STEEP SHORE, DEADLY ENVIRONMENT: THE CASE FOR A CULTURAL ANVIL ALONG THE UNEMBAYED ATLANTIC COAST

By: Joel D. Gunn

2002. Joel D. Gunn. Steep Shore, Deadly Environment: A Case for a Cultural Anvil Along the Unembayed Atlantic Coast. *North Carolina Archaeology* 51:1-33.

Abstract:
In his physiography of Eastern United States, Fenneman divided the Atlantic coast into embayed and sea island (largely unembayed) segments at the Neuse River. The southern North Carolina coast is unembayed because of geologic uplift. To the north (i.e., North Carolina and Virginia) and south (i.e., South Carolina and Georgia), submerged coasts and river systems support some of the world's richest estuaries. Cultural patterns inland from the two kinds of shorelines differ profoundly and reflect a fundamental characteristic of coastlines, shallow and rich or steep and impoverished. The ecological ramifications of these shoreline habitats sum to long-term stability or instability, both near-shore and inland. In pre-modern times, a key variable for human populations was the magnitude of late winter anadromous fish runs. Unstable landscapes such as existed on the southern North Carolina Coastal Plain have been discussed as "cultural anvils." The implications of the cultural anvil model are explored for the region.

Article:
Over the last 20 years, a local cultural chronology has emerged in the southern Coastal Plain of North Carolina that differs from surrounding regions in many respects (Herbert 1999; Irwin et al. 1999; Sanborn and Abbott 1999; Ward and Davis 1999:194-228). Rather than being a monolithic, in situ developmental sequence, the region appears to evolve as an extremely complex interleaving of indigenous cultures with traits from surrounding cultural complexes. This interleaving is evident in mortuary and ritual contexts, especially mound construction. Ceramics provide a sensitive, multidimensional analysis of the mixing of indigenous and introduced traits (Anderson 1996; Cable 1998; Sanborn and Abbott 1999:15). What are the underlying factors that generated this combustible cultural pattern?

In this article I examine southern North Carolina Coastal Plain cultural patterns in the context of the broader Atlantic Slope. I then frame these cultural patterns in a geologic and climatic perspective that illuminates their landscape context and boundaries. Some of the characteristics of the cultural chronology suggest a cultural process referred to elsewhere as a "cultural anvil," a cultural trap set by environmental circumstances (Fitzhugh 1972; Gunn 1979; Gunn and Sanborn 2002:64, 67). Landscape models have generally proven to be valuable and productive concepts (see Stine et al. 1997 for discussion and practical examples). The cultural anvil model, like all landscape models, incorporates the elements of geology, climate, and bioculture to understand cultural processes (Crumley 1994; Gunn 1994a). The cultural anvil model is especially effective where permanent conditions set by geologic and climatic phenomena beat out a relentless pattern of environmental change. Although archaeology is inherently a regional science (Willey and Phillips 1958)—a science whose spatial unit of analysis is the region—in this article I suggest that regional events and trends only make sense when understood in appropriate geological and climatic contexts.

Cape Fear Culture—What It Is Not and Is

The Coastal Plain within North Carolina (Figure 1) is divided by archaeologists at the Neuse River for a number of reasons (Herbert and Mathis 1966; Phelps 1983; South 1960; Ward and Davis 1999:194–195). Not the least of these reasons is that in historic times it was the boundary between the Iroquoian and Algonkian speakers to the north and probable Siouan-speaking groups to the south (Abbott et al. 1995:25). South of the Neuse River is the Cape Fear River, which parallels the border between North and South Carolina. The Cape Fear River basin is the focus of this study as it contains the characteristics that distinguish the southern Coastal Plain from surrounding regions. For reasons that will be discussed next, the northern South Carolina Coastal Plain shares attributes with its North Carolina sister region (Cable 1998) and should be considered a part of this study.

The prehistoric cultures of the Cape Fear River basin transition between the usual Archaic (8000–1000 B.C.) and Woodland (1000 B.C.– A.D. 1650) weapons systems and food preparation technologies: dart points to arrow points, fire cracked rock to ceramics. Some recent dating argues that ceramics may have developed as early in the Cape Fear River valley as anywhere along the Atlantic Slope (Jones et al. 1997; Sanborn and Abbott 1999:15). However, in the long term and broad areal perspectives, the regional cultural evidence remains relatively ephemeral across the millennia of prehistory. Although evidence is plentiful that people of the Coastal Plain knew of and had systematic exchanges of goods with Mississippian groups (A.D. 800–1600) to the west and south (Irwin et al. 1999:59; Ward and Davis 1999:210 ff), they never fully adopted the cultural regalia of the chiefdom- or state- based Mississippian

