

15. THE MIDDLE TO LATE WOODLAND TRANSITION IN THE SAVANNAH RIVER BASIN AND ADJACENT SUBREGIONS: REFINING TIME SCALES

David G. Anderson

Southeast Archaeological Center, National Park Service, 2035 East Paul Dirac Drive, Box 7, Tallahassee, Florida 32310

Global Climate Study and Archaeology in the Southeast

[Southeast; Tree rings, Global Climate Change, Teleconnections, El Niño; first millennium]

Global climate change is attracting tremendous interest and funding, and archaeology and history have much to contribute. There are very powerful climate-based data sets and models available for use in exploring relationships between climate and culture, that are attracting increasing attention by a wide range of scholars. I have no doubt that this will be an important area of research in the years to come.

The methods and concepts of global climate change can be brought to bear on the archaeological record. The articles in this volume document profound relationships between global climate and regional cultures in the mid-sixth century A.D., with the effects of the A.D. 536-545^{cal} event observed from a number of parts of the world. I say event, because I have no doubt that something did indeed happen at this time level, even if we do not fully understand what it was, or the global effects and teleconnections. The historical and archaeological data from western Europe, China, Africa, and the Maya area is pretty unambiguous. It is also clear that archaeological and historical records have important if not unique insights to offer those interested in the impacts of global change and teleconnected phenomena.

Archaeologists have begun exploring other global climate processes and signals in recent years. In particular, El Niño and El Viejo (also called "La Niña") signatures, corresponding to conditions of appreciably warmer and colder than normal water temperatures in the western Pacific and their attendant effects of global climate, are the subject of increasingly detailed research using both historical and archaeological data. Not surprisingly, given where the impacts of these processes were first noticed, historic and late prehistoric El Niño effects have been examined in particular detail in Peru and Chile in recent years. Examination of Spanish archival data has shown that a number of periods of major flooding, catastrophic erosion, and famioe over the past five centuries in that region are

directly tied to El Niño/El Viejo effects (Quinn and Neal 1983, Quinn et al. 1987). An article by Sandweiss and colleagues (1996) explores much earlier, mid-Holocene El Niño effects in western coastal South America, using multiple independent lines of evidence, including zooarchaeological data, to reconstruct climatic conditions and their effect on landscape and culture.

In the Southeastern United States, El Niño/La Niña (or El Viejo) effects include extended periods of somewhat above and below average rainfall and temperature, and catastrophic storm frequency, particularly hurricanes and tornadoes (Diaz and Markgraf 1992, O'Brien et al. 1996, Green et al. 1997, Bove 1998). How fluctuations in climate effected human settlement in the region, particularly through their impact on crop yields, flooding patterns, and storm damage, will likely be increasingly explored by archaeological and historical research in the years to come. Climate research at a number of institutions around the country, including the Center for Ocean and Atmospheric Predictive Studies at Florida State University in Tallahassee, in the same building where I work, are exploring long and short term climatic effects on contemporary society, such as on crop yields, heating/cooling costs, devastating storm frequency and damages, and sea-level change (e.g., O'Brien et al. 1996, Green et al. 1997, Bove 1998). Much of this research includes analyses of recent historical records, and it is not a great step to move these studies much further back into the past.

As I will discuss below, I have examined tree ring data to understand, at annual time resolution, relationships social and environmental variables in the Savannah River valley and adjacent regions during the late prehistoric and early historic era (Anderson 1994; Anderson et al. 1995). Tree rings are increasingly seeing use in the exploration of climate and culture issues in other areas of the Southeast as well. Ned Woodall is using the longest east coast baldcypress tree ring chronology from the Black River in North Carolina (this volume). David Stahle, Malcolm Cleaveland, and Dennis Blanton (1998) are using the excellent and lengthy tree ring derived rainfall reconstruction available from southeast Virginia to explore developments in the early history of the

Jamestown and Roanoke colonies, work that is demonstrating how critical climate was to their success or failure.

