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A Mid-Wisconsinan Pollen Diagram From Des Moines County, Iowa

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Core samples of peat from beneath Wisconsinan loess in Des Moines County, Iowa, were analyzed for pollen. The pollen sequence, dating from 24,900 to 28,720 RCYBP (radiocarbon years before present), was divided into 2 zones based on relative pollen percentages and pollen concentration. Zone B, at the base of the peat, is dominated by *Pinus* and *Picea* and is interpreted to represent a closed-coniferous forest, comparable to the modern boreal forest. Zone A, at the very top of the peat, is marked by the decline of *Pinus* and the increased importance of *Picea*. This is a regional event which marks the change to the late-glacial *Picea* forest which was devoid of *Pinus*.
INDEX DESCRIPTORS: Palynology, Quaternary, Farmdalian, Paleoclimatology, Paleocology.

During investigations of the Quaternary stratigraphy and soil-geomorphology in Des Moines County, Iowa, several buried Wisonsinan-age peats were encountered. The data presented here are from a core hole located in Washington Township, northwest Des Moines County, about 2.4 km (1.5 miles) west of the town of Yarmouth on the old Brun Farm. A detailed location is given in the Appendix. The site is in a cultivated field, on a prominent tabular divide, stepped down from the ridge at Yarmouth, that classically has been considered the edge of the Illinoian drift in Iowa (Leverett, 1899; Kay and Graham, 1943).

The upland areas around the site are mantled uniformly by about 2.7 m (9 feet) of Wisconsinan loess. The soils in the area are all mollisols formed most recently under prairie vegetation. The detailed stratigraphy of the core hole is given in the Appendix. The peat is part of a complex sequence of sediments and paleosols (see Appendix). The generalized stratigraphy of the site is: 0-2.7 m — modern soil and Wisconsinan loess; 2.74-3.38 m — peat, basal loess paleosol; 3.38-4.01 m — basal loess paleosol and sediments; over a Sangamon paleosol on Illinoian age sediments.

The peat was radiocarbon dated. The top of the peat from 2.74 to 2.82 m dated 24,900 ± 570 RCYBP (radiocarbon years before present; I-9357); the base of the peat from 3.30-3.38 m dated 28,720 ± 890 RCYBP (I-9358). The radiocarbon dates place the peat in the early part of the Farmdalian Substage of Illinois (Willman and Frye, 1970).

PROCEDURES

Pollen samples were taken from the peat at 2 cm intervals. The basal sample of the diagram was taken from the mineral rich IIA1b of the complex basal loess paleosol. The samples were processed using techniques modified from Faegri and Iversen (1964) to remove the pollen from the matrix. Samples were treated successively with 10% KOH, 10% HCl, 48%HF, and acetolysis solution. The residue was washed with tertiary butyl alcohol, transferred to silicone oil, and mounted on slides.

In each sample at least 300 pollen grains were counted. Percentage curves are based on total pollen, excluding spores. Pollen concentration (the number of pollen grains in a unit volume of sediment) was determined using a method modified from Maher (1972). A known number of exotic pollen grains *(Eucalyptus)* were added to a measured volume of the sediment during processing. To calculate the concentration of indigenous pollen in the sample, the following equation was used:

$$T = \frac{NR}{V}$$

where
- T = number of grains of taxon/cc of sample,
- N = number of *Eucalyptus* grains added to the sample,
- R = ratio of the number of grains of taxon to the number of *Eucalyptus* grains encountered during counting, and
- V = volume of the sample in cc.

POLLEN PERCENTAGE DIAGRAM

The pollen percentage diagram (Figures 2 and 3) is dominated throughout by *Pinus* (37-67%), *Picea* (5-24%), Cyperaceae (4-26%), and Gramineae (4-21%). Pollen of *Betula, Alnus, Salix,* Chenopodiineae, and Compositae range from less than 2 to 12%. The total nonarboreal pollen (NAP) is generally low, but ranges from 19 to 40%.