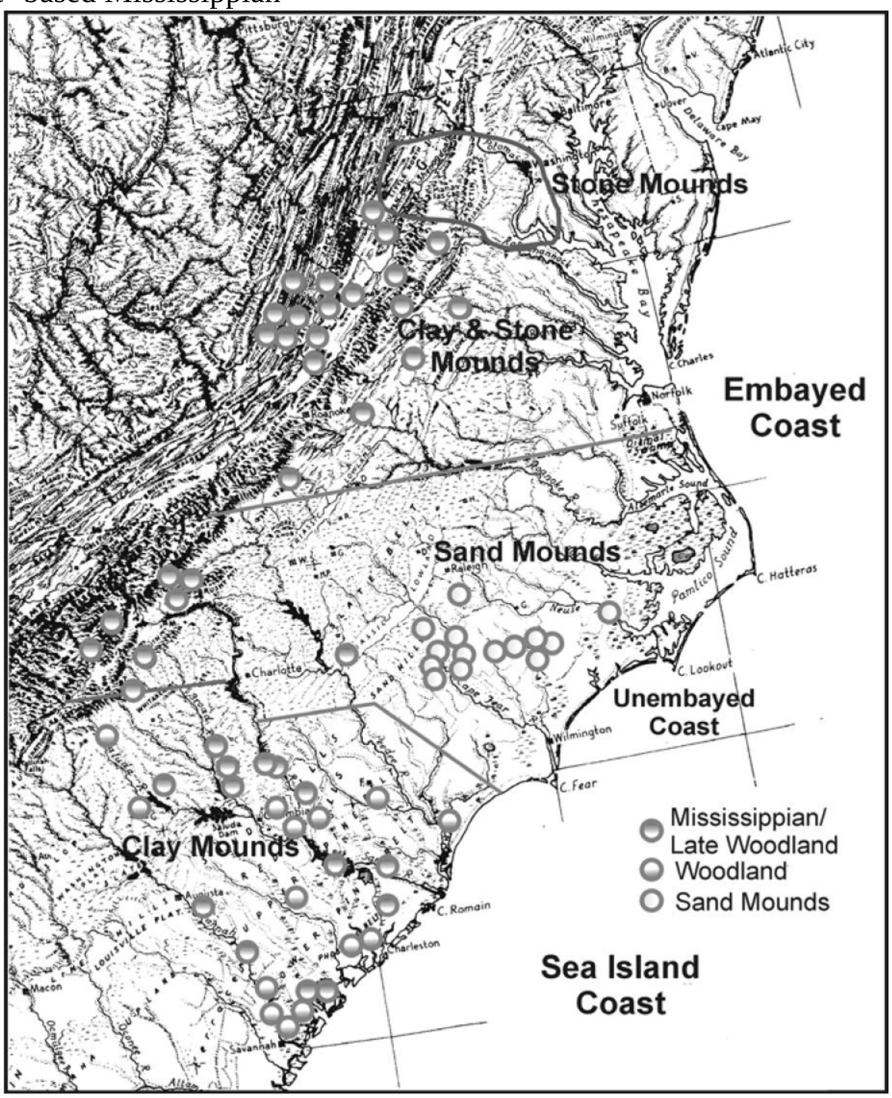


Figure 1. Distribution of stone, clay, and sand mounds along the Atlantic Slope (adapted from Dunham 1994, Frierson 2002, Gardner 1993, Levy et al. 1990).

civilizations. This distinction is recognized in the local cultural chronology as a continuation of the Woodland period until the seventeenth century. The period recognized in adjacent regions as Mississippian is termed Late Woodland (A.D. 800–1650) in the lower Cape Fear River valley.

The disjunction between the cultures of the lower Cape Fear River and surrounding regions is nowhere more apparent than in the distribution of accretional mounds, clay, rock, or sand structures designed initially for mortuary purposes in the Woodland and later for ritual in the Mississippian (Willey 1966) (see Figure 1). As near as South Carolina (Frierson 2002), and in the Appalachian Mountains and foothills (Dunham 1994; Levy et al. 1990), such mounds were recapped generation after generation for 100s of years and grew to great size. In the Chesapeake Bay area, rock mounds were constructed, some to considerable heights with standing interments (Gardner 1993; Gunn 1994; Pigeon 1853). In great contrast to these intentional structures, on the southern Coastal Plain, occasional opportunistically appropriated natural sand mounds were used for multiple interments. A possible cluster of constructed low sand mounds has been identified near the Cape Fear River channel on Rockfish Creek to the southwest of Fayetteville, North Carolina (Irwin et al. 1999:61; Ward and Davis 1999:206–210). Artifacts recovered from these mound burials clearly indicate contact with Mississippian groups, and perhaps origins from among them. They include 25 stone smoking pipes, some of which were platform pipes made in the style of the Ohio Valley Middle Woodland Hopewell tradition (Ward and Davis 1999:207).

A parallel line of evidence is historically recorded Indian trails. Recent research suggests that Indian trails in some cases may have origins as early as the Paleoindian period (M. Brooks, personal communication, 1998), and could have been elephant migration routes in the Pleistocene. A map of these trails as they were known in the historic period (Myer 1971) shows major paths skirting the Coastal Plain along the edge of the Piedmont, and proceeding onto the Coastal Plain in South Carolina and Virginia, but seldom going into the Coastal Plain in North Carolina.

The mound and path patterns seem to imply a rather donut-hole cultural enclave in the Coastal Plain. What are the underlying causes of the cultural donut-hole? Although without imposing mounds and depopulated in historical times, the region was certainly culturally active in prehistory. As far as they can be traced, given a less than refined cultural chronology, on occasion migrations and/or diffusions of cultural traits appear to enter into the southern Coastal Plain from north, south, or west, cross its landscape, but not penetrate beyond its opposite boundary (Figure 2). In other words, they seem to be trapped or “boxed in” by the southern Coastal Plain. Other cultural traits approach to or expand through the region. Ceramics varieties and some other traits provide examples:

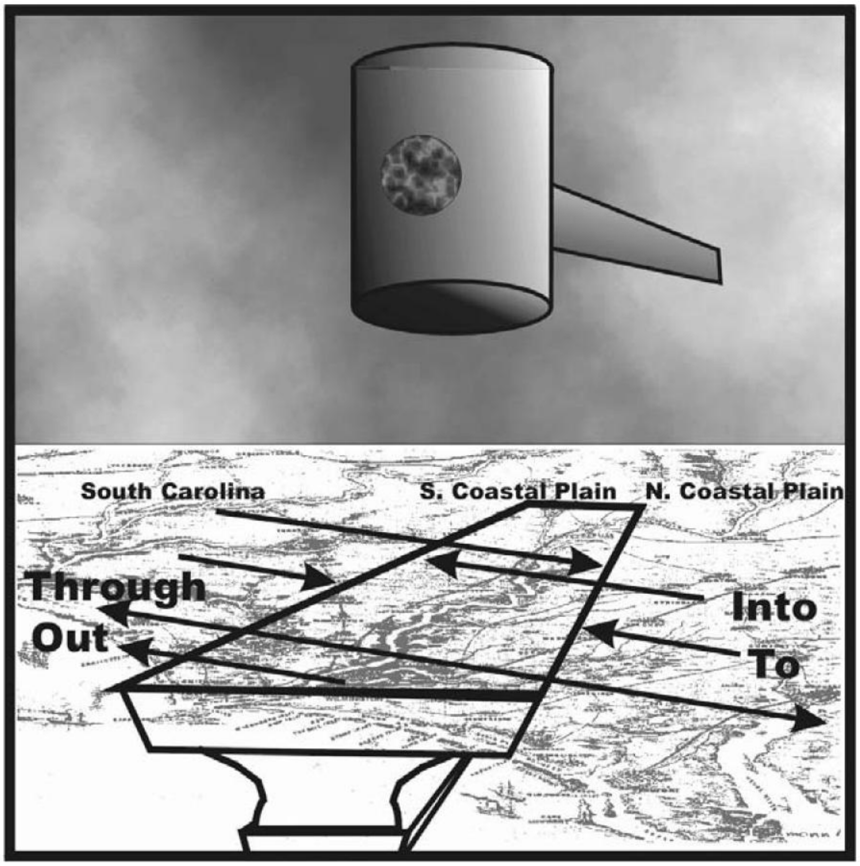


Figure 2. Movement patterns of traits relative to regions.

Into. There are several examples of traits penetrating into the region, but not spreading beyond it boundaries. In the Late Archaic (2000–1000 B.C.), Thom's Creek sand-tempered ware with reed-punctate and plain surface treatments appeared in South Carolina and crossed into the region spreading to the Neuse River but not beyond (Herbert 1999:43). Soapstone- tempered ware (Marcey Creek, 1200–800 B.C.) spread from the Chesapeake Bay region beyond the Neuse River (Herbert 1999:43). During the late Middle Woodland (around A.D. 600), Algonkian mortuary practices and physiology crept into the region from the north and halted half way across at the New River, then retreated to the Neuse River by the historic period (Mathis 2000). (What conditions restrain traits from spreading beyond the regional boundary opposite that of entry?)

