Stratigraphic, Floral and Faunal History of a Wisconsinan Silt Deposit

Bonnie Gray[1]
Department of Geology
Oberlin College, Oberlin, Ohio 44074

Abstract

A section of intraglacial sediments of Wisconsinan age from central Indiana was sampled and used in reconstructing the periglacial environment during a brief ice-free period. Data collected for pollen, plant macrofossils, and land snails indicate colonization of the newly deglaciated surface by mosses, ferns, grasses, sedges and several snail species. At least one pioneer tree species (*Alnus* sp., Betulaceae) was present, perhaps only in scrubby thickets. The vertical distribution of floras and faunas in the section is interpreted as a consequence of migration of species following the retreat of the glacier. There is a marked similarity between this sequence and the floral and faunal gradients surrounding present continental glaciers.

Introduction

During the maximum of the late Wisconsinan (Woodfordian Substage) ice advance in central Indiana some 20,000 years ago, the ice sheet made two major advances separated by a short period of retreat. Sediments deposited during this minor recession are distinguished in places by a fossiliferous silt bed containing abundant remains of a land snail, *Vertigo alpestris oughtoni.* This silt is a principal key bed in Wayne's (7) classification of Wisconsinan deposits in Indiana and is his basis for differentiating the Cartersburg and Center Grove Till Members of the Trafalgar Formation. Several exposures of this silt were studied by Wayne (6, 7, 8), who used fossil mollusks to reconstruct the periglacial environment. The purpose of this report is to describe a new but similar section and to interpret its ecological history.

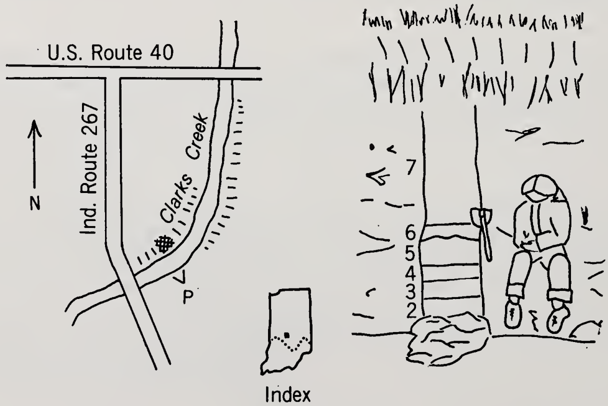
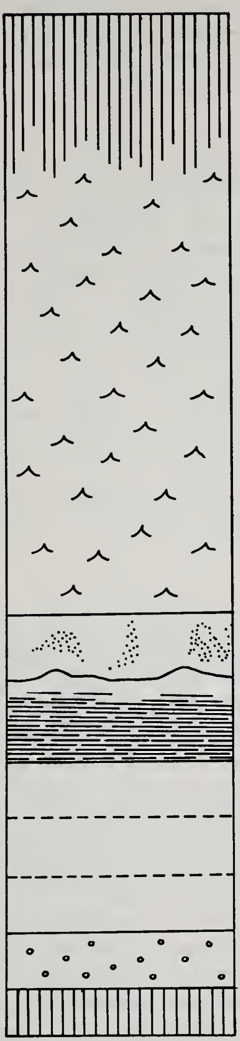


Figure 1. *Map and sketch of sample site. Hachures indicate creek bank exposures. Crosshatching shows the location of the section sampled and described; P indicates angle of photosketch. Point of shovel in the photosketch marks the base of the disturbed silt bed, Unit 7. The dotted line on the index map shows the maximum Southern extent of the Wisconsinan ice sheet.*

[1] Present address: Institute of Arctic and Alpine Research, University of Colorado, Boulder, Colorado, 80302.



Sample number	Description	Thickness (inches)
	Cartersburg Till Member. Not sampled.	
7	Silt, pebbly; blocky fracture, fine in lower part to coarse in upper part; pebbles are small in lower part to coarse in upper part. Disturbed, probably by frost action.	45
6	Clay, silty, brown, with pockets of reddish oxidized sand.	5 - 6
5	Silt, dark, organic; upper 1"-3" is contorted and is bleached to a light gray.	7 - 8
4	Silt, gray, oxidized in streaks and spots to reddish brown; contains some charcoal and organic matter.	5
3	Silt, as above; divisions are arbitrary.	5
2	Silt, as above.	5
1	Gravel, at creek level and water-saturated.	5+
	Center Grove Till Member, inferred. Exposed in lower creek banks to northeast. Not sampled.	