We recognize two zones based on the *Pinus* and *Picea* curves. Zone A, the *Picea-Pinus* Zone, extends from the top of the peat at 2.74 m to 2.82 m. Zone B, the *Pinus* Zone, extends from 2.82 m to the bottom of the diagram at 3.45 m.

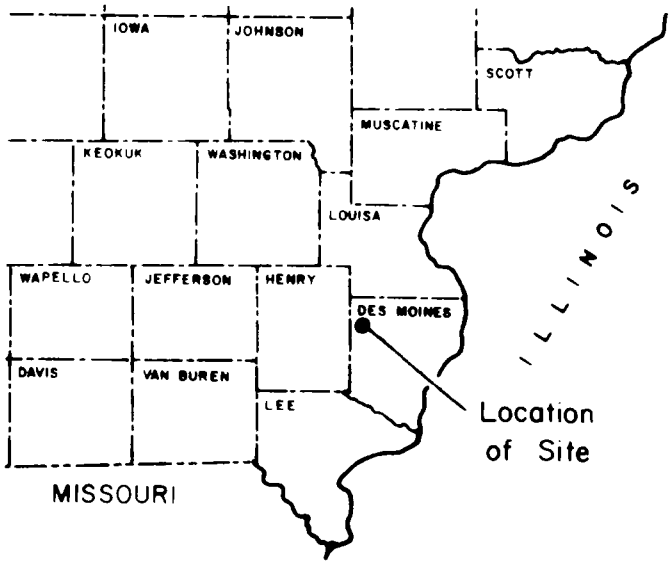

Figure 1. *Map of a portion of southeastern Iowa, showing location of site.*

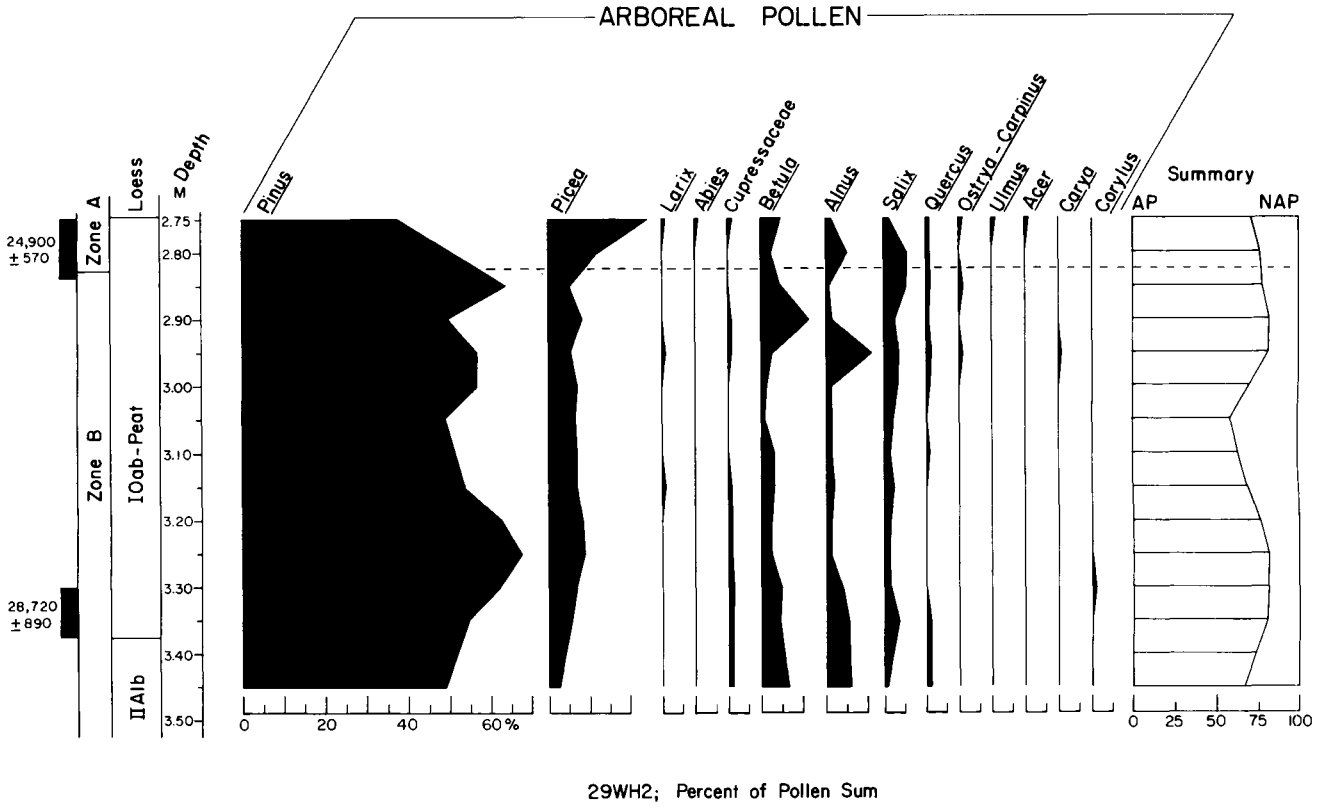

Figure 2. *Pollen percentage diagram, Brun Farm buried peat (29WH2); arboreal pollen (AP) and summary AP and NAP.*

Zone B is characterized by high *Pinus* percentages (average, 55%; range, 49 to 67%). *Picea* pollen percentages are low (average, 7%; range 3 to 8.5%). In the upper portion of Zone B, peaks of *Alnus* (10% at 2.94 m) and *Betula* (12% at 2.90 m) occur at single levels. Gramineae pollen peaks (21%) at the base, and Cyperaceae (26%) and Chenopodiineae (10%) peaks near the middle of the zone. *Salix* averages about 2%, but rises to about 5% near the upper boundary of Zone B. *Quercus* and Cupressaceae are present in low amounts (generally less than 1%), and other deciduous tree pollen are sporadically present.

Zone A, consisting of the upper two samples of the peat, is characterized by *Picea* pollen percentages increasing to 24% and *Pinus* decreasing to 37%. Pollen of *Betula, Alnus,* and *Salix* range from 2-5%, Cyperaceae remains high at about 18%, and Gramineae rises to about 10%. *Abies* pollen makes its only appearance in the top level, and deciduous-tree pollen is present at less than 2%.

POLLEN CONCENTRATION

