present collections by a single specimen found at the 8- to 10-foot level at locality 135-1. Although it has been described as a bog species by Ingram (1946, Nautilus, v. 59, p. 91), one example here among many thousands of shells does not indicate that it flourished among the molluscan assemblages under observation.

Family Succineidae

Genus *Succinea* Draparnaud 1801

The succineids are an ancient group of terrestrial gastropods with simple shells featuring a large ultimate whorl and aperture and scarcely four whorls. On the basis of the soft anatomy, four genera are recognized, but in general the shells do not reflect this. Therefore, fossil shells are referred to modern genera with varying degrees of confidence, including none at all. This report uses *Succinea* as the generic name, with the reference to other genera enclosed in parenthesis as if they were subgenera. Considering the difficulties involved, it would seem better, for paleontologists at least, if the modern genera were considered subgenera of the genus *Succinea*.

The succineids are worldwide in distribution, and are found on all continents as well as on many oceanic islands.

Succinea (*Oxyloma*) *retusa* Lea 1834

Succinea retusa Lea 1834, Amer. Philos. Soc. Trans., v. 5, pl. 19, fig. 86.

Oxyloma retusa (Lea), Pilsbry 1948, Land Moll. N. America, v. 2, pt. 2, p. 785, pl. 2, figs. 25, 26.

Succinea retusa was recovered from three faunal associations at Strawn NE locality 135-1, and in these the species was represented by only a few shells. These were unusually small, but they bore other characters of the species, especially the shape of the shell, which is quite distinctive. Living colonies of *S. retusa* inhabit the wet, brushy borders of the lake, especially southwest of boring 135-1, but these modern examples have shells unusually large for the species. The significance of these observations is not clear. *S. retusa* is found principally in northern United States and southern Canada, invariably in wet situations near streams, ponds, and lakes.

Suborder Orthurethra

Family Pupillidae

Genus *Vertigo* Müller 1774

The tiny shells of the pupillids are typically elongate spiral in form, rimate, ovoid, with flaring peristome around an aperture that usually contains a series of one to six or more denticles, although sometimes bearing none. The family is divided into several genera, all differentiated primarily on the basis of shell characters. The genus *Vertigo* is one of the most modified of the genera. The family is not only worldwide in its present distribution, but it is one of the most ancient (geologically speaking) of the terrestrial gastropods. Typical examples of *Vertigo* have been recovered from continental sediments of early Cretaceous age.

Vertigo modesta (Say) 1824

Pupa modesta Say 1824, Long's Exped., Appendix, p. 259, pl. 15, fig. 5.
Vertigo modesta (Say), Pilsbry 1948, Land Moll. N. America, v. 2, pt. 2, p. 982, figs. 528, 531.

Vertigo modesta is a species of wet situations, but it is nevertheless a strictly terrestrial pulmonate gastropod. Empty shells of pupillids can float for long periods of time and over long distances; therefore an occasional shell in a water-laid deposit is not at all remarkable.

In the present study, *V. modesta* is represented by a single shell recovered from the uppermost zone of locality 135-2. This occurrence is not considered significant in the interpretation of the total faunal assemblages.

ECOLOGICAL IMPLICATIONS OF THE BOGS AND THEIR MOLLUSCAN FAUNAS

Depositional Ecology of the Bog Sediments

It is evident from the local topography (figs. 1, 2) that each of the two bogs under study originated in an undrained depression in morainal topography. To what extent, if any, isolated glacial ice masses filled these depressions is not clear. It is also unclear to what extent the original lakes in these depressions formed from meltwater in situ and to what extent by runoff after precipitation on the surrounding slopes, nor does it seem very important. Possibly the temperature of meltwater from a slowly dissipating ice mass might have had some inhibiting effect upon the development of plants and animals in the associated lake, but at the latitude of northeastern Illinois this does not seem likely, especially under the climatic regimen that was producing ablation of the last Woodfordian glacier in the area at the time. A sizable flora and microfauna have developed, for example, in glacier-fed lakes in Antarctica, where climatic extremes are certainly greater than those that could have been expected in Illinois under then prevailing conditions.