To. Some traits ceased to advance at the boundary of the southern Coastal Plain. Croaker Landing clay and grog tempered ware reached only to the southern Coastal Plain northern boundary (Herbert 1999:43). The Algonkian movements crossed into the southern Coastal Plain, but later retreated to the northern Coastal Plain being limited to it. (What conditions restrain traits from entering a region?)

Through. Other traits extend through the southern Coastal Plain and into adjoining territories such as fiber tempered ware, which originated in the south and is found as far north as the Chowan River (Herbert 1999:43). (Were key elements of the Middle Holocene climate so different that Stallings territory included a range beyond the Neuse River? Or, was it merely that some Holocene climates extended the range of Spanish moss further north along the coast? Was Stallings a water-oriented adaptation and thus not limited by the characteristics of the southern Coastal Plain?) Middle Woodland Deptford sand-tempered, check- stamped ceramics not only crossed the southern Coastal Plain, but also expanded in the form of Yadkin grit-tempered, check- stamped ware into the westward adjacent Piedmont (Herbert 1999:44). (What were the contextual conditions that permitted these movements through the southern Coastal Plain into nearby regions?)

Out. Some varieties of ceramics appear to originate in the southern Coastal Plain and spread out from it. Hanover grog- tempered ware appears to begin in the region and later exit to South Carolina (Sanborn and Abbot 1999:15). Early Woodland Hamps Landing limestone tempered ware might be another such case as it appears in both North and South Carolina; dating remains ambiguous (Herbert 1999:43). (Under what conditions did indigenous inventions spread out of the southern Coastal Plain?)

The movement of cultural traits into the southern Coastal Plain has provoked an enduring debate. It has been the subject of attention since South began his studies around the mouth of the Cape Fear (Ward and Davis 1999:196). The cultural anvil hypothesis differs from that of South (1960) in that it supposes all boundaries of the southern Coastal Plain region pose filters and barriers to the flow of ideas and populations. The reason being that when the region is invaded, either by thought or deed, that movement presupposes a pre-adaptation to the then-current conditions of the southern Coastal Plain in one of the three surrounding regions. The extent of the movement will be constrained at the opposite boundary by characteristics of the region unless that region has assumed similar conditions. On occasions where new patterns run through the boundaries of the region, explanations other than environmental adaptation appear to be appropriate. For example, during the Late Archaic, fiber-tempered Stallings Island ceramics spread through the region as far north as the Chowan River (Herbert 1999:43; Ward and Davis 1999:199). Why was Thom's Creek, the contemporary of Stallings Island, constrained by the northern boundary of the region while Stallings was not? In an equally interesting reverse perspective, Early Woodland Marcy Creek steatite- tempered ware (Ward and Davis 1999:199) and Middle Woodland Mockley Creek (Ward and Davis 1999:203) found their southern limit at the Neuse River implying a mal-adaptation to the then-current conditions that prevented its movement further south.

The repeated occurrence of boundary-limited influxes of cultural phenomena into the southern Coastal Plain suggests an enduring cultural process. In the following sections of this article I attempt to find possible influencing factors that may underlie such a process. By "process" I mean an identifiable cultural development that reoccurs in a similar pattern multiple times. If it reoccurs twice, it is a possible process. If it reoccurs three times or more, it is a probable process. Support for a process emerges from the identification of a constellation of factors that arguably could account for the reoccurring features of the process. Since we view past cultures through their technologies, a new process will emerge with each new technological change such as the shift from stone boiling to ceramic-vessel food preparation technologies.

Cape Fear Arch—the Geological Anvil

The preeminent feature of the Atlantic coast that evidently separates the northern and southern Coastal Plain is the contrast in coastlines. From the Neuse River north, the coastline winds it way through a fractal maze of bays, islands, river mouth insets, and barrier islands. The length of the coastline from the Neuse to Chesapeake Bay traces five times the length of that to the south (Herbert and Mathis 1996; Phelps 1983; South 1960; Ward and Davis 1999:194–195). Early on, the contrasting features of the two zones of the coast impressed Fenneman (1938:38–46) enough for him to give separate names, "embayed coast" to the north and "sea island coast" to the south. Fenneman attributed this difference to the concave shape of the sea island segment of the coast. The concave coast focused tides accounting for higher tidal rises and more extreme water movements in and out of river mouths. This influx and outflux of sea water prevented the accretion of barrier islands and cut the coast into island segments between river mouths.

Culturally, the embayed-sea island distinction is significant because broad coastal estuaries such as those found north of the Neuse River support the transference of large runs of migratory or anadromous fish between salt and fresh water. Such fish runs are a key survival issue among subsistence hunters and horticulturists since they appear at a critical time of the year. During the late winter and early spring, food is most likely to be in short supply among hunters and gatherers and subsistence agriculturists (Gunn et al. 1998; Gunn and Stanyard 1999; Millis 1999). Thus, at the first level of analysis, the embayed coast could be expected to support a much more plentiful key subsistence resource than the sea island segment of the coast. This pattern ramifies up the Coastal Plain to the Piedmont boundary or fall line, the highest point in the rivers where anadromous fish can reliably be expected in the driest years (Gunn et al. 1998; V. Schneider, personal communication, 1998).

At the same time that Fenneman was describing the outline of the Atlantic slope, his geological colleagues were studying the Cretaceous and Cenozoic geological strata of the Coastal Plain and developing information that would serve to explain the differences in coastal outlines, and ultimately refine the description. Upper Cretaceous marine sediments were initially deposited around 100 million years ago against the crystalline Piedmont bedrock in deep formations (Sohl and Owens 1991). River deltas and near-shore currents did most of the work. Some time around the beginning of the Cenozoic (about 50 million years ago) the area of the southern Coastal Plain began uplift by geologic forces. Thus, while the Neuse River to the north and the Pee Dee River to the south remained low and subject to marine transgression and deposition, the Cape Fear valley was uplifted and left high and somewhat dry, a feature referred to as the Cape Fear arch (Figure 3). The Cape Fear River and its tributary, Rockfish Creek southwest of Fayetteville, North Carolina, cut deep into the Cretaceous sediments. For this reason, most of the geological type sections of Cretaceous age deposits are in the deeply dissected inner Coastal Plain and Sand Hills around Fayetteville.