Gordon Willey (1936) first realized the potential of dendrochronology in the 1930s when he was involved in the New Deal era excavations at Macon Plateau in central Georgia. In many ways his study was far ahead of its time, and it is gratifying to see that this kind of research is now

Refining Prehistoric Time Resolution

[South Appalachian Region, South Atlantic Slope; Wiggle matching, AMS dating, Archaeomagnetism, Dendrochronology; Temporal Resolution, Points, Pottery/Ceramics, Design motifs; Woodland, Mississippian]

As all the articles in this volume acknowledged, prehistoric chronological resolution leaves much to be desired, and we need to move toward achieving temporal precision closer to

We of course need more data categories in the Southeast that can be dated. Within the South Appalachian region, an order of ± 50 years (1200-1700^{cal}, at Shapiro 1990). In the Swift Creek era, the interval from the interval from comparable and Research with particularly the damaged areas) allowing us to vessels at a near Stephenson 1999 motifs becomes increasingly so interaction, as Woodland/initial will be invaluable A.D. 536^{cal} even

Research by paleo in refining archaeological sequences or records are now known and Cleveland 1985c, 1988, 1 context, and tie precision dating charcoal sample approximate placement. In are not available, it is order of 10 to 2 charcoal sample rings are present matching" tech precision AMS known temporal production curve (1996). Although time, it is only Kuniholm et al a dating technique potential of 10 t (Wolfman 1984 for the region archaeologists requisite fired cl

Tree Rings and Interactions

[Savannah River Slippage, Food Storage Thanks to the Malcolm Cleaveland of Arkansas, w

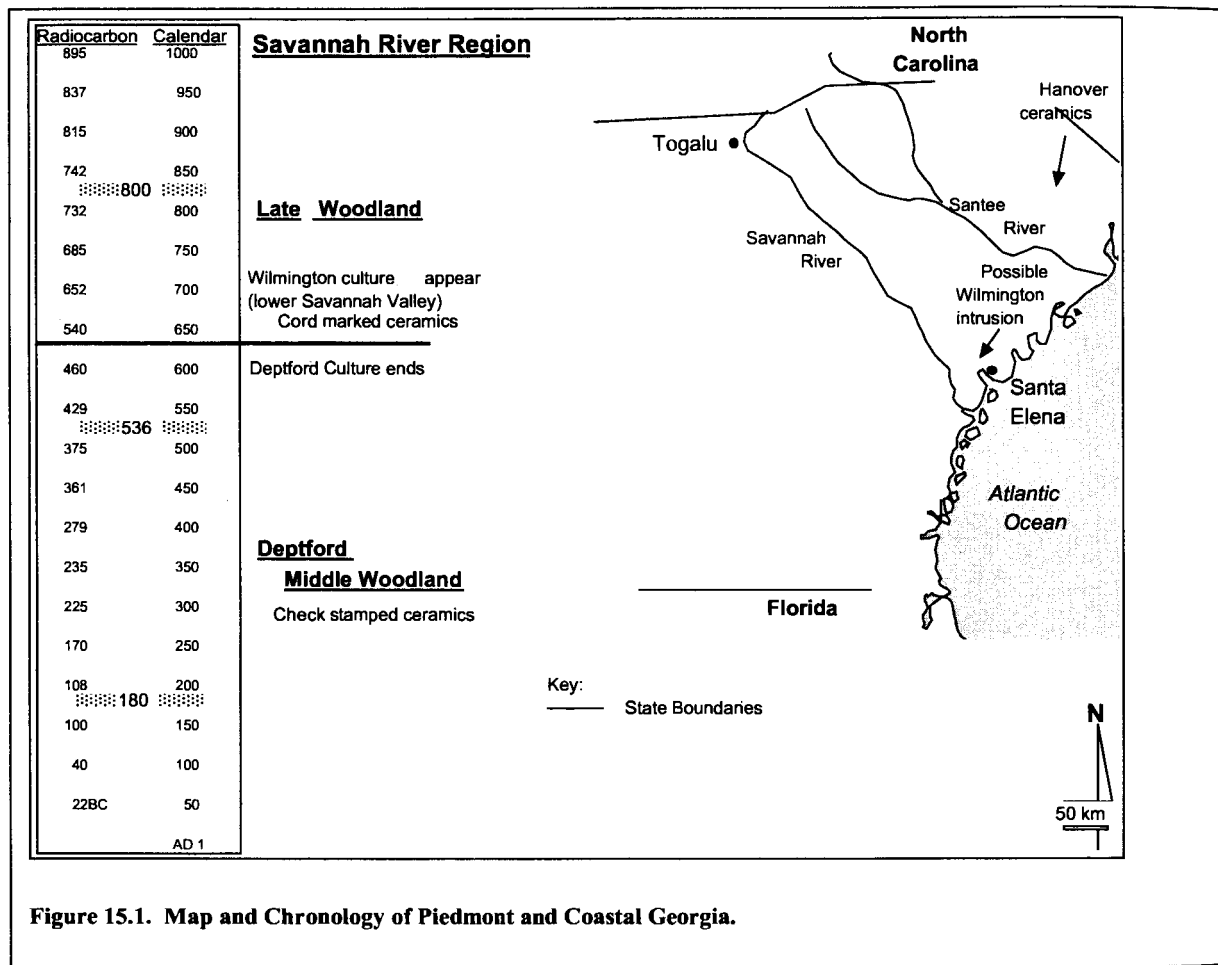


Figure 15.1. Map and Chronology of Piedmont and Coastal Georgia.