The pollen concentration (Figure 3) in the peat and related sediments ranges from about 19,000 to 675,000 grains/cc. The pollen concentration averages about 300,000 grains/cc. (Pollen concentration only includes taxa used in the pollen sum.) Changes in pollen concentration may be produced by 1) variations in the rate of pollen deposition, which may relate to regional vegetational changes; 2) changes in the rate of sediment deposition that may relatively dilute or concentrate the pollen content; and 3) differential compaction of the sediment, which affects the density of the material, and hence the concentration of pollen per unit volume.

The total pollen concentration strongly resembles the concentration of *Pinus* pollen (Figure 4). Because pine is so abundant, fluctuations in pine concentration can cause changes in pollen percentages of other taxa that are not accompanied by similar changes in pollen concentration of these taxa. A noteworthy example is at the base of Zone B. The percentage of Gramineae pollen decreases upward in the lowest 5 samples (Figure 3). The pollen concentration of Gramineae actually increases upward in these same samples from about 9,000 to 41,000 (Figure 4). The decreasing percentages are caused by the large increase in *Pinus* concentration from about 10,000 to a peak of 200,000 at this time (Figure 4). This increase overwhelms the modest increase in Gramineae concentration, and causes grass percentages to decline.

A second example occurs at the top of the diagram, *Picea* percentages rise sharply, to 24 percent but *Picea* concentration declines from 58,000 to 15,000 from sample 2.79 to sample 2.74 (Figures 2 and 4). *Pinus* concentrations drop from 250,000 to 22,000 in these samples, allowing *Picea* percentages to make up a larger part of the pollen sum.