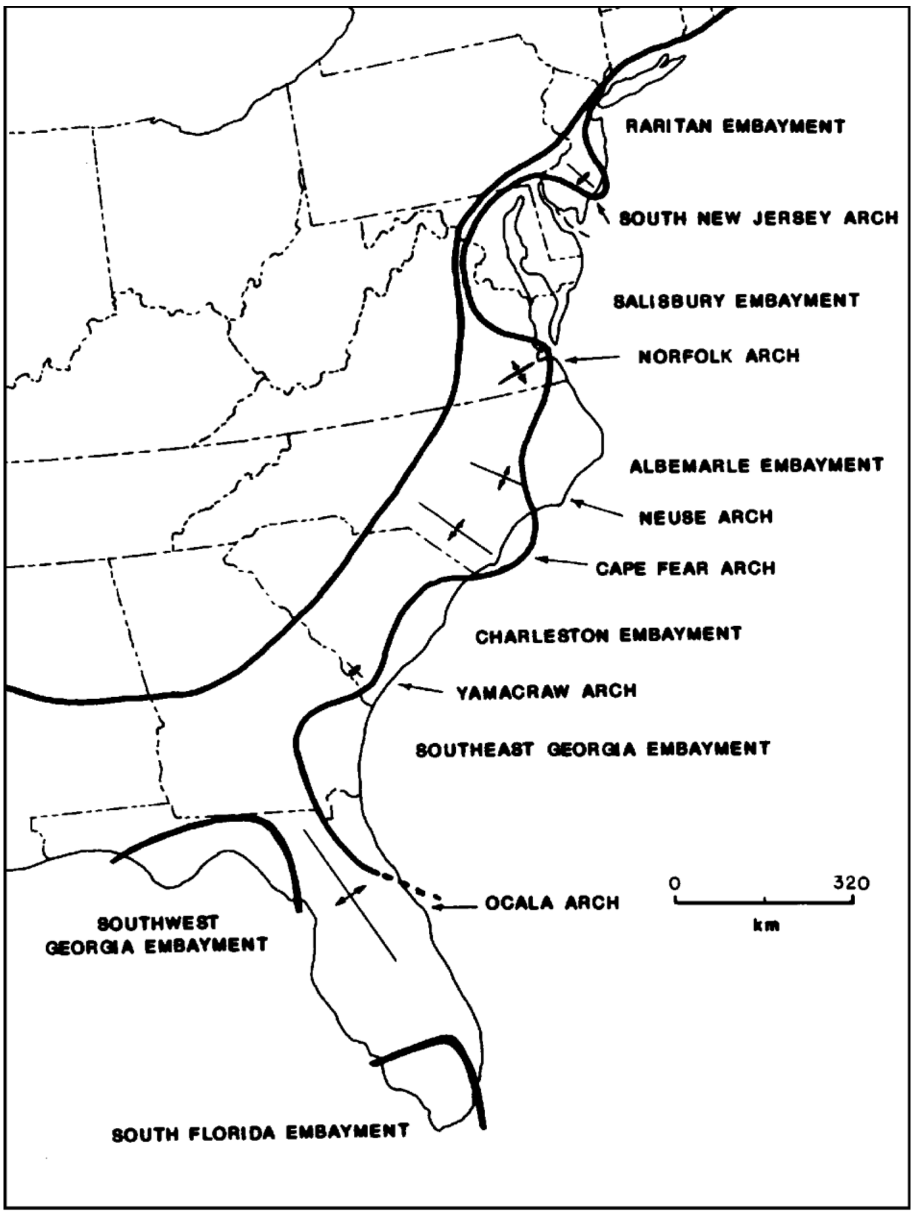


Figure 3. The Cape Fear Arch and other structural features of the Atlantic Coast (adapted from Ward et al. 1991).

Figure 4. Photograph of the deeply incised Cape Fear River during constructior of the Fayetteville Outer Loop.

The consequences of this uplift are more than a little noticeable. The Neuse and Pee Dee rivers are soggy, meandering rivers that bury their history in ample sediment loads. Since the beginning of the uplift, the Cape Fear River has been destroying its history as it cuts sideways to the southwest deep into a 100 million years of accumulation (Figure 4). Surrounding elevations are dry and occasionally have been near desert (Robinson 1986; Sohl and Owens 1991). In the Middle Holocene (4500– 7500 B.P.), sand blew freely in the Cape Fear valley, creating active sand dunes (Soller and Mills 1991:301–302). During the Illinoian glacial advance, blowouts appeared across the Cape Fear watershed on the Socastee formation, resulting in the highest density between Maryland and Florida of Carolina Bays, or oval upland ponds (Bennett and Nelson 1991; Soller and Mills 1991). These features are not visible in the Pee Dee and Neuse valleys because they were intermittently reworked by Cenozoic marine transgressions and not of sufficient elevation to support drought and the creation of aeolian features. The uplift also brings a solution to the unembayed character of the southern Coastal Plain shoreline. In the coastal zone, the steeper continental shelf created by the uplift imposes an attenuated breadth. In addition to the sea island process, the steep shore and narrow coastal zone further limits anadromous fish estuary habitat. The difference is so distinctive along the southern North Carolina coast that it will be referred to here as the “unembayed” portion of the sea island coast.

We are privileged to a firsthand account from 1663 of conditions on the Cape Fear arch. Between September 24 and December 4, 1663, the ships company of the Adventure explored the Cape Fear River basin traveling up several of its tributaries (Lawson 1967:72–79). It appears that they ascended just beyond present day Fayetteville in the main channel of the river. In the lower reaches of the Cape Fear valley they observed great pines growing in barren ground, in other places large dried swamps they judged good for pasture. On the Coastal Plain they reported “good lands” within two miles of the river but beyond that “all Pine Land, but good

Pasture Ground" (Lawson 1967:75). Along the river channel above Fayetteville were oaks, pines, and a number of other species of trees.

Some judgments can be made about the moisture regime of the period from these observations. The pine parklands on the Coastal Plain suggest an active fire regime and insufficient spring moisture to support deciduous varieties of trees. However, the oak-pine forests in the Sand Hills-Fall Line zone indicate that the elevation of those features triggered enough precipitation in the spring on a regular basis to sustain temperate species. Apparently the hydrological regime was not moist enough near the coast to sustain the large seasonal swamps as they were dry and grassy. The Adventure exploration was during the later Little Ice Age (1650–1750, Stahle et al. 1988:1518). Tree rings from the Black River (see below) "become drier" according to Stahle et al. (1988), though 1663 is only a decade into a century-long episode of drought. It may also be important that the Cape Fear valley was uninhabited by Native American, while one of its tributaries, perhaps the Northeast Cape Fear River near the coast, sustained substantial populations whose subsistence included acorns, fish, and corn. The Native Americans also appear to have been raising cattle and hogs.

Culturally, the rather peninsular character of the Cape Fear arch lends a certain coherence to cultural patterns in the southern Coastal Plain. Colonial Scots Highlanders (Fischer 1989:818; Powell 1989) occupied the Cross Creek confluence of the Cape Fear River following 1730 and created a distinctive American version of highland culture (Ray 2001). They continued up the elevated landscape to the west, apparently a product of the same uplift as the Cape Fear arch. They continued up the well-worn roots of the Uwharrie Mountains and the highest elevations in the southern Appalachian Mountains, such as Grandfather Mountain where the Highland Games are held to the present.

