INTEGRATION AND INTERPRETATION: PREHISTORIC ENVIRONMENTS OF EASTERN DELAWARE

Douglas C. Kellogg and Jay F. Custer

Center for Archaeological Research
Department of Anthropology
University of Delaware
Newark, DE 19716

GENERAL SUMMARY AND REVIEW

The two other studies explore the history of wetlands adjacent to large, important archaeological sites in the State Route 1 corridor. The river-valley peat deposits are the remains of past wetlands. The pollen, plant fragments, and seeds preserved in the peat deposits record the ancient plant communities in the area. The sand, silt, and clay material deposited by the rivers over the centuries show changes in river flow and wetland development. The wetlands have also recorded the impacts of rising sea level on the river systems. The study of Rogers and Pizzuto (in this volume) developed a new technique (LOI analysis) that allowed for more detailed interpretation of past wetland environments than had previously been possible. Brush (in this volume) studied the pollen and plant macrofossils in the wetland cores of Rogers and Pizzuto to show how the plant communities changed through time. The fossil pollen shows what types of plants were growing on the wetlands in the past, but also reflects the impacts of climate changes on the forests of the region.

Bay/Basins and Regional Climate

Newby, Webb, and Webb (in this volume) used pollen and sediment analyses of Walter's Puddle, a small "bay/basin" pond, to document changes in vegetation and climate in central Delaware. During the last ice age, spruce and fir trees grew in Delaware under a cold, wet climate. Melting of the ice sheet brought warmer and drier conditions to the region. The environment became so dry that after 12,000 BP Walter's Puddle dried up completely. No mud or pollen was deposited in the pond until after 6000 BP when water again stood in the depression. Because the dryness caused a gap in the accumulation of mud in the lake there is not a record of the environments between 12,000 and 6000 BP at Walter's Puddle.

After 6000 BP the climate of central Delaware was wetter and mud and pollen accumulated in Walter's Puddle again. A mixed forest of oak, pine, and hickory trees grew in the region. Buttonbush, alder, sedges, and other wetland plants grew around the pond. Only six pollen samples were taken from the mud above the gap in the Walter's Puddle core; therefore, subtle changes in vegetation and climate over the past 6000 years cannot be discerned. Also a slow sedimentation rate (0.01 cm/yr) combined with mixing of the sediments by currents, worms, or plant roots tend to average out variations in pollen through time (for example see, Davis 1974). In general, the pollen sequence from Walter's Puddle agrees with sequences summarized in regional overviews (for example, Gaudreau 1988; Delcourt and Delcourt 1987a).

From the initial Walter's Puddle study it was impossible to tell when the dry interval before 6000 BP began. Mud that accumulated after 12,000 BP may have been eroded by the action of winds. The actual length of the dry interval is also difficult to determine for the same reason. Dryness could have lasted 6000 years or perhaps only 100 years. Furthermore, the gap in mud accumulation might have been caused by hydrological changes unique to Walter's Puddle. Therefore, the second study in this volume by Webb, Newby, and Webb was undertaken.

Webb, Newby, and Webb (in this volume) used transects of cores across four bay/basins, including additional cores from Walter's Puddle, to determine if the dry interval at Walter's Puddle was due to climate, and to determine the length of the dry interval. All four basins had a gap in sedimentation, therefore, local hydrological conditions can be ruled out as the cause for the lower water levels. In three of the cores drying cracks were found below the gap in sedimentation. Regional climate change was responsible for lower water levels in all four ponds. Either precipitation decreased and/or temperature increased. In this case, both factors were responsible. The wetter climate before 12,000 BP was due, in part, to the cold air associated with the ice sheet margin close by in southern New York state (see Figure 10). As the ice sheet withdrew, precipitation moved north of the Delmarva region into Canada. In addition, the orbit of the earth around the sun had reached a position that increased solar heating of the earth (see Figure 9).

