THE POLLEN RECORD OF THE GLACIAL-INTERGLACIAL TRANSITION IN STEVENSON'S BOG, OHIO

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INTRODUCTION

The Laurentide ice sheet began its retreat from southern Ohio approximately 18,000 years bp. Associated with this retreat are a series of conspicuous recessional moraines, outwash deposits and topographic depressions. Stevenson's bog, a closed basin of 0.5 km^2 located on the western side of the Great Lakes outwash plain was selected to examine the climate record during the last deglacial to Holocene transition. Grain size, magnetic susceptibility, loss-on-ignition, radiocarbon and pollen content were used to assess past environmental changes recorded in a sediment record extracted from Stevenson Bog. The bog is located in the valley south of the St. Johns and north of the Union moraines amid classic outwash features on the Indian lake floodplain (Fig. 1). Indian Lake is a vestigial proglacial ice-contact lake on the Erie Sublobe outwash plain. It is underlain by ice-recessional sediment over argillose glacial till that covers Silurian limestone bedrock. The calcareous bedrock results in a surface and ground water classified as very hard, calcium-magnesium-bicarbonate waters (Debrewer et al., 2000). Typical soil characteristics for this region are permeable calcareous silt loams.

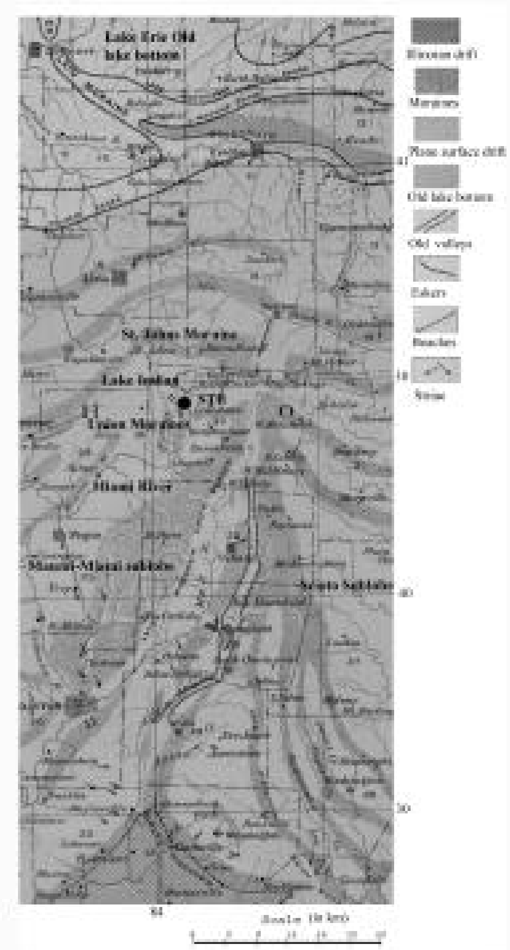

Fig. 1. Surficial Map of Scioto and Miami sublobes of the Erie glacial lobe. Stevenson Bog designated by a point marked STB (modified from Leverett, 1902)

Description of the Core

Two cores were taken near the center of the basin 3 meters apart using a modified Livingston corer. Three units have been identified. They correlate well across the two

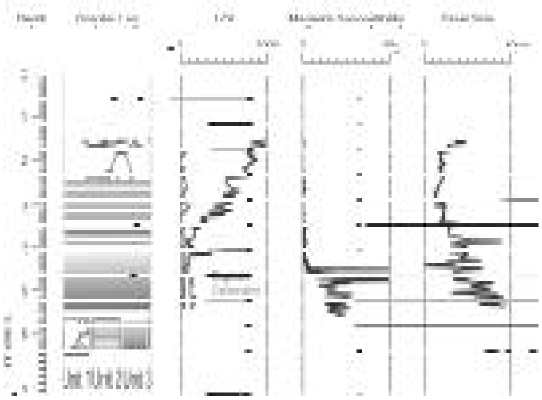

Fig. 2. Graphical representation of core units and graphs of LOI, MS, and mean grain size (average of three measurements per depth). Radiocarbon dates taken from Limnological Lab. RCD 1: 13, 490+-110 C-14 yrs BP. RCD 2:14, 360 +-120 C-14 yrs BP.

cores, having the same lithological units and thicknesses. The base of unit 3 at 541cm depth consists of massive mottled clay with sandy layers and large pebbles coarsening in grain size as one moves up core. There are a few organic stringers (Figure 2). At 382 cm depth, unit 3 turns into a massive dark green organic silt which grades upward into the banded green grey silts of unit 2 at 379 cm depth (Figure 2). The bands become more red and brown and grade up into the dark fibrous compact peat of unit 1 at approximately 248 cm. These units can be interpreted as a transitional sequence corresponding to glacial outwash deposits at the bottom transitioning into lake deposits and finally a modern peat bog.