starting to come into its own across the Southeast. Climatological data will be increasingly used to examine major periods of cultural change in the region, such as the emergence of complex agricultural societies in the central Mississippi valley after ca. A.D. 1000^{cal}, and their subsequent rapid spread over much of the region. A dramatic consolidation of settlement and increase in organizational complexity occurred in the American Bottom near St. Louis around A.D. 1050^{cal}, in and near Cahokia (Milner 1998; Pauketat and Emerson 1997). The role climate could have played in changes such as these has received comparatively minimal attention, but this situation is changing (e.g., Lopinot 1994; Milner 1998).

that of history and some measures of paleoclimate. Our archaeological data gives us resolution on the one-to-two century scale at best for much of the Woodland period in the Southeast, yet to resolve fine-grained climatic events and impacts, we often need to have annual or at most decadal scale data. Major Holocene climate episodes, in contrast, may extend over hundreds or even thousands of years, whose relationship to cultural developments may or may not be well articulated (Wendland and Bryson 1974; Gunn 1994). In part because our temporal resolution is relatively imprecise, prehistoric archaeology within the region has been a largely episode, or phase, oriented study, focused more on long term changes and patterns than on the dynamics of rapid and short term environmental or social change. There are, fortunately, a number of ways in which we can refine prehistoric chronology locally.

We of course need to work with traditional archaeological data categories to refine temporal resolution, and in the Southeast that certainly includes pottery and projectile points. Within Mississippian ceramic assemblages in the South Appalachian area, temporal resolution exists on the order of ± 50 years for the period from approximately A.D. 1200-1700^{ca}, at least in some areas (e.g., Williams and Shapiro 1990). For the preceding Middle and Late Woodland era, Swift Creek complicated stamped pottery, which spans the interval from about A.D. 100 to 750^{ca}, appears to offer us comparable and perhaps even better temporal resolution. Research with Swift Creek ceramic design motifs, and particularly the occurrence of unique flaws (i.e., cracks, damaged areas) in the paddles that produced these vessels, is allowing us to recognize presumably contemporaneous vessels at a number of different Swift Creek sites (Snow and Stephenson 1998). As relative and absolute dating of these motifs becomes more precise, we should be able to produce increasingly sophisticated models of cultural development, interaction, and change for the terminal Middle Woodland/initial late Woodland period. Such information will be invaluable for determining the impact, if any, of the A.D. 536^{ca} event on this culture.

Research by paleoclimatologists should also help appreciably in refining archaeological time scales. Dendrochronological sequences or reconstructions dating back 1,000 or more years are now known from a number of parts of the region (Stahle and Cleaveland 1992, 1994; Stahle et al. 1985 a, 1985b, 1985c, 1988, 1991). When found in good archaeological context, and tied to secure reconstructions, extremely high precision dating should be possible in cases where wood or charcoal samples with 50 or more growth rings are found, the approximate minimum number needed for secure temporal placement. In areas where dendrochronological constructions are not available, or where only floating chronologies are available, it is still possible to achieve a resolution on the order of 10 to 20 years using radiocarbon dating on wood or charcoal samples where from ca. 50 to 100 annual growth rings are present. This can be done through the "wiggles-matching" technique, or the fitting of a series of high precision AMS radiocarbon dates taken from growth rings of known temporal separation to the secular radiocarbon production curve (Clark and Renfrew 1972, 1973, Renfrew 1996). Although this procedure has been known for some time, it is only now starting to see common application (e.g., Kuniholm et al. 1996). Another high precision absolute dating technique, archaeomagnetic dating, offers the potential of 10 to 20 year interval resolution in the Southeast (Wolfman 1984). To do this, however, the calibration curve for the region must be developed, which means archaeologists must make the investment in taking the requisite fired clay samples.

Tree Rings and Atlantic Slope Climate-Culture Interactions

[Savannah River, Southern Piedmont; Tree rings, Seasonal Slippage, Food Storage, paleoclimate, El Niño; Mississippian]

Thanks to the dendrochronological work of David Stahle, Malcolm Cleaveland, and their colleagues at the University of Arkansas, we also now have excellent year by year

paleoclimate information from many areas of the Southeast (Stahle and Cleaveland 1992, 1994, Stahle et al. 1985 a, 1985b, 1985c, 1988, 1991). Baldcypress ring widths provide a good proxy measure of spring/early summer rainfall, a relationship that has been demonstrated using historic rain gauge data with a very high degree of correlation. This type of data will be increasingly used in the years to come to explore the effects of annual and longer scale variations in climate on local cultures, both during the prehistoric and the historic eras.