The beginning of the dry interval is probably about 11,000 BP because radiocarbon dates from just below the gap in all four ponds agree. Such consistent radiocarbon dates would not be expected if dried lake bottom mud had been eroded from the basins. The dates for the end of dry conditions are less susceptible to error, and are also consistent between the ponds. The basins filled with water again after 6000 BP. From 6000 BP to the present water levels in the basins have remained relatively high, and no significant gaps in sedimentation are evident. The radiocarbon date from Prison Pond above the gap does not agree with the dates from the three other ponds. Prison Pond is shallower than the other ponds and may have been sensitive to other dry intervals in the last 6000 years that did not affect mud deposition in the other deeper ponds.

Wet and dry are relative terms. We cannot determine the amount of precipitation that fell during the last 6000 years because the pollen data do not tell us the exact types of trees that grew on the landscape. Therefore, we cannot use modern ecological information on the known moisture and temperature requirements of, for example, red oak, to estimate past conditions. Thus, wetter conditions after 6000 BP, may still have been dry compared with the present climate of Delaware. The archaeological sites that date from the Woodland I time period found buried under wind-blown silts and sands (Curry and Custer 1982; Custer and Watson 1987; Ward and Bachman 1987) are evidence of the relative dryness of the climate in Delaware during the last 6000 years.

Riverine Marshes: Local Environments and Sea-Level Rise

The third study in this volume, by Rogers and Pizzuto, shows how three river systems developed and how wetlands grew to fill the valleys as sea level rose. The oldest sediments encountered were almost 12,000 years old, but most of the wetlands were younger. Each stream valley under went a slightly different sequence of development, but in general, their evolutions followed the same pattern. Fresh water wetlands existed in the Duck Creek river valley 11,500 years ago, and in the Leipsic River valley 8000 years ago. As the river channels shifted, wetlands expanded or contracted. When sea level reached high enough, some fresh water was pushed back up the streams by tidal action. Sediments then began to accumulate more rapidly and mudflats developed. Slowly tidal action became more significant and water levels increased. Ultimately salt water intruded into the rivers and vegetation in the wetlands began to be affected. The process is continuing and estuarine conditions will move upstream and salt marshes will develop and expand.

The study shows that wetlands existed in the river valleys that emptied into the Delaware River throughout the last 10,000 years. These wetlands would have been sources of fresh water and probably edible plant foods. They also would have attracted game animals. Thus, these environments attracted people as well. It is not clear how the dry period documented in the first two studies impacted these riverine wetlands.

The pollen studies by Brush (in this volume) were on cores dating to the last 5000 years - after the dry episode documented by study of the bay/basins. The oldest vegetation data in the marsh cores comes from pollen in Leipsic River core LR-1 and dates to about 5000 BP. As suggested by the pollen from Walter's Puddle, oak and pine forests dominated the landscapes at the time. However, continued dryness is indicated by fire-adapted vegetation such as bracken fern. More detail on the vegetation and climate of the last 5000 years was found in the three marsh cores studied than for the bay/basins. Many more samples, closely spaced in time, yield a higher resolution record of past environments.

The marsh pollen data suggest a wetter (and perhaps colder) interval sometime between 3000 and 2000 BP. Another dry interval followed. These changes correspond roughly with large-scale, climatic changes recorded in Greenland ice cores. The marsh cores, therefore, give regional information on climate and vegetation as well as local data that reinforce and corroborate the wetland interpretations of Rogers and Pizzuto.

TECHNICAL COMMENTS AND IMPLICATIONS FOR PREHISTORIC ARCHAEOLOGY

The data on prehistoric environments provided by the studies in this volume refine our understanding of prehistoric human occupation in the region. Modern environments in the study area are not good analogs for past environments. The climatic conditions and resources available to people in the past profoundly influenced their lives. Environments thousands of years ago were very different from the present. About 12,000 years ago the climate of Delaware was probably more like that of eastern Maine - cold and wet. However, there is no exact modern analog for the environments of the time because conifer trees of the boreal forest were mixed with more southerly broadleaf tree species (Delcourt and Delcourt 1987a; Gaudreau 1988; Jacobson, Webb, and Grimm 1987). The animals living in the area probably included extinct species like the mastodon, as well as, caribou, elk, and moose, but like the vegetation, a mixture of northern and southern animal species was present (see Graham and Mead 1987).

