A LATE-POSTGLACIAL POLLEN CHRONOLOGY FROM THE CENTRAL MISSISSIPPI RIVER VALLEY

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The area from which the pollen samples were collected is known at the American Bottoms; that portion of southwestern Illinois that extends roughly from the mouth of the Illinois River to the mouth of the Kaskaskia River and centers about the junction of the Mississippi and Missouri Rivers above St. Louis, Missouri. This area is of particular interest in North American prehistory because the largest concentration of archaeological sites of the Mississippian culture is to be found there. Mississippian culture is characterized by an agricultural economy, particular styles of pottery, and a social system sufficiently well-organized to plan and execute the construction of large earthen mounds. Monk's Mound, only a couple hundred meters from the locale of one of the pollen profiles, is the largest earthen structure built in the New World before the advent of earth-moving machinery. More than 15 other mounds and a large archaeological village are associated with this mound in a district that covers many dozens of acres. This archaeological site is known as *Cahokia*.

Pollen samples were collected from three sedimentary profiles on the banks of a slough that meanders next to Cahokia near Monk's Mound. The first pollen profile contains two pollen zones. Zone I, extending only to a depth of 6 inches, is characterized by percentages of pollen of Chenopodiaceae and Amarantaceae (cheno-am pollen) over 30%, and by wind-pollinated Compositae pollen also over 30%. Below this level Pollen Zone II is encountered, where only anaemogamous Compositae pollen occurs in excess of 30%. The unusually low frequency of arboreal pollen in the samples is characteristic of all the pollen records collected from the American Bottoms. The combined percentages of arboreal and unknown pollen types is less than 25% in 80% of the samples so far analyzed. This contrasts strongly with the pollen spectra from bogs in the

northeastern United States and was completely unexpected. The American Bottoms pollen spectra may be most favorably compared with those from alluvium in the Southwestern United States and that recently reported by Sears from the Grassland Province.

Before passing on to the next slide, I wish to point out that artifacts of Mississippian culture – in this case Old Village pottery types – were directly associated with samples of both Pollen Zones I and II. Since Pollen Zone I is so shallow, however, it is possible that the occurrence of ancient pottery in this surface level is due to redeposit ion subsequent to the prehistoric period.

The second profile was collected from the same slough but at a point approximately 2.5 kilometers distant. The uppermost sample in this profile contains an unusually high frequency of Arboreal Pollen. Almost all of it is pollen of *Salix*, and it undoubtedly indicates local overrepresentation. The second level gave a spectrum similar to those of Pollen Zone I at the first locality. Below this and extending to a depth of about 36 inches, the spectra are essentially similar to those of Pollen Zone II at the first locality in that Compositae is the only pollen type to contribute more than 30 % to the profile. Below 38 inches, however, the percentage of Compositae pollen decreases and grass pollen is the only type that contributes more than 30% to the profile. This change marks the boundary between Pollen Zones II and III.

The archaeological material from this locality is modern brick, wood and metal. It was recovered at the top of Pollen Zone II, and it will be remembered that Old Village Missippian culture pottery was recovered from Pollen Zone II at the first locality.

The third profile was collected about 200 meters from the first locality. Pollen Zones I, II and III are evidenced in this profile and a Pollen Zone IV was encountered in the lowest four samples. In Pollen Zone IV the percentage of cheno-am pollen is greater than 30% and the percentage of grass pollen is also greater than 30%. Old Village pottery was associated with pollen spectra representing Pollen Zones II, III and IV. If Old Village pottery represents a particular temporal episode of Mississippian culture history, the lowermost pollen

spectra are not older than the oldest date that can be assigned to the Old Village episode. Also, if the changes in the pollen zone sequence represent changes in environment, the Old Village phase of Mississippian culture is seen to have continued through at least three periods of distinctive environmental conditions and two environmental changes.