FIGURE 2. *Stratigraphic column of the section.*

Description of the Section

The section studied is along a relocated stream channel a few hundred feet south of the junction of U.S. Route 40 and Indiana Route 267 (Fig. 1), just east of Plainfield, Indiana (NE¼, SW¼, Sec. 25, T15N, R1E; Bridgeport 7½′ Quad.). At the base of the section, and exposed principally on the east bank of Clarks Creek, is the Center Grove Till member. This is overlain by about 6 feet of intraglacial sediment, predominantly silt. The best exposure of this silt is at the site sampled, near the southwest end of the exposure (Fig. 1). Here it is overlain by only a few feet of the Cartersburg Till Member, but along the east bank of the creek about 10 feet of this till is present. The stratigraphic sequence of the section is shown in Figure 2.

Fossils

Plant Macrofossils

Standard laboratory techniques were used to separate large organic remains from the rest of the samples. The plant remains consist mostly of a litter of unidentifiable bark, twig and tendril pieces. Moss fragments are common and apparently represent some upland form rather than sphagnum or other bog moss (George Jones, personal communication, April 1972). Also abundant are pale brown, roughly spherical capsules, 1 to 2 mm in diameter with trilete sutures. These are megaspores from some species of quillwort, an aquatic or amphibious herb with a sedge-like or grass-like habit. Quillworts range widely, from Mexico to Labrador (George Jones, personal communication, April 1972). The clustered leaf bases of sedge are also numerous in the leaf litter. At the sample site, some large stumps and roots, identified as alder (*Alnus* sp., Betulaceae) are preserved in growth position. Wood specimens from other sites in the *Vertigo alpestris oughtoni* bed are dated at 19,930 to 20,300 B.P. (8, Table 1).

Plant Microfossils

The method of pollen extraction used in this study was adapted from the method used at the Indiana Geological Survey laboratories. Samples are washed in a series of baths of $NaOH$, HCl acid and HF acid and then are dried in alcohol washes. The samples are then ready for mounting. They were scanned under 430X and 800X magnification, and each pollen grain and spore in every sample was described and sketched. All pollen and spores recovered are small forms in the 10 to 40μ size range. The majority are from the moss, fern, sedge and grass families (Fig. 3). Arboreal pollen identified as birch (Betulaceae) is present in Samples 4, 6, and 7. Although the number of grains recovered is small and firm conclusions cannot be drawn from the pollen alone, it is clear that the abundance and diversity of pollen and spores increases upward, reaches a maximum in Sample 4, and shows no significant decrease in number or diversity from that point to the top of the section. Mosses, ferns, sedges and grasses are represented in all samples. The birch pollen only appears high in the section stratigraphically, but it is persistent throughout the upper four samples.

Insects

An interesting surprise was the discovery of several well preserved beetle parts. Delicate, iridescent black body plates with pitted surfaces were most numerous. Several leg sections and two complete heads were also recovered. Coope has made ecological interpretations of sedimentary sequences based on beetle faunas (2). Some species evidently fed exclusively on certain plants and required very specific habitat conditions. Although limited resources and time prevented identification of the beetle parts found in this study, this is a challenging field for future research.

Sample number	Moss or fern	Grass or sedge	Birch	Unidentified	Sum
7	4	8	2	3	17
6	4	4	3	4	15
5	3	2	1	0	6
4	9	8	2	6	25
3	2	3	0	2	7
2	1	4	0	0	5
1	3	6	0	0	9

FIGURE 3. *Diagram showing frequency (by number) of principal types of pollen and spores in the section studied and sketches of some representative specimens. Magnifications vary; the bar scales represent 10μ.*

Snails

The criterion used for separating snails to be identified, counted and used for interpretive purposes was the presence of intact apices. In this way accidental double counting of broken individuals is avoided. Snails were then separated by genus and counted.