Paleo-Indian period life styles have been characterized as seasonal wandering following herds of large game animals (Gardner 1977:258-259, 1979; Custer, Cavallo, and Stewart 1983). Finds at the Shawnee-Minisink Paleo-Indian site, however, reveal that Paleo-Indians used a variety of plant resources also (McNett, McMillian, and Marshall 1977). In northern Delaware there is an association between interior swamps and Paleo-Indian sites and outcrops of high quality stone raw materials (Custer and Bachman 1986). The bay/basin ponds and wetlands were probably important watering holes for game animals. People would have camped nearby while hunting. The importance of such water holes probably increased after 11,000 BP as the climate became dryer until finally many of the small, shallow ponds dried up. Any ponds that remained were probably very important fresh water sources.

Archaeological sites dating to the time before about 6500 years ago are relatively rare in Delaware. Perhaps, the scarcity of fresh water made the area inhospitable. Settlements dating to the Archaic period are found near reliable fresh water sources. Even if there were some bay/basins and free-flowing streams in Delaware, they may have been unpredictable, or only seasonal fresh water sources. Perhaps, evidence

PLATE 8

Archaeological Field Work at the Pollock Site

of human occupation is sparse because few people ventured onto what may have been the "Delmarva desert".

After 6500 BP settlement around bay/basin features was common (Custer and Bachman 1986). Bay/basins apparently attracted people when they held water during wetter climate intervals. In Woodland II times bay/basins use declined, perhaps in response to the introduction of agriculture or increase in the use of coastal resources such as shellfish. The climate during the Woodland II was closer to the modern, relatively moist climate; therefore, access to fresh water was a less important consideration in selecting a campsite or village location.

The shift to the use of coastal resources coincides with the rise of sea level to its present elevation (Custer 1988). The infilling of river valleys that had been cut down to lower sea levels is documented by Rogers and Pizzuto (in this volume). The stabilization of sea level allowed the development of more extensive coastal estuaries and wetlands (Braun 1974; Custer 1988; Perlman 1980). Prehistoric settlement near the limit of tidal influence along a stream allowed access to a wide variety of food resources from interior forests, freshwater river and wetlands, and brackish and salt water estuary environments.

Archaeology of the State Route 1 Corridor: Preliminary Results

Fifty-five prehistoric archaeological sites ranging in age from 8500 to 400 BP were located in surveys of the State Route 1 corridor (Bachman, Grettler, and Custer 1988). Seventeen archaeological sites were investigated more intensively (Riley et al. 1993). Large scale excavations were undertaken at intensively occupied areas near the Leipsic River coring locality and also near the St. Jones River coring locality during 1990 and 1991 (Plate 8). Analysis of the archaeological findings is underway; only preliminary results are available.

Walter's Puddle. Walter's Puddle (Basin B) is located in the Blackbird study area, a large area surveyed for prehistoric archaeological sites early in the State Route 1 project (Custer and Bachman 1986a, 1986b). Ninety percent of 148 tested localities within 50 m of a bay/basin had evidence of prehistoric occupation. In Delaware there is little evidence of bay/basin use during the Paleo-Indian period (Custer and Bachman 1986b:5; Custer 1989:107). The earliest evidence of prehistoric bay/basins use in Delaware dates to about 8500 BP (Custer and Bachman 1986b:5). The studies presented in this volume suggest that this was the time of maximum dryness in the early Holocene. Many bay/basins did not hold water year round, but may have been seasonally wet. Within a generally dry environment, bay/basins would have been important fresh water sources. Archaeological sites dating to around 8500 BP are small, ephemeral hunting camps (Custer and Bachman 1986b:5). The archaeological evidence suggests short-term occupations of campsites while small groups of people moved around the landscape hunting and gathering wild foods.

Bay/basin use increased during the Woodland I period, but by the Woodland II period bay/basin use was rare. Climatic fluctuations during the last 5000 years are difficult to discern from the bay/basin pollen data; however, fresh water was apparently more widespread, in general, as the climate of eastern North America gradually cooled over the last 4000 years. Another factor was the development of coastal environments. By 6000 BP the rate of sea-level rise, due to the melting of the ice sheets, had slowed and by 4000 BP sea level had reached a level close to its present elevation. Biologically productive salt marshes and estuaries then expanded creating new opportunities for prehistoric people living on the Delmarva Peninsula (Custer 1988). The studies by Rogers and Pizzuto and by Brush (in this volume) document how these processes took place.