During prehistoric times the dry elevations of the Cape Fear arch witnessed the only intrusion of Mississippian mound building in the constructed sand burial mounds to the southwest of Fayetteville. Grog tempered ceramics seem to have moved up the Cape Fear River and been somewhat constrained to it as will be discussed below. Myer (1971) shows the only path to the coast from the Piedmont to wend its way down the Cape Fear desert to Wilmington.

Cultural Interleaving—A Confusion of Temper and Surface Treatment

As discussed above, influxes of cultural traits into the Cape Fear arch and southern Coastal Plain appear to have a bounded character. Although subject to a number of influxes of cultural traits across its region boarders, the spread of these traits seldom exceeds the opposite regional boundary. When traits do exceed the boundary of the region, it seems to be in cases where they originated in the region and spread outward from it, such as grog tempering (Sanborn and Abbott 1999:15). This pattern gives an interleaved character to the accumulated traits as appears in the shuffling of a deck of cards. It is also important to note that the boundaries seem to filter the range of traits that find acceptance in the region. A perfectly understandable example of this dynamic is clay mounds since clay is available only in limited quantities in dominantly sand and gravel sediments. However, the size of mounds is also limited by population size and consequent constraints on the organization of labor to build mounds. This is most likely a product of the anadromous fish limitation.

Because of the many physically independent dimensions of ceramic manufacture, such as paste and surface treatment, ceramics provide an unusually sensitive gauge of trait interleaving. An interesting case is Hanover ceramics. Grog-tempered ceramics appeared in the late Early Woodland-early Middle Woodland in the southern Coastal Plain of North Carolina in an associated pattern of paste and surface treatment recognized as the Hanover type (Sanborn and Abbott 1999:15). Three hundred years later, grog temper was manifest in the South Carolina Coastal Plain as two recognizable ceramic types, Hanover and Refuge (Cable 1998; Sanborn and Abbott 1999). Was grog tempering introduced to two groups of ceramists in South Carolina, each of which gave vessels with that temper a special cultural spin, a characteristic surface treatment?

An equally intriguing sequence of events unfolds during the late first millennium A.D. Hanover ceramics with a dominant temper of grog appeared (Herbert et al. 2002). Given the earlier dates for Hanover/ Deptford-like ceramics in the area, at about 1000 B.C. (Sanborn and Abbott 1999:15), the Middle Woodland and Late Woodland coherence of the dates obtained on the grog tempered sherds by Herbert et al. (2002) might be entertained as a reintroduction from the south around A.D. 500. A sand-dominated temper pattern continues until about A.D. 1500 (Herbert 1999:5; Herbert et al. 2002). However, during the Medieval Maximum a subset of Hanover ceramics acquires a grog-dominated pattern. The question might be asked if the population introduced from the Pee Dee imposed this pattern as part of their control of the region while local potters continued with their established paste construction habits. Was the transition gradual, or did contextual factors contribute to a founder's-effect cultural drift in ceramic manufacture? Was some other process involved such as a change in the marriage alliance patterns that altered the means by which potters came to the region?

In addition to the shifting grog temper scene, other influences were at work. During the early Middle Woodland, the region seems to have been dominated by cord-marked, pebbly sand-tempered New River ceramics (Sanborn and Abbott 1999) and a culture that sported Eared Yadkin points (Claggett and Cable 1982; Gunn et al. 1998). Probably around A.D. 200, fabric-impressed wares appeared from the north along with Wakefield points, a derivative or relative of Piscataway points in Virginia (Claggett and Cable 1982; Gunn et al. 1998; Kurchin 2001). Can the rhythm and timing of these interleavings be matched to detectable changes in conditions on the Cape Fear arch?

Cultural Analogy—Cultural Anvil

The prehistoric cultural upheavals evident in the southern Coastal Plain are set in the context of the elevated, drought-prone terrain of the Cape Fear arch and the relative lack of stability that anadromous fish provide. As such, the unembayed portion of the coast and its hinterland become, at least in theory, a region in which populations are likely to be unstable and to suffer occasional episodes of population setback. Such areas are referred to as "cultural anvils" (Fitzhugh 1972; Gunn 1979). People occupy cultural anvil regions during episodes when climate or other factors favor occupation by their technology. When the favorable regime collapses at too sudden a pace for readaptation, its human population follows suite. The classic example is that of the Naskapi of the Labrador Peninsula who subsisted on caribou as big game hunters. This pattern continued until an unusual episode of winter warming melted the snow enough to cause a sheet of ice over the moss and lichen food of the caribou. Without forage, the caribou population disappeared in one winter and the Naskapi were crushed as a big game hunting culture. They were forced to resort to Eskimo villages along the coast where they ate fish, the worst humiliation to their minds (Fitzhugh 1972). Presumably the Naskapi would eventually be replaced when hunting was better by a group moving in from a nearby region, the Montagni of the boreal forest, as the Naskapi themselves had done earlier. While the Naskapi are an unusually dramatic example, other cultural anvils can be readily cited. Among them are nineteenth-century Euro-American settlers of the Plains who flourished for a time but eventually experienced the dust bowl of the 1930s, a periodic drought phenomenon of the Plains (Gunn 1994a). The tragedy and cultural upheaval of the 1930s still resonates in parts of the country as distant as California, as illustrated in Steinbeck's treatment in *The Grapes of Wrath*.

The Black River Tree Rings: The Climatic Hammer

In the case of the Naskapi, the effects of global warming are readily evident: winter ice blocks access to moss and lichens – caribou die – end of culture. On the Cape Fear arch, the links between the earth system and local climate are not so immediately apparent. The exact impact of climate change on the unembayed segment of the Atlantic Coast and Coastal Plain requires patient investigation and the following is offered as a preliminary model.

For later cultural periods such as the Late Woodland, the central concept of a cultural anvil model might be represented in the following scenario. An episode of reliable rainfall in the appropriate season lures unsuspecting horticulturists from a nearby region. These "good times" are followed by an episode of insufficient and/or seasonally inappropriate precipitation. Population stresses inevitably arise. Were there a sufficient length of time between the luring and the stressing, evidence of a cultural adaptation would accumulate on the landscape. The subsequent period would be marked by some alternative pattern of cultural adaptation.

A pattern of stress can be seen in the transition from Middle to Late Woodland in the northern South Carolina interior Coastal Plain west of Charleston, South Carolina, a finding that originally suggested to this author that an anvil effect existed. At that time, single component site inventories indicate a sudden decline in the number (n=21 to n=5) of artifact categories (points, scrapers, ceramic wares, etc.). I later discovered that this transition could have been the outcome of a worldwide cooling event and local drying (Anderson 2000; Gunn 1991, 2000a).