Analyses

Two AMS radiocarbon dates were obtained from the Arizona AMS laboratory: one constrains the depth interval 358-374 cm to 13,490+/-110 yrs bp (AA40576) and the other constrained the depth interval of 448-452 cm to 14,360+/-120 yrs bp (AA40577). The latter AMS date provides the best estimate of when the ice left the site or the time of deglaciation in the region.

The grain size analysis was done using a laser particle counter at evenly spaced intervals of 4 centimeters. Magnetic susceptibility (MS) was measured before the core was split and described using a field susceptibility meter connected to an ‘F-probe’. The core was again measured at regular 4 cm intervals, three readings per depth. The susceptibility graph plots the mean of the three measurements and reinforces the grain size data. Loss-on-Ignition (LOI) was done at the same 4 cm intervals. Total organic carbon was obtained from pyrolysizing the sample at 550°C for an hour and carbonate content was determined after a 1000°C one hour burn.

Samples for palynological analysis were taken at 20 cm intervals to achieve a coarse broad spectrum of pollen fluctuations. Subsequent samples were then selected for the purpose of constraining warming and cooling periods reflected in the pollen percentage shifts. Although samples required different treatment, all were treated with hydrofluoric acid and glacial acetic acid, in order to dissolve the clastic and organic materials. The fossil grains were then mounted on slides and identified based on surface sculpturing and number of apertures.

Interpretation of Sedimentological Analyses

The data show a de-glaciation sequence, generally fining up core in average mean grain size (Figure 2). The coarser layers (fine sand) interspersed with mottled clay of unit 3 probably correspond to glacial deposits. Average mean grain size shows much more variation from 541cm to 370 cm than above 370 cm due to changes in lithology: the unit has a matrix of massive silt but contains inclined fine sand layers indicating higher energy in transport. The general fining

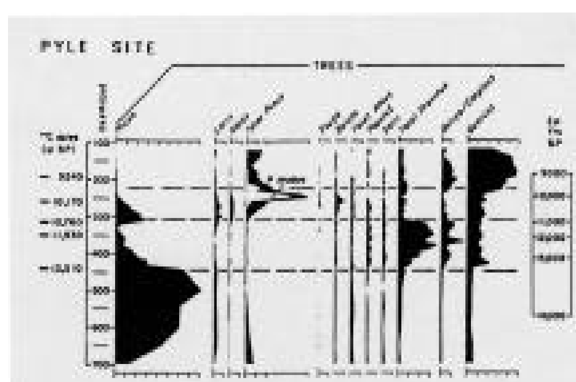

Fig. 4. Pyle Site summary pollen diagram. Note Picea increase climate reversal event ca.320cm (modified from Yu and Wright Jr., 2001 and reprinted from

upwards sequence the length of the core indicates an overall reduction in energy.

The fluctuations in magnetic susceptibility (MS) are even more pronounced and correspond to approximately the same depth interval as the grain size changes. The decrease in MS up core demonstrates a decline in clastic sediment influx (with iron and magnesium bearing minerals) and an increase in organic input into the basin as the glacier migrates north.

The LOI analysis follows a similar trend as well with low organics during the glacial period and a steady accumulation as the lake shallows into the relatively dry peat bog it is

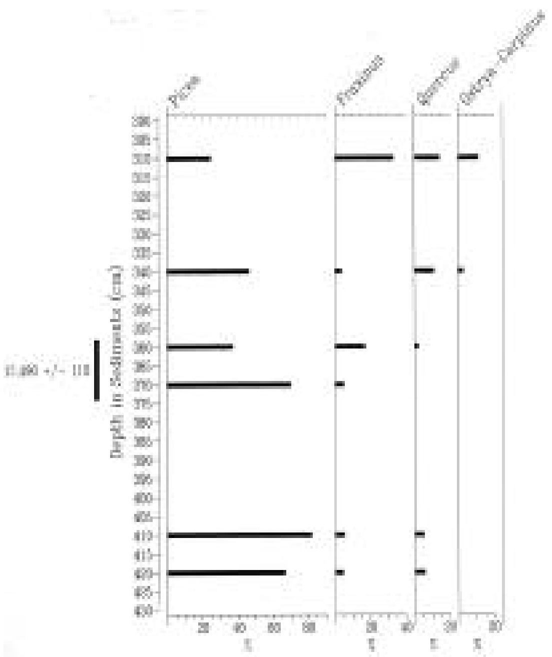

Fig. 3. Histogram of selected preliminary pollen data from Stevenson Bog core B to illustrate *Picea* reversal. AMS date (AA40576) noted.

today. At a depth of approximately 390 cm a rapid increase in organics reflects the transition from outwash plain to accumulating lake.