Duck Creek. Near the spot where Rogers and Pizzuto cored in the Smyrna River, five small archaeological sites were tested during the State Route 1 archaeological research (Riley et al. 1993). Most of the occupations date to the Woodland period, but evidence of earlier occupation was found at site 7NC-J-134. Unfortunately the site had been plowed and undergone extensive soil erosion (Riley et al. 1993). The coring of Duck Creek showed that wetland environments had been present throughout the past 11,000 years in the river valley.

Pollen data from core DC-3 date as far back as 5700 BP. The basal dates for this core are problematic because an older date was obtained above a younger date. Some redeposition of sediments eroded from the landscape following the earlier dry interval documented in the bay/basin studies may be responsible. If redeposition occurred then sedimentation rates calculated from pollen concentrations could be in error. This affects the pollen influx values presented by Brush (in this volume). Nonetheless, the pollen evidence agrees with the regional record largely indicating oak/hickory forests with some pines. The pines are either few in number relative to oaks and hickories, or are some distance from the core location because pines are much more prolific pollen producers than other trees and their pollen grains can be spread widely by wind.

Significant changes in the calculated pollen influxes coincide with changes in the geology of the core, so the environment of deposition must be considered in interpreting the data. For example, the influx in alder pollen appears to be related to shifts from forested wetland to emergent wetland and back to forested conditions. Birch pollen influx follows the same pattern suggesting a change from forested swamp to marsh and back to swamp at the core locality. Given such changes in the geology, and the local nature of the pollen record that accompanies such changes it is very difficult to extract regional climate information from the marsh core. The peat may represent a dryer interval of time when water levels dropped somewhat and the location was not inundated as frequently. Later a swamp environment developed, but this was due in part to sea-level rise. Rogers and Pizzuto (in this volume) place tidal influence in the later part of the peat unit.

Since about 1400 BP the location of core DC-3 was dominated by shrub and forest swamps adjacent to the stream channel, while mudflats occurred on the opposite side of the stream. As water deepened with sea-level rise the swamp forest was replaced by mudflats with emergent herbaceous vegetation. Now, brackish mudflat and emergent marsh cover the whole stream valley.

For people living nearby, the shifts in local wetland conditions were probably a minor consideration because the sea-level transgression shifted the environments slightly landward (upstream) through time. Thus, the same types of wetland environments were available regionally, even if certain patches changed in character and biological productivity. The important characteristic of these wetlands for human occupation was their ecological diversity. This diversity can be seen in comparisons between the three pollen diagrams from the three different stream/wetland systems. Thus, the Woodland period occupants of the area had access to a wide variety of environments, and presumably food sources and game habitats, throughout the period. Small procurement campsites of the Woodland I time period gave way to larger more sedentary settlements in the Woodland II suggesting that food resources were reliable and predictable.

Leipsic River. For most of the past 8000 years, wooded swamp grew along the Leipsic River where it will be crossed by State Route 1. Preservation was poor in core LR-1 - pollen was not found below 140 cm in the core and two other intervals of no pollen accumulation (or preservation) occur higher in the core. Alders and birches dominate the local vegetation, but wild rice grew during two times about 3000 BP and again at 2000 BP. Grass pollen influx was high, but fluctuated, from around 2500 BP until the present. The LOI values measured by Rogers and Pizzuto suggest forested swamp deposits during this time, but marsh is suggested by the pollen.

Seeds and charcoal were not analyzed in the Leipsic River core because of the preservation problems. The large fluctuations in pollen influxes suggest that local processes of vegetation change dominate the data here. The reconstruction of Rogers and Pizzuto places the arrival of tidal influence here at 500 BP. Thus, prehistoric occupants of the area had access to wooded swamps adjacent to the Leipsic River throughout the last 5000 years. Localized populations of herbaceous plants including grasses and wild rice would have provided edible wild foods.