I have used the tree ring derived paleoclimate data to calculate possible crop yields and stored food reserves each year during the Mississippian era, in the Savannah River valley and adjoining areas, where excellent long-term dendroclimatological reconstructions exist. These crop/storage estimates were then compared with the political history of the late prehistoric societies in this area, research reported at length elsewhere (Anderson 1994; Anderson et al. 1995). Periods of good and poor climate, as measured by extended periods of average and below average spring/early summer rainfall, were frequently found to be associated with periods of societal tranquillity and unrest, respectively. This relationship appears to reflect the importance of agricultural harvests in these societies, specifically the chiefly elites abilities to generate and then appropriate surplus production. However, as I have also taken care to point out, these relationships are by no means direct or unequivocal in every case, and are sometimes determined by a great many factors working in combination, not the least of which are regional political geography and the historical trajectories of the societies in question. I will return to these broader regional issues of the relationships between climate and culture later.

In a historic analog to these prehistoric investigations, tree ring derived rainfall measures were used to explore developments in the 1565-1587 Spanish colony of Santa Elena on the South Carolina coast. The Spaniards had the bad luck to settle Santa Elena during the worst decade of drought during the sixteenth century. The difficulties the colony faced no doubt played at least some role in the eventual decision to relocate the capitol of Spanish Florida to Saint Augustine in 1587, which occurred at the end of another severe climatic downturn, and probably not coincidentally was apparently the same year that the English "lost" colony to the north at Roanoke failed (Stahle et al. 1998). Given this, one could mount the argument that climatic fluctuations, as much as anything, explains why the people in the Southeastern United States speak English rather than Spanish. Early Spanish efforts at colonization in the region seem to have run into far more than their share of climatically-induced vicissitudes, from the hurricanes that destroyed the fleets of the 1528 Narvaez and 1559 Luna expeditions, to the multiyear long periods of droughty weather that characterized the beginning and end periods of settlement at Santa Elena (Figure 15.1).

As noted, examining the prehistoric Mississippian sequence in the Savannah River valley revealed similar correlations between climate and cultural phenomena. The same analysis, however, also indicated that the relationship was a highly complex one. The Savannah River Valley was largely abandoned by Mississippian groups, during a period of

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climatic downturn in the mid-fifteenth century, for example, but it also stayed abandoned during the century of favorable weather that followed. The rivalry and warfare between the powerful and expanding chiefdoms of Ocute and Cofitachequi in central Georgia and central South Carolina, with the Savannah chiefdoms caught in the middle, was likely of equal or greater importance in causing this abandonment (Anderson 1994, 1996a). Climatic induced stress—disrupting tribute flow and hence the position and authority of the chiefly elite, for example—could have helped push the Savannah River chiefdoms over the edge, but there were clearly other factors in play. The same was true in the early historic era, when the events at the Santa Elena and Roanoke colonies were played out against a much larger canvas, that of two powerful nation-states vying with one another for control of vast parts of the world.

Regional Scale Studies

[Atlantic Slope; Cultural Resources Archaeology, Regional Perspective; Woodland]

The Savannah River case indicates that adopting a regional perspective is likely to be just as critical to understanding culture change and interaction during the Woodland period, and particularly during the Middle-to-Late Woodland transition, the temporal focus of this volume, as it was in the later prehistoric era. Earlier generations of local archaeologists, particularly Joseph R. Caldwell in his classic 1958 monograph *Trend and Tradition in the Prehistory of the Eastern United States*, commonly proposed vast movements of prehistoric peoples over time and space, in maps filled with lines and arrows. While such a regional approach is something we should admire and emulate, we must also recognize that the sample sizes these scholars had to work with were extremely limited, based on work on a comparatively small number of sites. As a result, while many profound observations were made, many errors also occurred. Fortunately, we now have the data in hand to do a far better job.

Thanks largely to the rise of cultural resource management archaeology, there are now over 200,000 recorded archaeological sites in the Southeast, a dramatic increase from the ca. 10,000 or so recorded in 1970. The data in these records can and have been used to plot where people or at least sites were and were not on the landscape at various times in the past, notably over the course of the Paleoindian and Early, Middle, and Late Archaic in the case of my own work (Anderson 1991, 1996b). Unfortunately, such regional scale maps have yet to be prepared for the Woodland period, and we really do not have a very good idea about site distributions at the regional scale at the present. When such maps are ultimately produced for the Woodland period, I predict the results will tell us a great deal about population growth and change, and the rise and fall of cultural systems. The patterns that are revealed will generate new models and explanations, and will enable us to better evaluate the effects of climatic triggering events.