This illustration shows the palynological records of sediment samples collected at the Mitchell Site approximately 11 kilometers north of Cahokia. Because there is only a thin deposit of artifact-bearing alluvium at Mitchell, the samples were not superimposed. Thus we have no pollen profile, only a series of samples whose provenience is known relative to associated cultural remains.

A lake is located at the southern margin of the Mitchell Site. The three samples at the top of the diagram were collected from the soil surface along the lakeshore. All have the characteristic spectrum features of Pollen Zone I. It is particularly interesting that the arboreal pollen frequency is low in these samples, since the margin of the lake supports a dense growth of willow, oak, elm, *Prunus* and other trees. Two of the three samples were from moss polsters growing at the roots of trees; the third was taken beneath oak leaf litter. None, however, contains more than 25% arboreal pollen.

The next four samples were collected from the sediment surface a few cm. beneath the waters of the lake. Of the four, two yield the characteristic features of Pollen Zone I and two yield those of Pollen Zone II.

The next lower group of samples was collected from Mississippian architectural features and the final group of samples was collected from the cultural sediment horizon without association with Missippian features. About half the samples in these two groups show Zone II characteristics and about half show those of Zone III. Zone IV is not represented in the few samples so far analyzed from this site.

The recovery of consistent features of form and superposition in the three pollen profiles from the Cahokia area strongly suggests that environmental fluctuations have occurred. The recovery of similar pollen spectra from a site 7

miles distant strongly suggests that these fluctuations were regional rather than local.

Two basic questions now present themselves: First, what environmental changes seem evidenced by these data, and second, to what extent can the series of fluctuations be developed into an absolute chronology?

Today, a large portion of the surface are of the American Bottoms is the water surface of lakes, ponds, ditches, swamps and sloughs – each with distinctive plant communities. Most timber is to be found along the edge of bodies of water, though fairly dense stands of temperate trees may be found as second growths or forest remnants near houses or on terraces at the outer margins of the floodplain. But the ecological system of most of the surface of the American Bottoms is primarily influenced by man's industry. The majority of the land is either planted to maize and wheat or consists of fallow weedy plots, roads, ditch and railway embankments, levees or house sites. In the sense of being unforested, the region is a prairie; but because of the vast disturbance of the land by agricultural and earth-moving machinery it is a prairie composed of crop plants and weeds rather than grasses. The most prevalent weeds are members of the Chenopodiaceae. Amarantaceae and Compositae. This situation appears to be admirably reflected in the spectra of samples of Pollen Zone I.

Because of the association of modern refuse with samples of Pollen Zone II, we may be confident that Pollen Zone II ended after American settlement began in the area. Thus the boundary between Pollen Zones I and II must have been laid down less than 150 years ago. Surveyor's records of the 1830's and '40's indicate that at that time the region was mostly treeless, but the amount of surface area covered by swamps, sloughs and lakes was much greater. In order to improve the agricultural potential of the land, a great deal of filling and draining was undertaken during the last quarter of the 19th century and the first quarter of the 20th century. I believe that the cheno-am rise indicates sediment disturbance and that it is the combination of filling, draining, and the general use of tractors after 1900 A.D. which accounts for the high cheno-am frequency in Pollen Zone

I. Climatic fluctuation cannot be eliminated as a possible cause for the increased frequency of cheno-am pollen in Zone I, but in view of the present ecological situation it seems less probable.

I am tentatively dating the Zone I-Zone II boundary at 1900 ± 25 years A.D. Even if I am incorrect in this absolute date, the distinctive characteristics of Pollen Zone II must be identified as a reflection of the regional ecological system in effect at the time of white settlement. The historic record suggests this ecological system was swampy prairie. Swampy prairie was a common form among the various prairie types found in river valleys in Illinois that survived as relics and remnants into the 20th century when they were described by ecologists.

