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Holocene Vegetational Changes in Eastern Iowa

R.G. BAKER, C.A. CHUMBLEY, P.M. WITINOK, and H.K. KIM

Pollen and plant macrofossil analysis from three sites along an east-west transect in southeastern Iowa provide evidence for Holocene vegetational development. Colo Marsh at the west end of the transect is relatively complete, with a late-glacial spruce zone ending about 11,500 yr B.P.; a deciduous forest zone from about 11,500 to 8500; a prairie zone from 8500 to 4500, and prairie with oak from 4500 to present times.

Sediments from the site at the Indian Creek Nature Center, midway in the transect, date only from about 6000 to 1600 yrs B.P. This site also was dominantly prairie from 6000 (and probably before) to 4500 yr B.P. Oak and hickory were present from 4500 to 3500, and were joined by more mesic trees from 3500 to 1600 yr B.P.

Mud Creek occupies a very gently sloping drainage basin at the east end of the transect; the site there includes three dated levels ranging in age from about 9300 and 5500 yr B.P. The vegetation during that entire time was apparently mesic deciduous forest with abundant basswood.

Apparently an important vegetational boundary existed in eastern Iowa during early and middle Holocene time. In western and central Iowa prairie was dominant and climate was driest between about 8300 and 4500 yr B.P. At this same time, mesic deciduous forest prevailed in eastern Iowa.

INDEX DESCRIPTORS: Holocene, paleoecology, vegetational history, palynology, plant macrofossils, Iowa.

The Holocene vegetational history is poorly known beyond Wisconsinan glacial boundaries. Most vegetational reconstructions in this region are from localities in glaciated areas, where such conventional pollen sites as lakes, marshes and bogs are numerous. Although sites in unglaciated areas are present, they are not abundant and have been seldom explored. Examples of these atypical sites are beaver-pond deposits, oxbow-lake sediments, marshes in abandoned river channels and upland ponds formed by dune sands or blowouts. Sites such as these are often not ideal sites for either pollen or plant macrofossils (Jacobson and Bradshaw, 1981; Janssen, 1966) because 1) preservation may not be as good as in kettle lakes, 2) records are often of shorter duration, and 3) hiatuses are more common. Nevertheless, these sites often contain valuable records of vegetational history (e.g. Baker et al., 1986).

This paper reports on pollen and plant macrofossil analyses from three sites along an east-west transect in southern Iowa. The transect crosses a diffuse boundary in presettlement vegetation between prairie and mixed oak forest on the east and prairie on the west (Figure 1). Colo Marsh (Colo Bog of Brush, 1967) is a small kettle depression just within the Wisconsinan ice border near Des Moines. The surrounding area is now open farmland with nearby prairie remnants, and it was unforested and presumably prairie in presettlement times (Iowa State Planning Board, 1935). The site at the Indian Creek Nature Center is a small upland depression near Cedar Rapids, Iowa (Figure 1). It may have formed when sand dunes dammed drainages along the Cedar River during late-Wisconsinan time. It is 0.4 km from the Cedar River, is surrounded by dense Quercus-Ulmus-Tilia (oak-elm-basswood) forest at present, and apparently was forested in the 1800s (Iowa State Planning Board, 1935). The paleoecology of the Mud Creek area (Figure 1) was first investigated by Kramer (1972), who collected from several exposures along the creek but obtained only one radiocarbon date. The exposure investigated in this paper consists of three superimposed sets of floodplain-pond sediments. The shallow valley at Mud Creek is cut into pre-Illinoian drift. The area is presently open cultivated land and was unforested in the 1800s (Iowa State Planning Board, 1935).

METHODS

Colo Marsh was cored using a modified Livingstone sampler. Cores were wrapped in Saran Wrap and aluminum foil and stored at room temperature. At Indian Creek Nature Center, samples were collected from the upper 70 cm by digging a hole. Below 70 cm the silts were cored using the Livingstone coreer. Sediment monoliths from the

Fig. 1. Map showing locations of sites, late Wisconsinan glacial boundary and presettlement vegetation.

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upper 70 cm were placed in zip-lock bags, whereas the cores were wrapped in Saran wrap and aluminum foil. At Mud Creek, monoliths were dug from a curbside excavation and stored in zip-lock bags.