Four genera were recovered, including the bed marker fossil, *Vertigo*. One genus, probably *Vallonia*, was represented by only one individual. Representatives of *Succinea* appear in the silt immediately above the gravel in the lowest stratum of the section and increase in number upward to the middle of the section (Fig. 4). *Vertigo* and *Pupilla*, tabulated together because they are indicative of the same habitat, enter somewhat higher in the stratigraphic sequence and outnumber *Succinea* in the fourth through seventh stratigraphic units.

Succinea is adapted to a wide range of habitats. Today this genus lives on prairies and grasslands as well as in areas of discontinuous woods in the northern United States (1, 3). It is well adapted to life in grassy or mossy meadows without the presence of brush or trees. *Pupilla* and *Vertigo*, however, prefer wooded spots. Both presently occur in cool, humid climates in Manitoba and northern Ontario and also in the Rocky Mountains at higher elevations as far south as New Mexico (1, 3). All three genera require moist humic material in which to live and all forage for food in the decaying humus, eating algae and lichens, among other things (5).

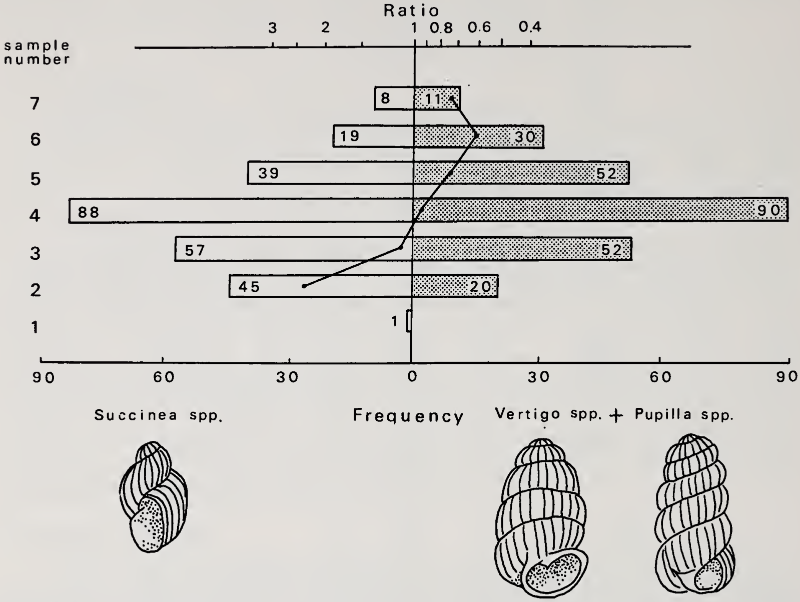


FIGURE 4. *Diagram showing the abundance of ecologically significant gastropod species. Bars designate observed frequencies; dots and connecting line show the trend of species dominance on a ratio scale. Compare with pollen and spore sums shown in Figure 3.*

Interpretation

Most present glaciers are in retreat, and around the margins of these bare ground is exposed. The first plant invaders on newly exposed rock rubble are lichens. Mosses and sedges move in rapidly, making possible the advance of pioneer tree species. Alder (*Alnus* spp., Betulaceae) and willow (*Salix* spp., Salicaceae) are able to establish scrubby thickets in moist protected pockets (4). The scene is then set for forest development beginning with larch (*Larix* spp., Pinacae) followed by other conifers.

Under the influence of transgression or regression, lateral facies relationships show up as vertical facies relationships in stratigraphic section. This principle, sometimes known as Walther's law, after the German stratigrapher who first clearly stated it, can also be applied to horizontal floral and faunal facies around present glacier margins. As the ice transgresses or regresses, the flora and fauna will presumably migrate accordingly, and this will result in vertical floral and faunal relationships in stratigraphic succession.