Other previously formulated subsistence models could easily work as components of a cultural anvil explanation. Loftfield's (1988) subsistence model for Woodland cultures in the Wilmington-New River area, which posits retreat to the coast during periods of poor agricultural productivity to collect shellfish, could be the product of an unstable culture-climate process in the coastal hinterlands on the Cape Fear arch; it would be a habituated version of the Naskapi fleeing to the coastal Eskimo. Mathis (personal communication, 2002) attributes the aforementioned retreat of the prehistoric Algonkian speakers from the unembayed section to the decline of shellfish and schooling fish in near-shore waters as sea level declined during globally cooler periods. Such conditions would have been coeval with drought in the interior Coastal Plain as both events are the result of global cooling. Woodall's (2000) model of shifting resource bases between lowland horticulture and upland mast depending on seasonality of moisture would be appropriate for the inner Coastal Plain where coastal resources were less accessible. In the Savannah River basin, Anderson et al. (1995) developed a storage model to explain climate- related cultural changes and adaptations. When droughts were of sufficient duration, cultural changes ensued. On the Cape Fear arch, the aggregated potential for climate, cultural, and population change would have contributed to the cultural transitional zone frequently discussed by various authors (Abbott et al. 1995; Cable 1998; Mathis 2000; Phelps 1983; South 1976; Willey 1966), which is generally identified with the unembayed, uplifted segment of the Atlantic Coast.

Refinement of local lithic and ceramic chronologies is required before they can provide a continuous cultural influx-outflux record that would definitively support a cultural anvil model. In the present state of knowledge two questions can posed whose answers imply relevant research:

1. What were the likely times of ideal conditions that would have encouraged influxes of populations or ideas/traits to the Cape Fear arch region?; and
2. Are there any particular incidents of cultural change that encourage this line of research?

The first question of appropriate times is largely a climatic question from the point of view of the cultural anvil model. The geological component is effectively stable for the time period of this study. As the above discussion of Pleistocene and Holocene sand movements suggests, global conditions appear to correlate with those of the Cape Fear arch in a three-faceted relationship. If global conditions are cold, as in the glacial or late Little Ice Ages of the 1600–1800s, cold droughts ensue. During globally hot times, as during the Middle Holocene (5500–2500 B.C.) or Medieval Maximum (A.D. 900–1250) (Gunn 1994c), hot drought transpires. In some yet-to-be precisely defined intermediate range of global temperatures, sufficient precipitation accrues at the correct time of the year to support more temperate climate and its associated ecology and complex of food plants dependent on late spring-early summer moisture. When was it neither globally too hot or too cold to cause culture-crushing droughts? When were conditions just right for people to enter the region and enjoy a sufficient amount of moisture at the right time of the year to hunt and crop?

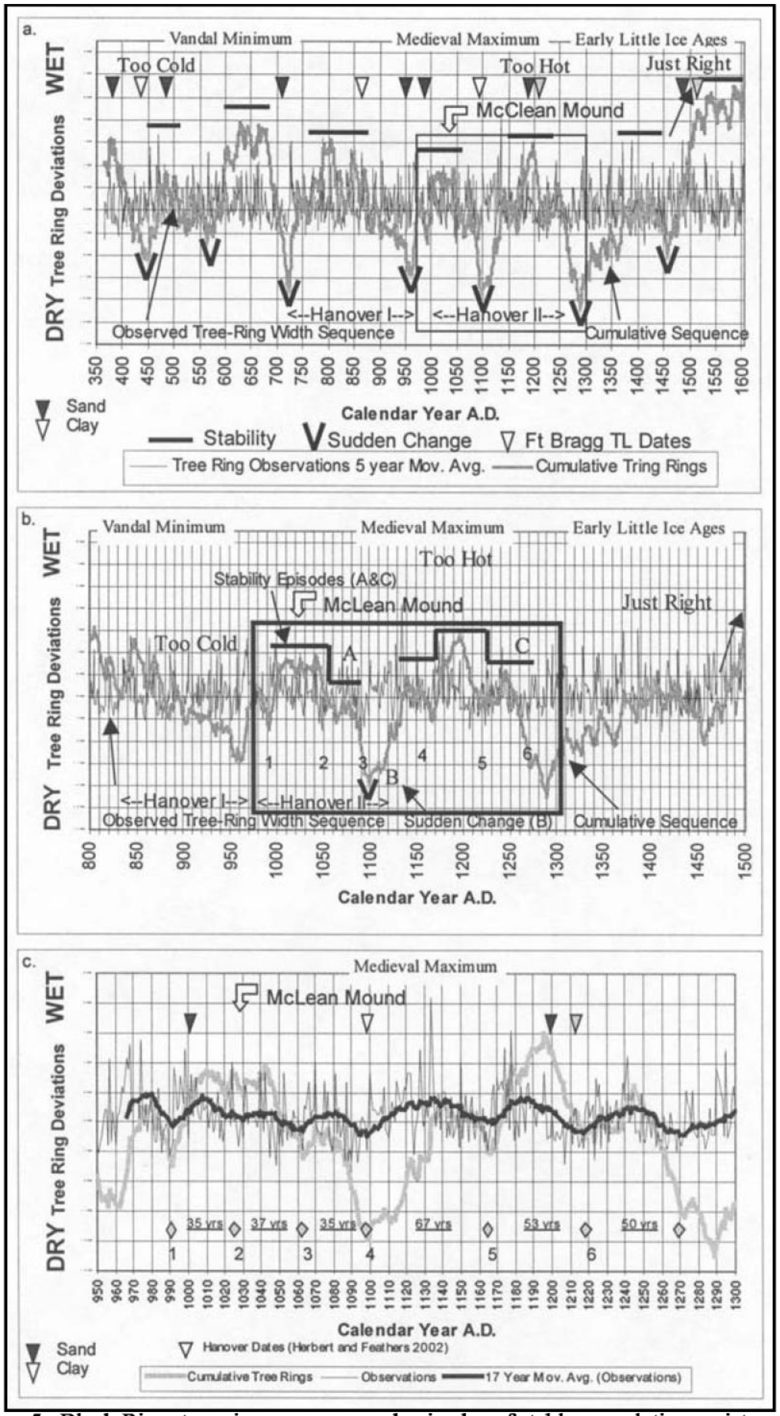
Tree Rings and Culture

The immediate entree to the question of appropriate climate on the Cape Fear arch is tree rings from the Black River, a tributary of the Cape Fear River on the Cape Fear arch. Stahle et al. (1988) found the longest tree ring record on the Atlantic Slope in the durable wetlands of the Black River. The great age of the trees has the favorable effect of making them appropriate for the study of long-term climate change (Esper et al. 2002: 2250). Why the Black River swamps should be such a reliable bed for the growth of bald cypress is an interesting question in itself: perhaps because of its extremely flat floodplain as it edges toward the center of the Cape Fear arch at its confluence with the Cape Fear River.