Cultural Change in the Coastal Plain

[Coastal Plain; Deptford/Linear check stamped, Wilmington/Cord-fabric impressed, Grog Temper, Immigration; Middle Woodland, Late Woodland]

What transpires in the terminal Middle Woodland and initial Late Woodland in the southern Atlantic Slope subregion? The 1,000 year long Deptford culture, characterized by linear check stamped pottery, comes to an end some time around A.D. 500^{ca}, and is replaced by Late Woodland complexes characterized by cord and fabric impressed pottery. This replacement is sometimes attributed to a movement of northern ideas and possibly people into the South Carolina and eastern Georgia Coastal Plain. In the northern part of the South Carolina Coastal Plain, this replacement is assumed to have been gradual. Indeed the stratigraphic columns from the few sites we have spanning the period, notably Minim Island and the Mattassee Lake sites from the lower Santee River, and the Blackwater Pond site cluster near the lower Wateree River, suggests a long cooccurrence for these finishes, with cord marked and fabric impressed finishes continuing long after linear check stamping drops out after ca. A.D. 500^{ca} (Anderson 1982; Cable 1997; Espenshade et al. 1989).

On the southern South Carolina and northern Georgia coast it has long been thought that grog tempered cord marked pottery of the Wilmington series arrived for the first time around A.D. 500 to 600^{ca}, when it (apparently) abruptly replaced earlier sand tempered Deptford materials (e.g., DePratter 1979, 1991). The traditional explanation has been that this reflected a movement of peoples into the region from the north (Caldwell 1952:316-317; Waring 1968:216, 221). Grog tempered ceramic manufacturing procedures had apparently been moving gradually southward for over a millennium, from antecedents in the Croaker Landing and Hanover series in coastal North Carolina, however, so a northern origin is not altogether unexpected (see Mathis this volume). Recent radiocarbon dates from sites in the Beaufort County, South Carolina area, furthermore, suggest that Wilmington may have appeared appreciably earlier (Espenshade 1994) and Deptford lasted appreciably later (e.g., Trinkley 1991, 1994) than ca. A.D. 500^{ca}.

Even given these caveats, the appearance of Wilmington ceramics in the vicinity of the mouth of the Savannah River does appear to be a more sudden and dramatic change than the slow spread (or long period of co-occurrence) suggested further to the north. While we have no unequivocal evidence in support of such an inference, it is tempting to speculate that what is sometimes called the 'Wilmington intrusion' (Waring 1968:221) reflects an actual movement of peoples from the north. In the context of this volume, one might speculate that northern peoples undergoing some type of climate-induced stress—Woodland era carpetbaggers if you will—forced their way into the lush southern South Carolina/northern Georgia Sea-Island area, where food may have been more plentiful. While this idea has never been seriously investigated, it should be, and at least now we have a possible causal mechanism to examine that is more intellectually satisfying, and possibly easier to test, than vague generalizations about migrations or the expansion of ceramic traditions. As Mathis (this volume) has shown,

furthermore, with Savannah River involving groups of Algonkian expansion and climatic events.

Cultural Change in the Coastal Plain and the Southeastern Piedmont, and

[South Atlantic Recognition, Decline of Middle Woodland]

Changes in settlement patterns between the Middle Woodland and Late Woodland periods are marked by population growth over the region area. The long network effectively elaborate (i.e., 1) accorded presocial societies. In southern along the Gulf the period following A.D. 750-800^{ca} organizational agricultural domestic gray cultures" (period are now right (Nassaney Island, and late such societies, organizational c

In the South Atlantic evidence for a transition is the coast of south previously. While pottery actually radiocarbon date validity of at least those that push Deptford and 1 Some of these determinations before I can appearance of V major cultural inference is at movement of people for a major Carolina area at

The same is true Atlantic Slope, from Lilly and decline in settlement and Late Woodland volume). At an Appalachian are other Late Wood

furthermore, what we are seeing at the mouth of the Savannah River could be the tail end of ripple effect involving groups farther to the north, a much larger Algonkian expansion whose causes could be related to climatic events.