Pollen samples were processed using techniques modified from Faegri and Iversen (1975). Samples were treated with KOH, HCl, HF, acetylsol fractionation, and a 2% solution of Clorex, floated in ZnCl2, and screened through a 7 μ sieve. Processed samples were mounted in silicone oil and pollen was identified using the reference collection at the University of Iowa Geology Department. Plant macrofossils were washed through 0.5 and 0.106 mm screens, handpicked under a dissecting microscope, and stored in glycerin. They were identified using the reference collection in the Department of Geology. Pollen analyses are plotted as percentages and concentrations of deciduous trees, (especially Abies, Acer, and Tilia) also present, especially Gramineae (sedges) and Triadenum forsteri (Spach) G1 (Marsh St. John's-wort) are present and increase towards the top of the zone. A few macrofossils of weedy colonizers (Amaranthus, Oxalis, [wood-sorrel] Urtica dioica L. [nettles], and Monarda fistulosa L. [wild bergamot] and Verbena hastata L. [vervain] and prairie taxa (Lobelia spicata L. [spiked lobelia], and Rudbeckia subtomentosa Pursh [coneflower]) are also present.

In zone 3 the aquatic elements and most of the wet-ground and fen elements disappear, (probably because of poor preservation of macrofossils in this zone), and only Triadenum forsteri and Carex (sedge) spp. remain abundant. Intervals of Sparganium peat occur in this zone; such peatlands are currently rare in Iowa (Conard 1952; Grant and Thorn, 1955; Peck, 1978). Fruits of the forest understory species, Eupatorium rugosum Hautt (white snakeroot) appear only at the top of this zone.

Mud Creek

Mud Creek occupies a drainage basin with very gentle slopes. The fossiliferous sediments were exposed in a curbside, where three separate sets of floodplain-pond fillings are superimposed on one another. These sediments probably accumulated in an oxbow lake or beaver-dam pond. A hiatus is likely between the sediments of each level, so no pollen or macrofossil zones were delimited. Pollen was relatively well preserved in the sandy silts of the lower levels, but poorly preserved in the overlying dark organic silts (Figure 7). The upper silts were considerably above creek level and were more oxidized than the lower silts.

Pollen analyses from three levels show that trees and shrubs have relatively high pollen percentages. Quercus, Ulmus and Tilia pollen each reach about 20% in one of the three levels, with Tilia increasing upward to 40%. Nonarboreal pollen is also present, especially Gramineae and Ambrosia. Three radiocarbon dates, one from each level, give the times represented by each pollen sample: 5480 ± 80, 6820 ± 90, and 9310 ± 50 yrs B.P. (Table 1, Figure 7).

Plant macrofossils at Mud Creek were abundant in the lower sandy silts, but nearly absent in the upper silts. Bud sclers of Ulmus americana L. (American elm) and fruits of Tilia americana L. are relatively abundant as macrofossils, but no macrofossils of Quercus were found. Oak is a predominantly upland tree in the Midwest, and is rarely found as a macrofossil. Fruits of Carpinus caroliniana Walt. (hornbeam), Ostrya virginiana (Mill.) K. Koch (ironwood) and wood of Juglans sp. show that other forest trees were present. Shady forest understory plants include Aralia racemosa L. (spikenard), Campanula americana L. (tall bellflower), Menispermum canadense L. (monseed)
Fig. 2. Pollen percentage diagram from Colo Marsh.
Colo Marsh
Macrophossil Concentration Diagram

Fig. 3. Plant macrofossil concentration diagram from Colo Marsh.
Fig. 4. Pollen percentage diagram from Indian Creek Nature Center.
Fig. 5. Pollen concentration diagram from Indian Creek Nature Center.
Indian Creek Nature Center
Macrofossil Concentrations

Fig. 6. Plant macrofossil diagram from Indian Creek Nature Center.
Mud Creek Forest Plants and Weeds
Macrofossil Concentrations

Fig. 8. Plant macrofossil diagram from Mud Creek.
Table 1. Radiocarbon dates from the Colo Marsh, Indian Creek Nature Center and Mud Creek.

<table>
<thead>
<tr>
<th>DEPTH (CM)</th>
<th>RADIOCARBON YEARS B.P.</th>
<th>LAB NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colum Marsh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>95-100</td>
<td>4,490 ± 80</td>
<td>Beta-14233</td>
</tr>
<tr>
<td>150-155</td>
<td>6,190 ± 90</td>
<td>Beta-14234</td>
</tr>
<tr>
<td>195-200</td>
<td>8,300 ± 100</td>
<td>Beta-14235</td>
</tr>
<tr>
<td>202-207</td>
<td>9,420 ± 150</td>
<td>Beta-15007</td>
</tr>
<tr>
<td>245-250</td>
<td>11,570 ± 140</td>
<td>Beta-14236</td>
</tr>
<tr>
<td>Indian Creek Nature Center</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-25</td>
<td>1,960 ± 70</td>
<td>Beta-21012</td>
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<td>70-75</td>
<td>3,980 ± 70</td>
<td>Beta-21013</td>
</tr>
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<td>123-142</td>
<td>5,820 ± 80</td>
<td>Beta-32478</td>
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<tr>
<td>Mud Creek</td>
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<td></td>
</tr>
<tr>
<td>117</td>
<td>5,480 ± 80</td>
<td>Beta-7341</td>
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</tr>
<tr>
<td>223</td>
<td>9,310 ± 90</td>
<td>Beta-7342</td>
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</tbody>
</table>

and Thalictrum, probably T. dioicum L. (meadow rue) (Figure 8). Weedy taxa include Acalypha (three-seeded mercury), Amanthus (amaranth), Ambrosia trifida L. (giant ragweed), Chenopodium and Urtica dioica. Wet-ground taxa are also abundant, especially the sandy silts.