DISCUSSION

Interpretation of the pollen diagram suggests that the Des Moines County area was dominated by a *Pinus* and *Picea* forest during at least the early part of the Farmdalian substage. *Pinus-Picea* consistently comprise 52-77% of the total pollen, and total arboreal pollen ranges from 60-83%. These values, and the generally high pollen concentrations, compare favorably with modern samples from closed coniferous forest from Canada (Lichti-Federovich and Ritchie, 1968; Webb and McAndrews, 1976). The forest in this time period contrasts with the

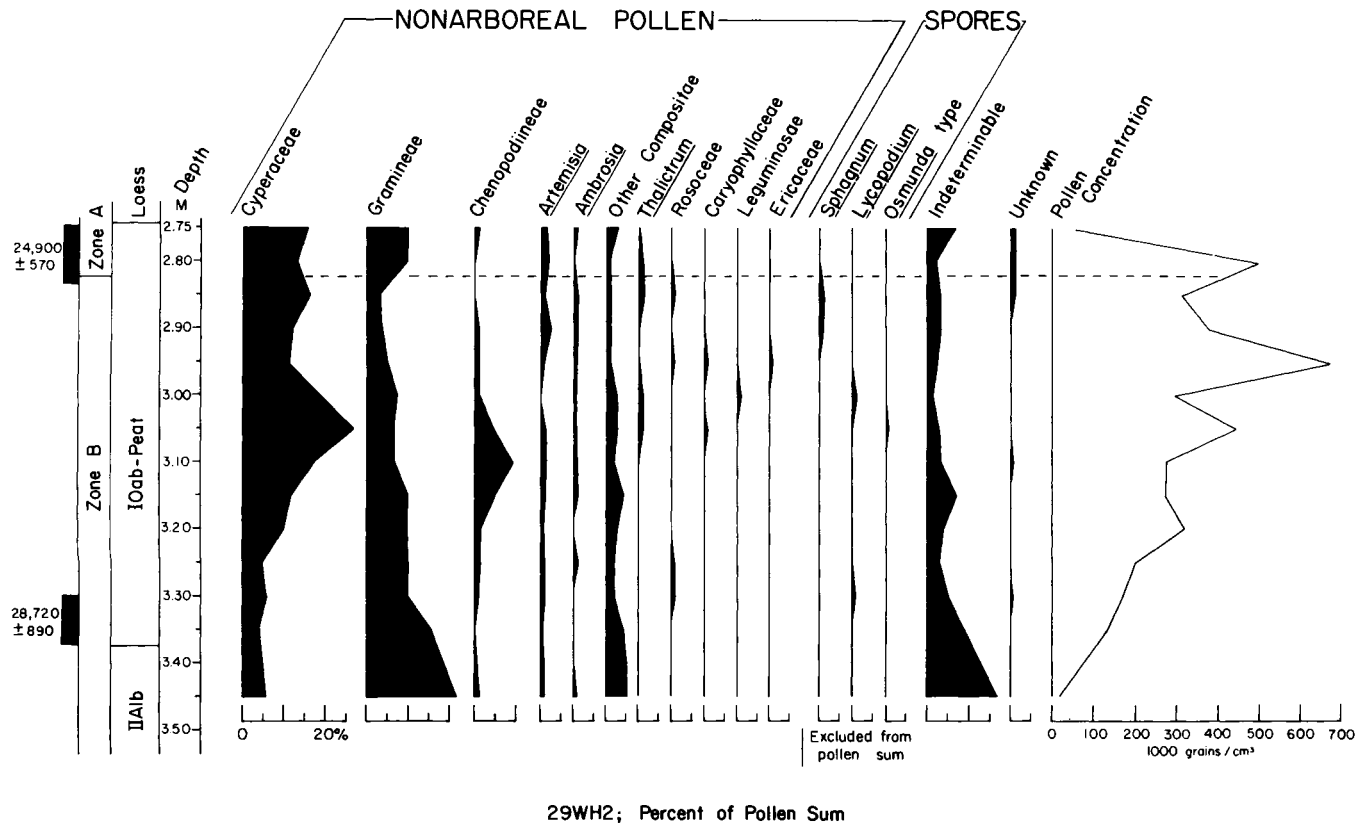

Figure 3. *Pollen percentage diagram, Brun Farm buried peat (29WH2); non-arboreal pollen (NAP), spores, and total pollen concentration.*