Cultural Change in the South Appalachians, Piedmont, and North Georgia Subregions

[South Atlantic Slope; North Georgia; Regional Studies; Recognition, Decline, Absence, Pottery/Ceramics Designs/Finishes, Middle Woodland, Late Woodland 'problem'; Late Woodland]

Changes in settlement patterns appear to have occurred between the Middle and Late Woodland in some parts of the Southeast, but this does not seem to be associated with a marked population decline or organizational simplification over the region, or even within in the South Appalachian area. The long-distance Hopewellian-derived exchange network effectively ceases by ca. A.D. 300^{ca}, and with it the elaborate (i.e., log tomb, mound burial) mortuary treatment accorded presumably high status individuals in some societies. In some parts of the Southeast, however, notably along the Gulf Slope and in the Lower Mississippi Valley, the period following A.D. 500^{ca}, and particularly after ca. A.D. 750-800^{ca} there is evidence for increases in population, organizational complexity, warfare, and the use of agricultural domesticates. What used to be called the "good gray cultures" (*after* Williams 1963) of the Late Woodland period are now recognized as vibrant cultures in their own right (Nassaney and Cobb 1991). The Coles Creek, Weeden Island, and late Swift Creek cultures are classic examples of such societies, that in no way reflect a decline in organizational complexity from what came before.

In the South Appalachian area perhaps the most dramatic evidence for change at the Middle to Late Woodland transition is the so-called "Wilmington intrusion" along the coast of southern South Carolina and Georgia noted previously. While how abrupt the appearance of Wilmington pottery actually was has been questioned by several recent radiocarbon dates, I retain a healthy skepticism about the validity of at least some of these determinations, particularly those that push the boundaries of our previous dating of Deptford and Wilmington ceramics by several centuries. Some of these dates, frankly, are so divergent from previous determinations that I must await more supporting evidence before I can accept them. I personally believe that the appearance of Wilmington ceramics in this area represents a major cultural disjunction, but readily grant that such an inference is at present unproven. Aside for this possible movement of peoples down the coast, I do not see evidence for a major cultural disjunction elsewhere in the South Carolina area at this time.

The same is true, I believe, in portions of the interior south Atlantic Slope, and here my conclusions differ somewhat from Lilly and Webb, who suggest a possible hiatus or decline in settlement may have occurred between the Middle and Late Woodland periods in northwest Georgia (this volume). At an increasing number of locations in the South Appalachian area the radiocarbon record, associations with other Late Woodland/initial Mississippian wares, as well as

some stratigraphic evidence, however, clearly indicate that simple stamped Connestee and Cartersville-like assemblages, as well as related wares like Santee and Vining Simple Stamped, continue to occur well into the Late Woodland era (Anderson 1982, 1985, Anderson and Schuldenrein 1985, Anderson and Joseph 1988, Elliott and Wynn 1991, Pluckhahn 1997, Worth and Duke 1991, Worth 1996). Wetmore and her colleagues (this volume) in particular have amassed an exceptional amount of evidence in support of a continuation of Connestee from the Middle through the Late Woodland in western North Carolina. A similar case based on multiply dated materials in good context can be made in at least three other parts of the South Appalachian area, along the lower Santee River in South Carolina, the upper Savannah River in northern Georgia and South Carolina, and in the central Ocmulgee River of Georgia (Anderson 1982, Anderson and Schuldenrein 1985, Pluckhahn 1997; Worth's Raccoon Ridge site is likely to prove another such context). Across the South Appalachian area, furthermore, the Middle Woodland to Early Mississippian complicated stamped tradition follows what to my mind is a fairly even progression, from Deptford/Swift Creek to Napier, Woodstock, and Etowah.

Accordingly, what has been called the 'Late Woodland problem' in north Georgia (Rudolph 1991)—that a major population decline may have occurred following the end of the Middle Woodland—is not one of an absence of sites, but rather a recognition problem. Thanks to the work of a great many researchers in Georgia and the Carolinas over the past two decades, we now know that ceramic finishes like simple stamping have a long tenure and wide distribution on the South Atlantic slope, and are a critical (and previously unrecognized) indicator of Late Woodland/initial Mississippian period settlement.

Given the fact that large scale population relocations or 'abandonments' have been well documented in the late prehistoric Southeast (e.g., Anderson 1996a, Williams 1990), however, it is hard to argue that such events were not occurring well into the past as well. That is, regional political conditions (i.e., patterns of interaction between societies, encompassing such things as warfare, exchange, and alliance) were likely quite important in the spacing of societies across the Southeast far into past, probably throughout the Woodland and well into the Archaic period. Accordingly, Lilly and Webb's argument that the distributions of these wares are not uniform over the region, and that they may be absent from portions of northwest Georgia, is quite reasonable. In northwest Georgia there may well have been a disjunction, or abandonment of the area at the end of (or ending) Cartersville locally, and that this may well have happened some time in the fifth or sixth centuries. I believe this abandonment, if that is what occurred, was probably quite localized, however, and can probably be as readily explained by changes in regional political geography as to a sudden change in climate (although I will also acknowledge that the two factors can be linked). In other parts of the South Appalachian area, occupation continued uninterrupted from the Middle to the Late Woodland.