The stratigraphy and fossil assemblages of the deposit studied clearly show the successive environments that developed as the ice sheet retreated following deposition of the Center Grove Till Member and then readvanced to deposit the Cartersville Till. During deglaciation, material carried by the melting ice began to be deposited immediately. The fineness of the silt dominant throughout the section suggests that this was an area of overbank deposits, perhaps near a system of braided outwash streams or possibly a broad swale where outwash ponded. During times of high water, meltwater overflowed its channels and, because of its decreased velocity in overbank areas, dropped its load of silt. The thickness of the sedimentary units, together with the sparseness of pollen, gives the impression that the rate of sedimentation was fairly rapid. Floating ice masses could raft and drop larger material carried from the nearby glacier—pockets of sand, occasional pebbles, cobbles and trapped organic debris. Stratigraphic Unit 5 (Fig. 2) is a bed of leached, light gray silt, highly contorted and irregular in thick ness. Some degree of soil development is suggested by the leaching, and it seems likely that the contortion was caused by intense frost action. Such disturbed soils occur today at high altitudes and in arctic regions where temperature regimes are severe. Above this unit is a thick bed of highly disturbed sediment (Unit 7), probably deposited very near the returning glacier's front. The distortion in this sediment may show the effect of intense frost action and subsequent contortion by the overriding ice sheet.

The upward increase in number of pollen grains and spores, along with the increase in diversity of pollen types, indicates increasing colonization of the area by plants. Stratigraphically first on the scene and readying the substrate for alder thickets were mosses, ferns and sedges. These groups are all represented by pollen and spores from the lowest to the highest stratigraphic units. In addition, mosses and especially sedges were significant contributors to the organic litter that was reclaimed from the samples. Large fragments of alder (*Alnus*, Betulaceae) also were recovered. The birch pollen (Betulaceae) in the upper part of the section is therefore assumed to be alder pollen.

Snails rapidly moved into areas colonized by plants. *Succinea* occurs in the lowest silt deposit of the section. This indicates that the area was colonized by gastropods very shortly after deglaciation. Like the pollen, the snails show an increase in number of individuals upward through the section. The advent of *Pupilla* and *Vertigo* suggests that the region was at least partly forested, if only by scrubby clumps of alder in damp, protected places. The presence of these two genera also suggests that the climate remained quite cool and humid throughout the ice-free period.

The fossil data from this section, together with the stratigraphic sequence, convey a picture of gradual colonization of the newly opened area by plants and animals as the ice retreated. This trend was arrested by the return of the ice sheet. Walther's law would seem to predict a roughly symmetrical advance and retreat of the flora and fauna as the ice regressed and transgressed. The data gathered, however, are markedly asymmetrical, showing no distinct retreat of living things as the ice returned. It is possible that this results from truncation of the intraglacial deposits by the readvancing glacier, but the transitional contact at the base of the Cartersburg Till (Fig. 2) argues against any significant amount of truncation. Perhaps, therefore, the asymmetry reflects the slowness with which newly opened habitats were colonized and the stability of the communities once they had become established. Perhaps irreversible environmental changes, such as the development of soils, allowed the well established plant and animal communities to persist until they were overridden by the ice itself.

Acknowledgments

For location of the site, help in the field and assistance in preparing the paper for publication, I thank Drs. Ned Bleuer and Henry Gray of the Indiana Geological Survey and Dr. Sidney White, Ohio State University. Dr. R. Peter Richards, Oberlin College, research advisor, gave continual support and encouragement, for which I am also thankful.

Literature Cited

1. BAKER, F. C. 1936. Quantitative examination of molluskan fossils. J. Paleontol. 10:72-76.
2. COOPE, G. R. 1968. Insect remains from silts below till at Garfield Heights. Ohio. Geol. Soc. Amer. Bull. 79:753-755.
3. JOHNSON, G. H. 1965. The stratigraphy, paleontology and paleoecology of the Peoria loess (upper Pleistocene) of southwestern Indiana. Unpublished Ph.D. Dissertation, Indiana Univ., Bloomington. 215 p.
4. MARR, J. W. 1948. Ecology of the forest tundra. Ecol. Monogr. 18:117-144.
5. MORTON, J. E. 1967. Molluscs. Hutchinson Press, London, Eng. 244 p.
6. WAYNE, W. J. 1959. Stratigraphic distribution of Pleistocene land snails in Indiana. Sterkiana. 1:9-12.
7. ________. 1963. Pleistocene formations in Indiana. Indiana Geol. Surv. Bull. 25. 85 p.
8. ________. 1965. The Crawfordsville and Knightstown moraines in Indiana. Indiana Geol. Surv. Rep. Prog. 28. 15 p.