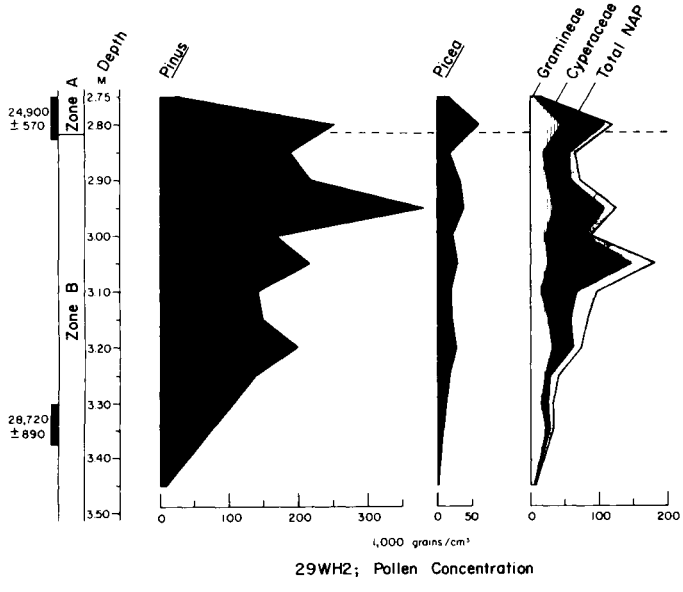

Figure 4. *Concentration diagram of selected pollen taxa.*

late-glacial period when *Pinus* was missing from the *Picea*-dominated coniferous forest which was present in much of the Midwest (Baker and Van Zant, 1976; Wright, 1971). The Farmdalian forest seems more comparable to the modern boreal forest.

The top and bottom samples show the lowest pollen concentrations on the diagram. In part this can be explained by dilution with mineral sediment. The bottom sample is below the peat, from the mineral rich IIAb horizon of this complex organic-mineral paleosol. The pollen concentration of this sample should logically be lower than the peat. The topmost sample was taken from immediately below the loess-peat contact, and is likely diluted by the onset of loess deposition which terminated the formation of the peat. These changes in pollen concentration are also complicated by changes in the composition of the pollen rain.

At the bottom of the diagram the low *Pinus* percentage and high values of Gramineae may indicate a more open forest environment, prior to about 28,720 RCYBP. This is compatible with the findings of Mundt and Baker (1979) from Blackhawk County, Iowa. They show a *Pinus* NAP zone younger than 34,000 RCYBP, but older than a *Pinus-Picea* zone. The lower *Pinus* and higher NAP probably contribute to the lower total pollen concentration.

At about 24,900 RCYBP in zone A *Pinus* percentages decline while *Picea* increases. This decline in *Pinus* and rise in *Picea* is a region-wide event reported by Van Zant, Hallberg, and Baker (in press) as older than 22,750 RCYBP, in Muscatine County, Iowa; by Mundt and Baker (1979) as older than 21,000 RCYBP, from Blackhawk County, Iowa; and by King, (1973) as about 20,000 from Boney Spring, Missouri.

The successive *Alnus* and *Betula* peaks, followed by the *Picea* rise — *Pinus* decline is the opposite of pollen and vegetation changes recorded regionally in Minnesota at the end of the Wisconsinan late-glacial period (Wright, et al, 1963). Between approximately 10 and 11,000 RCYBP in southern Minnesota, spruce forest declined very rapidly. *Betula* and *Alnus* expanded rapidly to colonize available sites and then declined as *Pinus* immigrated into the area. The significance of these Farmdalian changes, if any, remains to be seen.