Whatever may have been the original source of the water in these lakes, it seems obvious that they have been maintained by runoff from the surrounding slopes since the lakes began accumulating sediments some 10,000 or more years ago. Furthermore, the lakes attained in former times a level distinctly higher than the present level. Evidence for this is especially clear at the Strawn NE locality, where a plain some 200 yards wide, north of the main body of the lake, is judged to be a wave-cut terrace about 10 feet higher than the present level of the water (figs. 1, 2).

The deposits in the former lakes that provide the samples from which the molluscan faunas were obtained certainly owe their origin to materials washed from surrounding slopes; although this conclusion needs no defense in a closed basin, the best positive evidence here is that the less than 2 micron fraction of clay minerals is indistinguishable from that obtained from the tills of the area (H. D. Glass, 1972, personal communication).

In each case, the drainage area supplying runoff to the bog lakes is small; Strawn NE (fig. 1) has an effective drainage area (bounded by the 750-foot contour) of less than a square mile. At Batavia W (fig. 2) the drainage area is somewhat larger (bounded approximately by the 720-foot contour) and encompasses well over a square mile.

The rate of sedimentation into the bog lakes has been slow. Assuming a conservative figure of 10,000 radiocarbon years B.P. as the age of the deposits and 200 inches as the depth of the sediments, the average rate of accumulation has been 0.02 inches per year, or 2.0 inches per century. In spite of the small size of the drainage areas of the two bogs, it appears that: (1) rainfall during the post-Woodfordian interval must have been minimal, and/or (2) the slopes must have been well protected from erosion by a dense vegetative cover.

At the Strawn NE bog lake, the sediments are extremely fine grained, and pebbles are rare except near the base of the lake deposits. The borings might well have missed any gravel trains from entering drainage, but another observation is more difficult to dispose of. For many years, the marl deposits at Strawn NE were removed by a jury-rigged dragline that stretched for a long way across the lake and was situated near the entrance into the lake of a drainageway from the east (fig. 1). Where the dragline scoop was emptied into trucks, a large amount of marl collected, and since abandonment of the harvesting operation several years ago, this "spoil pile" has been subject to wind and rain. Nevertheless, no pebbles were to be found, although the accumulation must represent a rather large sample area. The conclusion seems inescapable either that runoff into the bog lake was not competent to move rock particles larger than silt and very fine sand, or that larger particles were not available because of the protection of covering vegetation on the surrounding slopes. Heavy vegetative cover should result in populations of terrestrial mollusks, but there is almost no evidence of these animals, from the borings, from the large numbers of fossil shells exposed by recent wave action, or from the hundreds of shells exposed on the spoil pile previously referred to.

The sediments contain fossil plants (diatoms) in the basal sediments; in the upper half of the deposits, plant remains become very conspicuous, but are decomposed beyond the possibility of identification. A few fossil seeds were recovered, most of them from sedges (*Cyperus* sp.). Pollen was not investigated; but since the bogs are alkaline, pollen may be poorly preserved.

Each of the two bog lakes terminated in a matte of sphagnum peat, not more than 12 to 18 inches thick at Strawn NE but 4 to 5 feet thick at Batavia W. The base of this peat is approximately 2,000 radiocarbon years old (ISGS-134).

Ecological Implications of the Molluscan Faunas

The molluscan faunal assemblages recovered in the two bog deposits are predominantly aquatic in habitat requirements; of the six taxa that occur at every level in both bogs (fig. 3), all are aquatic and three are branchiate gastropods. Ten species occur in more than 20 of the 31 faunal assemblages; of these, five are obligate aquatic animals (*Amnicola gelida*, *A. leightoni*, *Valvata tricarinata*, *Pisidium nitidum*, and *P. compressum*) using gills for gaseous exchange, although they may be able to exist for brief periods of time without open water. Terrestrial gastropods are very rare in these collections;

among the four species that may be characterized as terrestrial (*Succinea retusa*, *Carychium exile*, *Helicodiscus parallelus*, and *Vertigo modesta*), only *S. retusa* is represented in more than one faunal assemblage, and by more than one shell. In short, the molluscan species in the assemblages under study here are overwhelmingly aquatic in habitat requirements.