The Black River tree ring chronology begins in A.D. 365 and runs unbroken to the present. A cumulative graph (Bell 1975) of the tree ring time series distinguishes periods of stability from sudden change (Figure 5a). The Medieval Maximum provides a clear example of the distinction between periods of stability and sudden change. In the middle of an approximately 300-year period of relative stability, a sudden change around A.D. 1100 marks local drought, probably the result of a global cooling event. This pattern is recognizable in the climatic profiles of the Medieval Maximum in many regions worldwide. The cultural impacts are also clearly observed. In Europe the construction of cathedrals slowed. In the American Southwest, the building of new Anasazi settlements abetted for a time. The change is thought to be the result of volcanism.

The cumulative graph of the Black River tree-ring sequence from A.D. 365 to A.D. 1604 shows several sudden changes (see Figure 5a). They separate seven periods of stable spring-summer moisture appearing around A.D. 400, 600, 800, 1000, 1200, 1350 and 1500. Herbert et al.'s (2002) ceramic dates (also shown) demonstrate that in their present study they correctly selected specimens to date the entire sequence. However, another sampling design might determine if cultures (e.g., Hanover I, Hanover II) became archaeologically visible during these periods of stability, and disappeared during sudden changes. Humans can adapt to almost any condition as long as it is stable for a sufficient period of time. Do the periods of stability in spring-summer moisture correspond to population surges in the southern Coastal Plain? Are there distinctions between just right climates and other periods of stability? These are questions that could be answered by a highly resolved (i.e., <50-year) cultural chronology. Existing data suggests this may be the case as is discussed below.

Stahle et al. (1988) found a reoccurring pattern of droughts and wet periods through the entire Black River tree ring sequence. The cycling of wet-dry periods reoccurs 28 times. The range of duration of these periods is 21 to 63 years. Thus, the seven long-term periods outlined above contain a more refined sub-chronology of short-term periods. The difficulty of dealing with such highly resolved, short-term chronologies frequently ends archaeological analysis because direct comparisons falter as the resolution of the climatic sequence falls below the resolution of the local cultural sequence. In some locations of the American Southwest prehistoric human activities can be documented on a year-by-year basis and no such faltering occurs (Dean 2000). On the Atlantic Slope, the approximately 100-year resolution of the human chronology poses a formidable threshold that can only be crossed with difficulty, although there are new methods on the horizon (Anderson 2000:161). Methods that offer direct dating of artifacts (such as thermoluminescence of ceramics and lithics) and wave functions derived from large numbers of dates (Gunn



←Figure 5. **Black River tree-ring sequence and episodes of stable cumulative moisture:** ***a.*** **A.D. 365–1605;** ***b.*** **A.D. 800–1500; and** ***c.*** **A.D. 950–1300 (Medieval Maximum).**

2000b; Gunn and Stanyard 1999) to obtain statistical resolution offers some immediate means of breaking this impasse.

If reasonable affiliations can be discovered between tree ring moisture measures and human occupation events, the more resolved climatic chronology can resolve the cultural chronology. If there are identifiable relationships between climate and culture, the annual resolution of the tree-ring regime establishes an environmental process that has reoccurred many times during the periods of overlap between tree rings and ceramic technology. It probably reoccurred many other times before the start of the tree rings during the ceramic period. During the non-ceramic technologies, there were other processes yet to be recognized that await other highly resolved environmental measurements. Thus, part of the answer to the second question is to identify culture/climate processes during the duration of different cultural technologies.

The Medieval Maximum is of particular interest in this study because it exhibits a pronounced drought cycle according to Stahle et al. (1988: 1519), as it encompasses Hanover II ceramics defined by Herbert et al. (2002:104). The climatic cycling during this episode appears in Stahle et al.'s 1614-year graph. Its pronounced qualities are visually evident. There were six (Figure 5b and c, numbered 1 to 6) relatively large magnitude and distinct (statistically significant) wet and dry cycles during this episode.

The character of these droughts differs before and after the A.D. 1100 sudden change. Before, the wet-dry cycles are near the average duration of 34 years (Figure 5c). However, after the sudden change the cycles extend to 50–67 years in duration. Eddy (1994:30, fig. 4) has studied solar emissions historically through records of aurora borealis and believes that the early Medieval Maximum solar emissions were modestly elevated as during the twentieth century (Lean et al. 1992). However, during the late Medieval Maximum the sun was unusually active, perhaps with monthly average sunspot numbers as high as 260, well above normal twentieth- century monthly values. Was the extended length of the late Medieval Maximum wet-dry cycles on the Black River related to the higher solar emissions? Climate now at the turn of the third millennium suggests so. High solar emissions in combination with greenhouse warming are part of the current record North Carolina drought context. Did late Hanover II peoples have to cope with similar conditions? The Hanover II culture must have been drought adapted, especially in the late Medieval Maximum. Does this condition explain the more local character of the ceramics, sand-grog temper? Could it reflect a more parochial and culturally isolated perspective than early Hanover II? The scenario implied by the climate suggests as a hypothesis that Hanover II will eventually fall out into two sub-periods as more is understood about its dynamics and dating is improved in terms of population density and artifact frequencies. Thus, the environmental chronology suggests a more highly resolved cultural chronology, a theme for future research.

Lifetime Scale

The short-term wet-dry cycles in the tree rings approximate a human lifetime. They provide intriguing insights into the year-to-year conditions that would have been faced by inhabitants of the Cape Fear arch. They suggest that in the interaction of environmental and cultural chronologies, cultural adaptations at lifetime scales may be detected. Spectral analysis of the tree-ring series shows that the strongest cycles are at 3.7, 10.1, and 17.9 years (Stahle et al. 1988:1518). That these are also related to global scale conditions is implied by the fact that the periods of these cyclicities approximate the El Niño, solar emissions, and lunar gravity influences that have been detected in global climates. Apparently in some combination these cycles produce an alternating wet and super dry cycle that averages about 34 years (Stahle et al. 1988:1519). All of these factors are lifetime- scale environmental changes.

Although seldom overtly recognized in archaeological writings (see Hill and Gunn 1977 for extended discussions), lifetimes must be the de facto temporal unit of analysis of cultural sequences. The human life cycle with an early learning phase and a late application phase imposes an element of stability on cultural change at around 50 years. This simple acknowledgment could lend some order to our otherwise elusive understandings of past cultural sequences at short-term time scales. Humans cope with life in 50-year chunks.

The lifetime scale of analysis is clearly important in both the tree-ring record and historic record. Stahle et al. (1988:1519) point out that occasional extreme events of unknown physical origin occur. Such events, either of wet or dry, would have provoked unusual and probably difficult times. Such an event is recorded historically in the Winston-Salem, North Carolina, Moravian records for the year 1816. This year followed the Mt. Tambora, Sumatra, eruption, the largest such event in the Holocene. The year 1816 is known the world over as "the year without summer" (Stommel and Stommel 1976). During that year, the Moravians reported frost in August.