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APPENDIX

The Brun Farm buried peat samples were taken from a drill-core. The core hole (IGS No. 29WH2) was located in the SW¼ of the SE¼ of sec. 18, T 72N, R 4W, approximately 27.5 m (90 feet) north of the center line of the east-west gravel road. The peat is part of a very complex sequence of sediments and paleosols.

The description below uses standard weathering zone terminology after Hallberg, Fenton, and Miller, 1978; and standard soil horizon nomenclature from Soil Survey Staff, 1975, p. 212, 459-463. For simplification the roman numeral prefixes used to indicate different materials in the soil horizons begin with the sub-loess paleosols.

The stratigraphy of the core hole is:

0-2.74 m (0-9 ft.) — Modern solum and deoxidized and leached Wisconsinan loess; heavy silt loam to silt loam.

2.74-3.38 m (9-11 ft.) — 10ab-10eb; Wisconsinan peat — basal loess paleosol; black (10YR2/1) peat to silty peat; compact fibrous laminated zones, with some thin beds of fine-grained organic debris; texture of mineral fraction is silty clay loam; leached. 2.74 to 2.82 m — dated at 24,900 ± 570 RCYBP (I-9357); 3.30 to 3.38 m — dated at 28,720 ± 890 RCYBP (I-9358).

3.38-3.63 m (11.1-11.9 ft.) — IIA1b; basal loess paleosol; very dark gray (10YR3/1) silty clay loam; weak very fine to fine granular and crumb structure; few thin clay films; fine (1-2 mm) stratification weakly apparent; some large pieces of charcoal and organic matter; leached; early Wisconsinan sediments.

3.63-4.01 m (11.9-13.2 ft.) — IICgb; dark greenish gray (5GY4/1) silty clay loam with few greenish gray (5GY5/1) mottles; very weak very fine subangular blocky grading to massive; few fine vertical root tubules with coatings; clear upper, abrupt lower boundary; leached; early Wisconsinan sediments.

4.01-4.11 m (13.2-13.5 ft.) — IIABgb; gleyed Sangamon Paleosol; greenish gray (5GY4/1) silty clay loam, with common dark olive gray (5Y3/2) mottles and coatings on peds; weak very fine subangular blocky structure; common fine vertical and horizontal root tubules; some charcoal and fine organic matter; abrupt lower boundary; leached; Illinoian stratified sediments.

4.11-4.19 m (13.5-13.8 ft.) — II1B1tgb; Sangamon Paleosol; greenish gray and gray (5GY-5Y4/1) silty clay, with a few pebbles; moderate fine subangular blocky; common fine root tubules; many thin clay films and dark olive gray (5Y3/2) coatings; clear lower boundary; leached; Illinoian stratified sediments.

4.19-4.50m (13.8-14.8 ft.) — IIIB22tgb; Sangamon Paleosol; dark greenish gray (5GY and 5G 4/1) silty clay loam, with common bluish gray (5B5/1) mottles; strong fine subangular blocky structure; common fine and medium root tubules; continuous moderate clay films, with thick clay and dark gray (5Y4/1) coatings along prominent vertical faces and tubules; gradual lower boundary; leached; Illinoian stratified sediments.

ABBREVIATED DESCRIPTION TO DEPTH

4.50-4.88 m (14.8-16.0 ft.) — IIIB23tgb — B3tgb; Sangamon Paleosol.

4.88-5.03 m (16-16.5 ft.) — IIICgb-mottled unoxidized and leached Illinoian stratified sediments; some secondary carbonates at base.

5.03-7.16 m (16.5-23.5 ft.) — Yarmouth Paleosol.

7.16-7.62 m (23.5-25 ft.) — Mottled, oxidized and leached pre-Illinoian (classic Kansan) till.