Unfortunately, little is known specifically about the habitat requirements of freshwater mollusks. As long ago as 1932 Morrison studied the molluscan faunas in the Northeastern Wisconsin Lake District and noted the hydrogen ion concentration (pH) and dissolved carbonate in the waters of the various lakes; the latter datum he reported in parts per million. Subsequently Morrison has been widely quoted on the assumption that his observations establish the limits, in terms of pH and dissolved carbonates, of the molluscan species reported. In point of fact, his observations can be considered no more than what they were—observations. It is probable that the lakes do extend beyond the limits of tolerance as far as acidity is concerned, but no limits were even hinted at on the alkaline end of the scale, and no laboratory experiments were carried out to determine tolerance limits. Mollusks which have shells require carbonate for their development; these animals obtain carbonate directly from ambient waters or from plants which they consume. The range of pH in which freshwater mollusks may live and reproduce is extremely great; Hunter (1964, p. 87) reports that four species of freshwater pulmonates that transmit schistosomes were shown by laboratory experiments to be able to breed in waters varying from pH 4.8 to pH 9.8. Hunter found (1964, p. 86) that while pH may be a limiting factor in the distribution of freshwater mollusks, ". . . the most important chemical factor is dissolved calcium, varying more than a hundred-fold in fresh waters with mollusks."

Morrison points out that, normally, thin-shelled unionid mussels in waters with low pH and low "fixed carbon dioxide" have shells so flexible that they may be distorted by twisting without breaking (1932). Waters with less than 3 mg/liter of calcium support very few mollusks; in Britain such waters were observed to support a species of *Lymnaea*, one of *Ancylis* (*Ferrissia*), and several species of *Pisidium*. Waters having 8 to 10 mg/liter of calcium support up to 17 molluscan species, while an Irish lake having about 50 mg/liter of calcium supports 32 species (Hunter, 1964, p. 86). Boycott (1936) reports that of 62 species of freshwater mollusks in Britain, 26 can live in waters containing less than 10 mg/liter of calcium and 6 occupy lakes and streams having more than 10 mg but less than 20 mg/liter, while the remainder required waters having at least 20 mg/liter of calcium.

Temperature is not likely to have been a problem at the two bog lakes under investigation, as it is well known that mollusks can survive wide ranges of temperature. Odhner (1923) in a report on Novaya Zemlya, an island off northeastern Siberia well above 70° N latitude, found *Pisidium conventus* active in the brief summers, where winter temperatures are extremely severe. *Lymnaea peregra* lives in thermal waters at 45° C in the Pyrenees, while the same species has been observed active under ice in lakes in Scotland (Hunter, 1964, p. 86). Even from these brief observations and from the modern distribution in North America of the species listed in figure 3, it can be concluded that temperature could not have been an important factor in the survival of the species recovered from the two bogs.

From available evidence, it is probable that the trophic state of the two bog lakes was favorable to the growth of mollusks; the accumulation of organic materials, including diatoms in the lowermost sediments, and increasing quantities of plant remains as the lakes increased in age, point to a condition of eutrophy. "Mollusks are most plentiful in eutrophic lakes with hard water, less common in oligotrophic lakes, and absent from certain dystrophic lakes with little calcium" (Hunter, 1964, p. 87). Inasmuch as the two bog lakes were apparently eutrophic in a strongly basic environment since marl formed in large quantitites, it is not surprising that populations of many species of mollusks were maintained there for a long period of time (approximately 10,000 radiocarbon years).

Several studies of bog lakes or ancient bog deposits have been made in the general latitude of northeastern Illinois, one of the most interesting and informative of these being an investigation of Dollar Lake, a few miles northeast of Kent, Portage County, Ohio (Dexter, 1950). Dexter attempted to correlate molluscan faunal assemblages with vascular plant zones and with pH. He found that at depths greater than 12 feet, the bottom was bare of vascular plants and devoid of mollusks. He also found that in spite of the general basic condition of a bog, surface waters reached a pH of 6.0 at the time of the spring turnover. Unfortunately, Dexter makes no mention of precise quantities of dissolved carbonates in the water. He reported the occurrence of 12 aquatic mollusks, 5 of them common to the Strawn-Batavia faunas. These are: *Promenetus* (*Menetus*) *exacuous*, *Valvata tricarinata*, *Helisoma campanulatum*, *Lymnaea obrussa*, and *L. palustris*. He also mentions *Succinea retusa*, and several additional aquatics by genus only.