There are three possible explanations for these data (1) a transport-related shift in lake level shoreline changed the distance sediment travels to be deposited at the core site (2) variation in sediment load into the lake shift the source or the location of the ice sheet, and (3) wind patterns influenced by climate and the behavior of the glacier.

There is a general progression from fine sand at shorelines to fine muds in the center of most water bodies. Thus, grain size fluctuations could be explained by shifts in the water shoreline based on meltwater input and the evaporation regime both influenced by climate (Menking, 1997). A study of the Stevenson Bog fluctuations provides an indirect study of transport distance of sediment into the basin and the rate of glacial retreat. A shift in katabatic winds off the ice sheet is another potential influence. As the ice sheet recedes, the change in depth causes a tunneling effect which changes the wind patterns and increases velocity. Greater winds are capable or carrying heavier minerals into downwind basins.

Interpretation of Palynology Results

The use of pollen data as a proxy for climate assumes the following: (1) for pollen to be useful in climate reconstructions, vegetation must generally be in equilibrium spatially and temporally with climate and (2) fossil data oscillations are only attributable to climate change with extraneous factors accounted for (Bartlein et al., 1984). The use of large special and temporal scales satisfies these two conditions by reducing the impact of non-climatic variables (Bartlein et al., 1984). Spatially, Stevenson's Bog is rather small as water bodies go, and pollen signals are thus more susceptible therefore to fluctuation from local stimuli. However, using data from other cores in the region would allow for generalizations of my results on a regional scale as. The Stevenson site pollen profile correlates well with other sites in the vicinity such as the Pyle site, so chronologies from these sites can be used in conjunction with the two AMS dates obtained in this study to establish a local chronology.

A network of radiocarbon dated pollen profiles is available for both the Mid-West and the Northeast (Bartlein et al., 1984). Fewer sites have been investigated in Ohio. Broad regional trends are: (1) a spruce-dominated boreal forest or woodland moving north in the early-Holocene and retreating south after 3000 yr B.P and (2) a prairie-forest border moving east into Wisconsin by 8000 yr B.P. and west again after 6000 yr B.P. (Bartlein et al., 1984).

Preliminary pollen frequencies show the general trend of a spruce-dominated assemblage in older sediments with increasing amounts of hardwood and pine (Figure 3) as one moves upcore. Spruce (*Picea*) is a conifer typical of a cooler northern climates while ash (*Fraxinus*) is a deciduous tree characteristic of somewhat warmer temperatures. It is one of the first plants to react to the change in climates. There is a reversal in the decline in spruce by 310 cm reflecting a cooler climate- probably the Younger Dryas event. A similar reversal at the Pyle site is interpreted as this late glacial climatic event. The pollen stratigraphy for this portion of the Stevenson Bog core is consistent with the ‘A’ (spruce) zone of Davis (1960). Continued warming eventually led to the oak/hickory dominated deciduous forest (Davis ‘C’ zone). There are indications of an initial decline in spruce and increase in ash at about 360 cm; then a sharp increase in ash and decrease in spruce at 340 cm. This probably corresponds to what is now recognized in Northeastern and European pollen profiles as associated with the Allerod warming event.

Davis' A-zone is characterized internally by an initial decline in spruce and rise in ash. Samples higher and lower in the core than the depths listed in Figure 3 are currently being processed, but one would expect T-zone, a grass, *Artemisia*, sedge and low arborial trees dominated tundra assemblage in the oldest deposits and B zone with oak and hickory species above.

The pollen evidence is conclusive in demonstrating a cold reversal, however, although it corresponds to the Younger Dryas interval, there multiple possibilities as to the origins of this event. The cold reversal may be directly related to a climate shift or it may stem from a localized lake-induced cooling effect. There is isotopic evidence of a shift in the drainage patterns of Lake Agassiz during that time interval (10,000 to 12,000 yrs bp) from discharging into the Mississippi to discharging into the Great Lakes causing a localized atmspheric cooling (Lewis and Anderson, 1991).

CONCLUSIONS:

The analyses demonstrate a de-glaciation sequence which supports data previously gathered at sites in the vicinity. A climatic cooling event is expressed in the pollen profile and further pending AMS dates instrumental in constraining the depth interval, will be compared to other sites.

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