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16. EPILOGUE

David G. Anderson

Southeast Archaeological Center, National Park Service, 2035 East Paul Dirac Drive, Box 7, Tallahassee, Florida 32310

The mid-sixth century appears to have been a period when human societies in many parts of the globe experienced appreciable stress. We do not know exactly what happened, but there is evidence to suggest that global climate changed somewhat in the years around and following ca. A.D. 536, growing slightly cooler. Tree ring records, sea level curves, and documentary accounts, as well as more indirect archaeological evidence, all indicate that something apparently happened to effect climate at a planetary scale.

What we have chosen to call the A.D. 536 event, if indeed a single event is ultimately implicated, and not a series of events and/or processes operating over a number of years, appears to have had long term effects on both climate and culture. The ensuing three centuries were somewhat cooler than normal, with the result that a number of cultural systems in widely differing parts of the world exhibit evidence for depopulation, changes in land use, large scale relocation or movement, or a reduction in organizational complexity.

Critically important lessons of this volume, accordingly, are that human cultural systems can be profoundly effected by comparatively sudden changes in global climate; that such changes can occur at any time; and that these changes do not need to be large or dramatic to have long-term and far reaching effects. Our global technological civilization, while unquestionably resilient, is not invulnerable to such changes, and we must beware of hubris when judging its ability to cope with what the universe can throw at us.

The changes observed in mid-sixth century cultures worldwide may eventually be linked to a specific physical mechanism, such as a volcanic eruption, meteor impact, or some other natural phenomenon. It is the belief of most of the authors of this volume that something significant, at least in terms of its effect on human cultures, did occur at this time. A fairly sudden change in global climate appears to be the most likely explanation for what has been observed. We ask our colleagues in the natural and physical sciences to seriously explore this possibility.

The extent to which global climate may have changed in the mid-sixth century, we must emphasize, was comparatively minor when compared to some of the truly dramatic events that have occurred in earth history, such as the extended periods of continental glaciation that characterize much of the Pleistocene epoch, or the cataclysmic asteroid impacts at the ends of the Permian and Cretaceous periods. Nonetheless, for human societies in many parts of the globe even a comparatively minor change in climate, like that inferred to have occurred at ca. A.D. 536, could have had profound effects. We must explore what happened in the mid-sixth century, and more importantly, determine whether similar events or processes occurred at other times in human history

and prehistory, what their effects were on the cultures of the time, and assess the probability of similar events occurring in the years to come. Seriously addressing such questions, we believe, can profoundly shape how we as a civilization look at the world around us, and plan for the future.

As exciting and challenging as determining the physical causes of A.D. 536-like events is determining their effects on human cultural systems. Here archaeology and history have much to contribute, by providing detailed information on the short- and long-term consequences of global climate change. This potential is increasingly being recognized. In the mid-sixth century, as we have seen, different reactions to the A.D. 536 event occurred in societies at differing levels of organizational complexity. In general, those societies most dependent upon intensive agriculture, and at the same time least able to fall back on alternate resources, appear to have been the most vulnerable. These tended to be among the most complex civilizations of the time, as the case studies in this volume from Western Europe, China, the Mayan area, and eastern Africa indicate. Organizational change, typically a reduction in complexity or social unrest, as well as outright suffering (i.e., starvation, disease) appear to have been greatest in these societies. In contrast, less complex societies dependent on wild plant and animal resources, such as some of the native societies of the southeastern United States, seem to have come through this event more or less unscarred. Even in these societies, however, there are hints that all was not completely well, given evidence for changes in subsistence practices, material culture, and settlement patterning, as well as for occasional large scale population movements. That the extant regional civilizations did not completely collapse in most of the areas examined in this volume during the mid-sixth century, however, indicates that whatever happened to the global climate system was comparatively mild or short-lived. It also indicates that the state level cultural systems of the time were themselves quite resilient. A hallmark of complex organizational forms, particularly state level societies, of course, is the ability of their ruling classes or elites to marshal resources, and use them to advance their personal agendas. Survival and the maintenance of power are, of course, the most fundamental social agenda of such groups, and hence only the greatest of trauma could end these systems.