Reynolds (1959) described the molluscan fauna in a covered bog deposit from a cornfield in Ohio; the recovered faunal assemblages were entirely aquatic. He analyzes the various species as to percent of the total, but does not specify whether the figures were arrived at from population numbers or by some other means. La Rocque (1952) in an earlier study speaks of percent "by volume." Reynolds uses Morrison's data from a study of molluscan faunas in Wisconsin lakes (without reference), but strangely speaks of "fixed carbon dioxide ratio" in parts per million. Reynolds accepts Morrison's data as if they established the limits of tolerance of the various species concerned. Reynolds discusses the absence of terrestrial elements in the faunas and concludes that terrestrial gastropod shells could not drift as far as 150 feet, the approximate distance of the excavation from the original soil. Reynolds reports the following species, which are common to the Strawn-Batavia faunal assemblages: *Pisidium compressum*, *P. nitidum*, *Sphaerium sulcatum* (= *S. simile*?), *Amnicola leightoni*, *Lymnaea obrussa*, *Gyraulus altissimus*, *Helisoma anceps* (= *antrosa*), *Helisoma trivolvis*, *Physa gyrina*, *Promenetus exacuous*, and *Valvata tricarinata*. In all, Reynolds reported 7 species of sphaeriids and 11 kinds of gastropods.

Another significant study of ancient lake faunas was made by Zimmerman (1960), who described 38 species of mollusks taken from the Newell Lake deposit in Logan County, Ohio. Among the 21 kinds of aquatic mollusca, 13 are common to the Strawn-Batavia assemblages: *Valvata lewisi*, *Amnicola leightoni*, *Pseudosuccinea columella*, *Lymnaea obrussa*, *Helisoma antrosa*, *H. campanulatum*, *H. trivolvis*, *Planorbula armigera*, *Promenetus exacuous*, *Gyraulus altissimus*, *Ferrissia parallela*, and *Physa gyrina*. He also noted *Succinea retusa*. Zimmerman also utilizes the data of Morrison on pH and "fixed carbon dioxide" as if they established tolerance limits for various species. He compares his faunas with Pleistocene molluscan faunas reported by Baker (1918).

Baker (1918, p. 659) lists mollusks recovered from four ponded deposits on the Champaign Moraine in Urbana and nearby Mahomet. Recognizable species comparable to the Strawn-Batavia assemblages include: *Valvata tricarinata*, *Sphaerium sulcatum* (= *S. simile*?), *Pisidium compressum*, *Helisoma antrosa*, *H. campanulatum*, *H. trivolvis*, *Gyraulus altissimus*, *Physa gyrina*, *Lymnaea caperata*, and *L. obrussa*. In a later study, Baker (1930) reported these species, which are common to the two bog assemblages: *Sphaerium sulcatum* (= *S. simile*?), *Valvata tricarinata*, *Helisoma antrosa*, and *Ferrissia parallela*.

More recent studies of fossil molluscan assemblages include those of Leonard and Frye (1960), who reported on Wisconsinan molluscan faunal assemblages in the Illinois Valley region. Species common to the Strawn-Batavia faunal assemblages include: *Carychium exile*, *Helisoma trivolvis*, *H. antrosa*, *Planorbula armigera*, *Gyraulus altissimus*, *Lymnaea dalli*, *L. parva*, *L. palustris*, *Valvata tricarinata*, and *Amnicola leightoni*. *Lymnaea dalli* and *L. parva* were frequently recovered from loess deposits; the animals apparently lived near small ephemeral ponds on the loess surface, although other evidence of these ponds was not always apparent.

In a report on Illinoian and Kansan molluscan faunas, Leonard, Frye, and Johnson (1971) listed 65 species of aquatic and terrestrial mollusks from 29 localities; among those species common to the Strawn-Batavia faunal assemblages are: *Aplexa hypnorum*, *Armiger exigua*, *Gyraulus altissimus*, *L. dalli*, *L. obrussa*, *L. palustris*, *Pisidium compressum*, *Valvata tricarinata*, and *Vertigo modesta*.