The spectra of Pollen Zone II are characterized by relatively high frequencies of pollen of some anaemogamous species of the Composite family. Yet in the vast majority of ecological descriptions of wet prairie types, plants of such genera are usually listed as rare if they are noted to occur at all. Sampson's ecological survey of the prairie communities of Illinois indicated that *Ambrosia* (the only anaemogamous composite which he lists) is only to be found in xeric locales. In 1930, however, Turner collected frequency curves on swampy prairie stations from the Illinois River valley and the Mississippi River valley. The basic difference in the floristics of the two areas was that on the floodplain of the Mississippi there was only one dominant plant: *Spartinia Michuaxiana* Hitchc., or slough grass. But on the floodplain of the Illinois there were two dominants: slough grass and *Iva ciliata* Wild. – one of the anaemogamous Compositae. Since we know from historic records that the region was swampy rather than xeric. It appears that the pollen record supports a reconstruction of an aberrant, but not unknown, prairie form in the American Bottoms at the time of White settlement.

In support of this reconstruction, I assessed the ubiquity of the pollen non-arboreal swamp plants in the samples: *Sparganium*, Cyperaceae and *Polygonum*. Since the majority of the samples were collected from slough deposits, it is not surprising that pollen of swamp plants should be found in all of

the pollen zones. However, *Sparganium* pollen was recovered only in samples attributed to Pollen Zone II, Cyperaceae pollen occurred three times more frequently in samples from Pollen Zone II than those of Pollen Zone I, and *Polygonum* pollen was found in twice as many Zone II as Zone I samples. Clearly, the pollen of plants adapted to swampy conditions is more prominent in Pollen Zone II than in Zone I; this aspect of the pollen record also, then, supports recognition of Pollen Zone II as a reflection of the sort of wet prairie identified for the region from the 19th century historic record.

On the basis of reduction of the Compositae curve and the reduced frequency of non-arboreal swamp indicators I suggest that Pollen Zone III represents a shift towards aridity relative to Pollen Zone II. However, interpretation of changes in non-arboreal pollen frequencies is, I recognize, far more problematic than interpretation of changes in the frequencies of arboreal pollen types. On the whole, the growth and density of trees on a landscape will tend to be controlled by regional climatic conditions. The non-arboreal flora of a temperate climatic region is more specifically controlled by conditions of the growing season. The change towards conditions of greater aridity reflected by the change from Pollen Zone II to Pollen Zone III, then, should be recognized as one from effectively wetter to effectively drier conditions during the span of the growing season. This could be accounted for by a change in total annual moisture reception, but might also be accounted for by a fluctuation in the periodicity of moisture reception.

Today, and during historic time, yearly spring flooding of the American Bottoms region allows the effective moisture available to herbaceous plants to be very high at the beginning of the growing season. I believe that the difference between Pollen Zones II and III could be explained if zone III was characterized as an episode in which (relative to zone II) moisture reception in the earlier part of the growing season was less and during the later part of the growing season it was greater.

Turner's explanation of the prominence of *Iva ciliate* in the Illinois River valley prairie attributed this occurrence to the fact that there was poorer drainage

there and the soil was saturated for a longer period during the growing season. Considering that grasses in general are earlier germinators than the Compositae, I suggest that this effect is due to the soil being too saturated for efficient germination of grasses, so species of Compositae compete more effectively when the soil dries out.

In developing a pollen chronology for the American Bottoms one of the more perplexing problems has been dating the Zone II-Zone III boundary. There is no independent way to assign an absolute date to this change. Even if more radiocarbon dates were available for the Old Village occupation of Cahokia, it is likely that the statistical range of error of such determinations would be too great to give an adequately precise date for the shift. We know that the boundary falls some time during the Old Village occupation, which is presently dated between 700 and 1200 A.D. The problem is when the shift occurred during that interval.