**DISCUSSION**

Correlation of these sequences is dependent on reliable radiocarbon dates. The dates from Colot and the Indian Creek Nature Center are bulk-sediment dates, whereas those from Mud Creek are wood dates. Bulk-sediment dates are more subject to contamination from pre-Quaternary carbon and from rootlets than wood dates. However, all materials were pre-treated to remove carbonates and rootlets, and all dates correlate well with the closest other sites in the area. There is no reason to doubt the validity of any of the radiocarbon dates.

The Colo Marsh pollen sequence is comparable with those of other small marshes on the Des Moines Lobe (Durkee, 1971; Kim, 1986). From the time of deglaciation (probably about 13,000 yr B.P.) to about 11,000 yr B.P., a Picea-Larix forest was present in the Colo area (Figure 2), and over much of the state (Baker et al., 1980; Chumbley, 1989; Kim, 1986; Van Zant, 1979). A small pond existed during the later stages of this time, and Naias flexifis (naiad) was the dominant aquatic plant (Figure 3). As climate became warmer in zone 2, Abies and a succession of deciduous trees occupied the area between about 11,000 and 8300 yr B.P. Potamogeton became established in the pond. About 8300 yr B.P. the forest abruptly disappeared, and prairie elements became established around Colo Marsh. Water levels in the marsh fell, and aquatic plants virtually disappeared. They were replaced by marsh and wetland plants including Scirpus validus and/or S. acutus and Polygonum lapathifolium L. (smartweed), and weedy annual plants such as Chenopodium and Amanthus (Figure 3).

An air mass climate was warmest and driest in the Colo Marsh vicinity between about 8300 and 4500 yr B.P., when prairie and weedy elements replaced deciduous forest, and the water levels dropped, converting the pond to a weedy marsh. Subsequently cooler and wetter conditions prevailed. Quercus returned to the region, probably in a savanna or along valley walls, and water levels rose to support a rich aquatic flora in the marsh.

This pattern is supported by dated organic layers in a upland drainage basin near Ames, Iowa, where prairie elements were present at 5490 ± 110 yr B.P. (Beta-16616), but forest elements were dominant at 2660 ± 90 (Beta 19099) (Van Nest and Berris, in press).
Fig. 7. Pollen percentage diagram from Mud Creek.
Transeau (1935) used the term prairie peninsula for the eastward extension of prairie into Illinois, Indiana and Ohio. This extension was assumed to have occurred during the middle Holocene warm period. Previous work in Minnesota, South Dakota and northwestern Iowa (McAndrews, 1966, Van Zant, 1979; Waddington, 1969; Watts and Bright, 1968; Wright et al., 1963) indicated that prairie incursion began earliest in the west (ca. 10,000 yr B.P.) and latest in eastern Minnesota (about 7000 yr B.P.). Prairies remained in the Dakotas but disappeared earliest in eastern Minnesota (about 5000 yr B.P.). Sires in central and western Iowa follow this trend (Kim, 1986; Van Zant, 1979).

By comparison, sites in Illinois (King, 1981) and Wisconsin (Winkler et al., 1986) show little evidence of prairie invasion, but Webb et al., (1983) map the prairie border farther east into Illinois at 3000 than at 6000 yr B.P. Climate models based on pollen data (Bartlein et al., 1984) also suggest that 1) mid-Holocene precipitation decreases were greatest in the west and almost non-existent in the east, and 2) that mean annual temperatures were slightly cooler 6000 yr B.P. than they are at present in eastern Iowa, southern Wisconsin and Illinois. However, these models of past vegetation and climate are all projected across Iowa, where almost no data were available.

The prairie-forest border is presently coincident with boundary conditions separating predominantly dry Pacific air masses from Arctic airmasses to the northeast and maritime tropical (Gulf of Mexico) or atlantic airmasses from the southeast (Bryson, 1966). Arctic airmasses to the northeast and maritime tropical still prevail in eastern Iowa. However, these models of past vegetation and climate are all projected across Iowa, where almost no data were available.

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