A study of the geology and paleontology of Pleistocene Lake Saline in southeastern Illinois (Frye, Leonard, Willman, and Glass,1972) revealed several species common to the Strawn-Batavia assemblages: *Promenetus exacuous*, *Amnicola gelida*, *A. leightoni*, *Gyraulus altissimus*, and *Valvata tricarinata*.

One of the conclusions to be drawn from these observations on previous occurrences is that the faunal assemblages found at the Strawn and Batavia localities, in spite of being relatively young, are composed of molluscan species established in Illinois since much earlier Pleistocene times. Most of these species also occur in Pleistocene faunal assemblages in other areas, as, for example, in the studies in Ohio previously referred to.

Inasmuch as it has been shown that freshwater mollusks are capable of living in waters that vary greatly as to temperature, pH, dissolved minerals, and trophic state, the ecological inferences which can be drawn from the molluscan fossils recovered from the two bogs in question are somewhat limited.

1. An unexpected result of an analysis of the molluscan assemblages is that the molluscan faunas in the two bogs are strikingly similar; such differences as do occur are apparently not important. For example, *Helisoma campanulatum* is found at the Strawn NE locality in only 2 of 20 collections, while at Batavia W the species occurs at every level investigated (fig. 3). The significance of this difference in occurrence is not clear.

2. At neither of the two bogs, at any time in their history extending over 10,000 radiocarbon years or more, were freshwater molluscan faunas as abundant as the number of fossil shells per cubic unit would indicate, because the rate of deposition was extremely slow (2 inches per century). Since no etched shells were observed at any level, it can be concluded that most of the shells that settled to the bottom were preserved. The presence of intact pairs of sphaeriid shells bolsters this conclusion. It therefore follows that molluscan

populations were not abundant at any time in the history of the Strawn NE and Batavia W bogs, since population density per cubic unit is essentially constant except in the lowermost few inches of the deposits.

3. Although there is evidence of higher water levels in the basins that now contain the bogs and bog lakes at Strawn NE and at Batavia W, there is also some evidence that water levels fluctuated widely. *Physa gyrina hildrethiana* is recognized as especially adapted to surviving ephemeral pools, andas a result seldom reaches full size. The almost uniformly small size of the examples recovered tends to support this thesis, although obligate aquatic mollusks occur in the same samples. The conclusion is that *P. g. hildrethiana* lived in peripheral parts of the lake, and were left stranded as water levels fell, while amnicolids and other branchiates lived in the open waters at the center of the bog basin.

4. The sparsity of specific data concerning the ecological requirements of freshwater mollusks makes it difficult to describe the conditions under which the mollusks lived in the Strawn NE and Batavia W bogs. The most that can be done is to use the time-honored (but not necessarily accurate) system of comparing the fossil assemblages with living molluscan faunas. On this basis, it can be concluded that the molluscan faunal assemblages in the two bog lakes lived in relatively clear, cool waters, moderately eutrophic, basic in reaction, sufficiently supplied with dissolved carbonates to support strong growth of molluscan shells, and characterized by fluctuating levels. This favorable environment drew to a close about 2,000 radiocarbon years B.P. when, apparently because of declining water levels, sphagnum moss produced a matte that probably covered the entire surface of the open water. Molluscan populations declined sharply at this time; shells are found only in the lowermost 2 to 3 inches of the peat. Molluscan populations in the two lakes are now very sparse.

5. No evidence of the Altithermal Interval at about 7,500 radiocarbon years B.P., which should occur at approximately the 10-foot level in the two bogs, can be seen in the faunal assemblages.

Finally, as far as is known to me, the molluscan faunal assemblages reported here are the first freshwater faunas reported from the time interval 10,000 to 2,000 radiocarbon years B.P. and documented by direct radiocarbon analyses.

Core samples would add to the accuracy of the knowledge of the vertical distribution of mollusks in these sediments; and studies of diatoms, ostracods, and pollen would broaden the scope of an understanding of the post-Woodfordian geological history.

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