Prehistoric occupation in the Leipsic area was extensive and intensive (Riley et al. 1993). Prehistoric archaeological sites line both sides of the Leipsic River. On the north side of the river is the Leipsic site complex with evidence of occupation throughout the Woodland periods. There appears to be less intensive use of the sites between 2000 and 1000 BP. Semi-subterranean house pits and underground storage pits (Plate 9) were abundant from 3000 to 2000 BP and after 1000 BP. Oak, charcoal and charred hickory nuts are among the floral remains recovered from prehistoric pits, hearths, and houses (Riley et al. 1993).

PLATE 9

Excavating a Prehistoric Feature

On the south side of the river is the Pollock site complex with evidence of occupation and use from late Paleo-Indian times through the Woodland II period. The most intensive use of the sites was during the Woodland I period. House and storage pits are common. Preliminary data suggest, at least, fall occupation based on the presence of charred hickory nut hulls from prehistoric features. More complete information will be available after the analysis of flotation samples (Plates 10 and 11) from 350 features at the Leipsic sites and over 1100 from the Pollack sites (Grettler, personal communication). Pizzuto and co-workers have taken more cores from the Leipsic River and these are currently under study. Integration of the environmental and archaeological studies will be possible when all of the analyses are completed. The combination of detailed environmental data and large scale archaeological excavations promises many new insights into prehistoric life in Delaware.

St. Jones River. The paleoenvironments of the St. Jones River area are complicated by the fact that the stream meandered and changed its course through time. The core analyzed for pollen came from a meander cut-off channel that dates to after 2000 BP. Again large changes in pollen deposition coincide with geological changes in the core. Prior to about 1000 BP the cut-off channel accumulated pollen in muddy deposits probably in relatively shallow water with alders and river birch. Open water is indicated by water lilies and other aquatic species. Wild rice is abundant just before 1000 BP. The regional pollen signal again reflects the dominance of oak, hickory, and pine trees. After 1000 BP the pollen influx decreases significantly. This change coincides with the transition from open water to marsh as the channel filled with sediment.

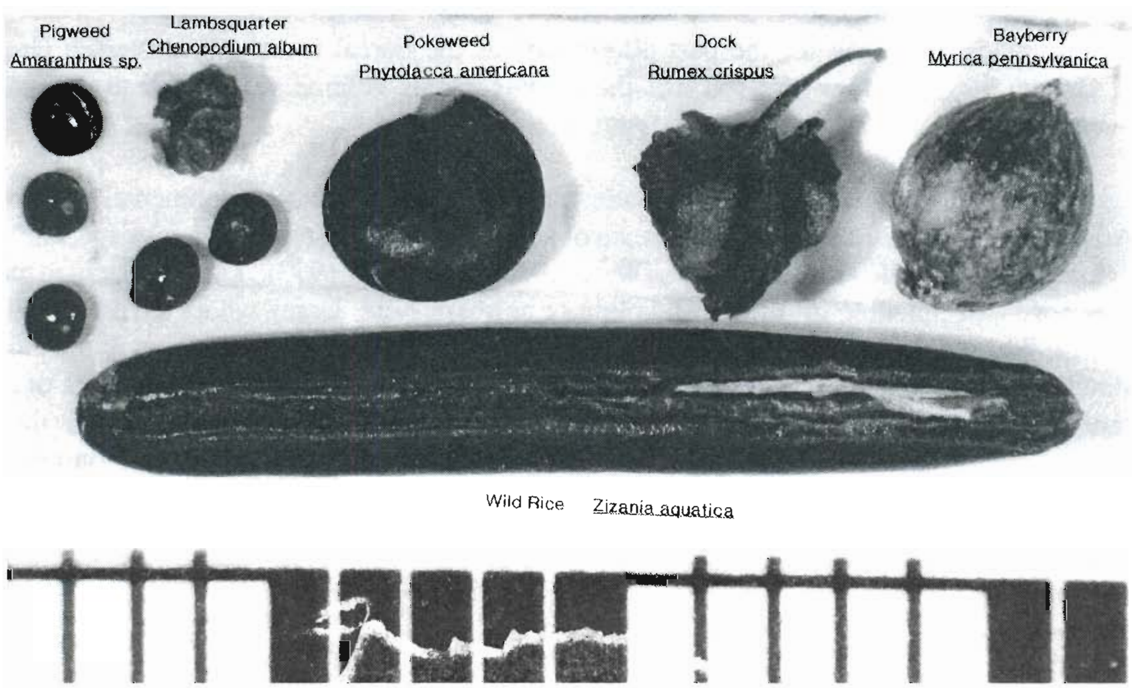
Active and abandoned channels provide the most diverse wetland habitats of the four areas studied. Both flowing and standing water environments were present. The cut-off of the meander channel may coincide with increased river flow, but other cut-offs would have to be dated to demonstrate a regional