State-level societies in the sixth century, as indeed at any time, overcome periods of adversity by having the ability to buffer food shortfalls through the use of adequate appropriation and storage technologies, and having the physical force necessary to maintain control over these resources. While suffering may have been profound among commoners, and individual elites and their families may have perished in some areas, no doubt many elites and their supporters, and hence the organizational systems they

formed, were able to continue, albeit in weakened or changed condition. It is thus critically important to explore relationships between climate change, food production (i.e., crop yields, fishing harvests), and cultural (i.e., socio-political or organizational) stability. Fortunately, a great deal of research along these lines is now being conducted, as climate modeling becomes more sophisticated, and the global impact of events like El Niño, or carbon dioxide and fluorocarbon emissions, is coming to be widely appreciated, far beyond the realm of a few knowledgeable researchers. Basic questions that are coming to be asked by governmental bodies as well as individual citizens in nations around the world include: (1) what kinds of changes might we expect to occur in global climate in the years to come? (2) how vulnerable are our current cultural and political systems to such changes? and, (3) how can we minimize or at least anticipate any possible negative consequences of such changes? As we have seen in this volume, the past offers a vast record for comparison, and archaeology and history can make major contributions to the answering of these questions. Such questions are fundamental to human existence and perhaps even to our survival. Just as the asteroid impact that killed off the dinosaurs sixty five million years ago gave our mammalian forebears the chance to spread over the planet and achieve dominance, a similar event could end our own species' reign on earth. As this volume has attempted to demonstrate, there appears to be little doubt that similar, albeit lesser events have also shaped the course of human development. We have seen through archaeology and history that whole civilizations have been profoundly effected by natural calamities, such as the eruption of Santorini on the island of Thera in the eastern Mediterranean in the mid-second millennium B.C., the eruption of Mount Tambora in 1815 (Stothers 1984), or the aftermath of the A.D. 536 event. The record of earth's history is being closely scrutinized for evidence of past trauma, and the incidence and effects of massive volcanic eruptions or the impacts of extra-terrestrial objects such as meteors, comets, or asteroids has moved from the realm of wild speculation to serious scientific examination in the recent years. We now know, for example, that large objects regularly hit the earth, with a probability of occurrence, or periodicity, that is related to the size of the impactor (Gehrels 1994). Thus, a major life-shattering event like the impact at (and creating) the Cretaceous-Tertiary, caused by a ca. 10 km diameter asteroid, occurs about once every 100 million years or so. It is fortunate that such events are extremely rare, because such an impact today would probably result in the extinction of our species and, as in past comparable events, most life on earth. Less dramatic impacts, by objects a few hundred meters to a kilometer or so in extent, occur more frequently, every few hundred thousand to few million years. Such an impact, while perhaps not fatal, would likely result in the collapse of our global technological civilization (Sagan 1994:311-313). Finally, every few hundred years, the earth is hit by an object a hundred meters or so in diameter, causing the devastation of the largest of nuclear weapons. Such an impact in a densely populated area would cause unimaginable suffering.

Whether the A.D. 536 event was caused by the impact of an object somewhere in the few hundred to few million year periodicity range, or resulted from some other cause, such as

a massive volcanic eruption, is currently unknown. The physical signatures of such events should be ultimately discernible, although if an extraterrestrial source, such as a comet or asteroid is involved, these will likely differ appreciably depending on whether a land or ocean strike occurred, and on the composition of the impacting body.

How many unrecorded yet equally profound or even greater events have shaped the human past? We now know, for example, that a major asteroid impact occurred in the southern Pacific ocean approximately 2.15 million years ago, and that it apparently had significant and long-term effects on global climate (Gersonde et al. 1997). What role, if any, did this late Pliocene event play in the evolution of our own species? The emergence of the genus *Homo* occurs about this time, as well as a fairly dramatic upswing in stone tool use, and it is at least possible that these events are in some way linked. We know from the aftermath of Mount Pinatubo, Mount Tambora, and other examples dating back over the centuries that major volcanic eruptions can effect global climate, and have a major impact on human society (Simkin and Siebert 1994). The systematic examination of such events, through the cooperation of scholars in the various disciplines capable of exploring these kinds of questions, we believe, can greatly improve our understanding of the past.

Ultimately, what holds our interest as archaeologists and historians is how our species, and its varied cultures and individuals, have responded to perturbations in global climate such as those discussed here, and how they will likely respond in the future. The contents of this book suggest that we have much to contribute to the study of these questions.

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The Years without Summer

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Edited by

Joel D. Gunn

BAR International Series 872

2000