By correlation with the historically known climatic shift in Europe between 1200 and 1500 A.D., the boundary between Pollen Zone III and Pollen Zone II might be explained as an American version of Recurrence Horizon RY I. On this side of the Atlantic a climatic shift in the same direction as that of Europe – from warmer-drier to cooler-moister – is historically documented from Greenland for the same time period, and diverse fluctuations in pollen records from the Southwestern and the Northeastern United States have been accounted for on the same basis. Fluctuations in the growth of tree-rings and known cultural changes in the Southwest have also been attributed to this climatic change. In fact, one archaeologist has based a reconstruction of Mississippian culture history on the hypothesis that such a climatic change occurred at this time and had certain effects on the agricultural potential of lands occupied by Mississippian populations.

While I admit that the mass of evidence and interpretation now available favors correlation of the Pollen Zone III – Pollen Zone II boundary with these other fluctuations, and thus the assignment of an A.D. 1200-1300 date, I must in all honesty state that I favor a date closer to A.D. 1000 for the shift. I do not maintain that the date of 1200 A.D is incorrect for Europe, Greenland, or the tree-

ring record. But I am not convinced that this date is demonstrably correct for palynological fluctuations in the United States.

In 1960 I processed and analyzed sediment samples from archaeological sites in the Colorado Plateau province of Arizona and New Mexico. Because of the availability of a chronology for pottery types supported by dendrochronology, it was possible for me to date many of the pollen records from these sites through their associated ceramic assemblages with an accuracy of 100 years. In that area I found that a shift in the non-arboreal pollen record occurred also, and that the date of the change was A.D. 1000 $\pm$ 100. Under no circumstances could the pollen records involved have been deposited as late as 1200 A.D. and even 1100 A.D. would be an extreme date from my evidence. I apologize that these data have not yet been published, but they are now in press. To my knowledge this date of 1000 A.D for the pollen fluctuation is the only one from the continent that can be said to have adequate documentation and precision for the time period of interest here. Other absolute dates are based on radiocarbon determinations, which are not ordinarily precise within 200 years, or on correlation with the documented shifts in Greenland and Europe.

It seems anticlimactic to return to the pollen sequence at this point, but there is still Pollen Zone IV to be reckoned with. At present I am hesitant to make specific claims about the validity of Pollen Zone IV as a reflection of regional environmental conditions. Pollen Zone IV is observed at only one locality and it is possible that it represents some local edaphic phenomenon and not a regional environmental one. It will be noted that Pollen Zone IV spectra derive from samples of sandier sediment. I consider it quite possible that the increased percentage of cheno-am pollen that characterizes this zone reflects nothing more than the immense amount of surface disturbance which may have resulted from mound construction at Cahokia – perhaps Monk's Mound, which is only a couple of hundred meters distant.

The antiquity of the Zone III-Zone IV boundary is an unresolved matter, as is the antiquity of the base of this pollen sequence. I can only say at this time that the chronology is no older than the oldest date that can be assigned to Old

Village pottery. According to current archaeological estimates, this would be in the area of 700 A.D.

In summary, the oldest date that can yet be assigned to the pollen chronology from the American Bottoms is in the neighborhood of 700 A.D., so the chronology goes back 1500 years at most. All pollen zones show a primarily non-forested, or prairie, ecology. This seems to have undergone changes through time that may have had significant effects on the cultural phases of the area. The lowermost pollen zone may be either a local or a regional phenomenon. It seems to indicate a phase of sediment disturbance, but this could be due to cultural or ecological-edaphic factors. The upper three zones of the pollen sequence seem to reflect regional ecological occurrences, since they can be reproduced at localities up to 11 kilometers distant. Pollen Zone III, which I believe may end closer to A.D. 1000 than A.D. 1200, seems to reflect a relatively more arid environment. The shift from more arid to more moist conditions at the end of Pollen Zone III may be only a shift in the timing of moisture received during the growing season and not a basic change in the climatic configuration of the American Bottoms region. Pollen Zone II, in my opinion, dates from approximately 1000 to 1900 A.D. It is relatively moister than the lower zones and seems to correspond to descriptions of the area in the mid-19th century. The uppermost pollen zone shows indications of sediment disturbance. It evidently reflects the recent disturbance of the ecological balance of the region by mechanized agriculture.