PLATE 10

Flotation of Feature Fill to Recover Plant Fragments and Seeds

PLATE 11

Plant Fragments and Seeds Recovered from a Feature



pattern. Dryer local conditions after 1000 BP are suggested by the build up of sediment and peat to the top of the contemporaneous water table in the cut-off channel core.

Intensive occupation of the area adjacent to the core locations occurred during the Woodland period, most intensively during the Woodland I at the Carey Farm and Island Fields sites. Evidence of use of the area dates to the late Paleo-Indian period and extends to the Late Woodland II (Watson, personal communication). Brush notes large influxes of charcoal that suggests fires in the region; perhaps, the cooking fires and clearance activities of the prehistoric inhabitants of the area are reflected rather than a dry climate. Flotation samples from over 1200 prehistoric features are in analysis (Watson, personal communication). Pizzuto and co-workers are currently studying other cores from the St. Jones River adjacent to the prehistoric occupations. The studies of prehistoric occupations along the St. Jones and the Leipsic rivers will be the most detailed in the region and will provide a new benchmark for comparisons throughout the mid-Atlantic.

CONCLUSIONS

The studies reported here have substantially added to our knowledge of past environments. The studies of the bay/basin features have clearly shown that the early Holocene of the Delmarva Peninsula was warm and dry. The dry period is contemporaneous with the extension of the "prairie peninsula" (Delcourt and Delcourt 1987a:98; Jacobson, Webb, and Grimm 1987; Gaudreau 1988) and the maximum of solar warmth at about 9000 BP (Kutzbach 1987).

The four pollen records presented here agree on the broad outlines of the regional vegetation and, by inference, climate. Subtle changes during the last 5000 years are difficult to resolve. Changing conditions in the riverine wetlands suggest changes in water flow; however, dynamic responses to sea-level rise are also responsible for changes in the geology of the cores. Paleoenvironmental studies have focused on the dramatic changes at the end of the last ice age, and more subtle changes in Holocene vegetation and climate have been neglected. Some studies (for example, Denton and Karlen 1973) suggest a 2500 year cycle of temperature fluctuation that is responsible for "Neoglaciations" including the "Little Ice Age" documented in Europe and other areas of the world (Grove 1988). Studies across northern North America uniformly show gradual cooling for the past 4000 years as the boreal forest has expanded (Jacobson, Webb, and Grimm 1987). More research like the studies in this volume are needed to determine the Holocene vegetation and climate of the mid-Atlantic Region.

The Delmarva Peninsula falls in a climatic transition zone. Paleoenvironmental studies of the southern Atlantic coastal plain show the importance of southern pine forests on the landscape, and cypress trees are significant at the pollen study localities (Watts 1980; Whitehead 1973). The Appalachian mountain chain slashes northeast pinching off the coastal plain in northern New Jersey where ice age glacial scour has transformed the landscape to the north. Elevation affects the climate and vegetation of the mountains and latitudinal changes are evident northward of the Delmarva (Gaudreau 1988). The network of regional pollen diagrams used to reconstruct climate patterns (Delcourt and Delcourt 1984, 1987a) show that a zone of dynamic tension falls across the Middle Atlantic region. Therefore, regional vegetation and climate reconstructions (e.g., Delcourt and Delcourt 1987a; Gaudreau 1988; Watts 1983) are not sensitive to the local conditions on the Delmarva Peninsula.

The importance of the studies in this volume is that they provide the local data that archaeologists need to interpret past lifeways at particular places and specific archaeological sites. The environments reconstructed were the ones that people came into contact with in their daily lives, rather than those created by abstractions and extensions of data and information from other areas and developed for other purposes. The studies in this volume complement the archaeological studies of the State Route 1 corridor, and contribute to our knowledge of Delaware's past by showing how environments changed and developed in the past.