> Bethabara Aug. 22, 1816. Yesterday and today it has been very cool. Several days ago it hailed a few miles from here, and last night there was frost here and there. [Fries 1947:3313]

Although spared the scourge of summer freezes and snows experience further north (Stommel and Stommel 1976), unusual weather was evident. The mixed pattern is instructive since it may correspond to other sudden change events recorded in the tree ring climates. The days in 1816 were unusually hot, especially for the globally cooler nineteenth century, with the thermometer reaching as high as 104°F. However, the nights were remarkably cool. Some crops such as corn faltered or died all together. The wheat harvest, however, was unusually good. This was because the climate was essentially Mediterranean; that is, with a wet winter and an unusually long dry period in the summer for the wheat to dry and be harvested. Streams were so low in the summer that some of the struggle for food involved problems with mills not running. The winter was harsh, often preventing attendance at church. Many were sick and many died.

Bathania March 14, 1816. Easter Sunday. The weather was still very cold for the time of the year, and this morning there was heavy frost and ice. In addition many among us were not well, so in accordance with the wish of many members the Easter litany was prayed this time in the church about six o'clock in the morning. [Fries 1947:3315]

Bathania Sept. 1, 1816. After the sermon we knelt and prayed that our faithful God and Savior would relieve the present distress in our neighborhood. For many weeks it has not rained and during the summer it has been so dry that nothing could grow in our gardens, no cobs could develop on the cornstalks, our mill had to stop for lack of water, and almost no meal could be secured. For lack of meal many people have cooked wheat and eaten it. We and many of our fellow-citizens consider this as a punishment sent by our God and Lord for the great indifference shown to Him, and we prayed fervently that from His merciful heart He would make and end of it and send us other weather and rain. [Fries 1947:3316]

Fortunately, the rains soon came in over abundance and the crisis passed. In the end-of-the-year summary, it was remarked "Because of the most unusual weather during this year the output of the produce of the land was pathetic. Late frosts ... ruined the prospect of fruit.... [P]ractically no rain fell for 15 weeks [in the summer] ... food rose unusually high in price ... in the spring a serious type of illness ... less of the usual fever in the fall...." (Fries 1947:3286). Such short anomalies of weather almost certainly occurred at other times in the more remote past, such as the year A.D. 536, with worldwide ramifications (Gunn 2000a). Interestingly, in the Black River tree rings neither the A.D. 536 event nor the year without summer are evident as huge departures from the usual. From the above description, it can be seen that 1816 was a sudden change of great import to the people and cultures of central North Carolina. In Europe the A.D. 536 event had the greatest impact on tree rings of any 15-year period in the last 6,000 years (Baillie 1994). This discrepancy implies that the Black River tree rings are subtle in their response to global climate, not surprising given the proximity of the ocean and especially the Gulf Stream. It could help to account for the great longevity of the Black River bald cypress. It also serves as a warning that highly significant cultural events can be rendered subtle in the paleoclimatic record. It is important to note that there were winners and losers—no corn, but a great wheat crop.

The overview of the foregoing discussion is that local tree rings reflect global climate conditions, and relate to local cultures, through a pattern of wet and dry cycles ranging in duration from 30 to 60 years. Imposed upon and contributing to the variation in duration is global temperature variation: as global conditions depart from moderate temperatures, the cycles become dominated by drought. Drought results from either too hot or too cold global conditions. In long-term perspective (>100 years), the tree rings appear to support this climate change process inferred above from geomorphology. During the early stages of Medieval Maximum and the Little Ice Age (A.D. 1300–1600), relatively moist conditions prevailed (Stahle et al. 1988:1518). As conditions progressed toward hot and cold in the two periods, the Black River tree rings turned relatively dry. Modern meteorological observations reinforce the impression that global warming intensifies drought. A drought in 1985 and 1986 was one of the five worst droughts in the 1614-year tree-ring record. The preceding 29 years (1956–1985) were among the five wettest periods in the entire record. All of this supports the contention that middle global temperatures were just right for Cape Fear arch cultures, while too hot and too cold temperatures resulted in troublesome droughts. It can be added as of 2002 that the turn of the millennium droughts along the east coast are the worst on record, which, given the accelerated rate of global warming in the last few years, lends further credence to the too-hot-is-dry hypothesis. The shifts in global atmospheric flow patterns that implement the moisture changes have been examined elsewhere (Gunn 1997). Some of the climate cyclicities detected in the Black River Tree rings are equivalent to human lifetimes. It is in the lifetime cycles that climate variation meets head-on with culture's most fundamental stability factor.

Hanover II on the Anvil

To address the second question, are there incidents of culture that suggest climate effect, I will re-examine the mound distributions presented earlier from the perspective of the cultural anvil model. Groups in the Coastal Plain and Piedmont of what is now interior North Carolina were always consensus-based bands and tribes rather than power-based chiefdoms or rule-based states (Rogers 1993). Although the population densities were less than sufficient for power-based societies, they appear to have mimicked surrounding, more densely populated polities in language and whatever other practices that proved feasible for them. Among these was the burial of the dead in mounds. However, the mimicked version of mound interment was primarily burying individuals in opportunistic mounds, generally sand hills in the Coastal Plain.

A restudy of sand hill burial mounds by Irwin et al. (1999) shows that most appear on the Cape Fear arch. To some extent, the sand hill burial mounds fill the accretional mound void (see Figure 1). In more than one mound, interments were secondary and multiple, indicating mobile populations returning to traditional burying grounds for final disposition of the dead. However, in a few exceptional mounds around Fayetteville the structures appear to be accretional (Irwin et al. 1999:61). These constructed mounds suggest an element of stability and capacity to mobilize labor otherwise absent in Coastal Plain mounds. Beyond the annual rituals of burial and intensification, ceremonial elements would have been incorporated to calendar planting and harvesting. A village site (31CD967) associated with the Middle/Late Woodland period was found on the south flank of Rockfish Creek to the east of the Hope Mills mounds (Gunn and Sanborn 2002) (Figure 6). This village and the mound sites are located in the vicinity of the deeply incised Rockfish Creek on wetland tributaries. Slightly elevated, long linear sites adjacent to wetlands on the well-drained upland margin of Rockfish Creek seem to be the occupation habitat of choice of the village community and its presumably associated mounds. Such a habitat would have provided a contrasty environment that supplied both arable land and hunting-fishing habitat.

It might be supposed that the Fayetteville mounds were constructed during a time when populations of the southern Coastal Plain were sufficiently dense and connected to surrounding groups that they could entertain relationships with the more established accretional mound groups. In fact, if the region of the Cape Fear arch functioned as implied by the cultural anvil model, they were probably immigrants from areas of

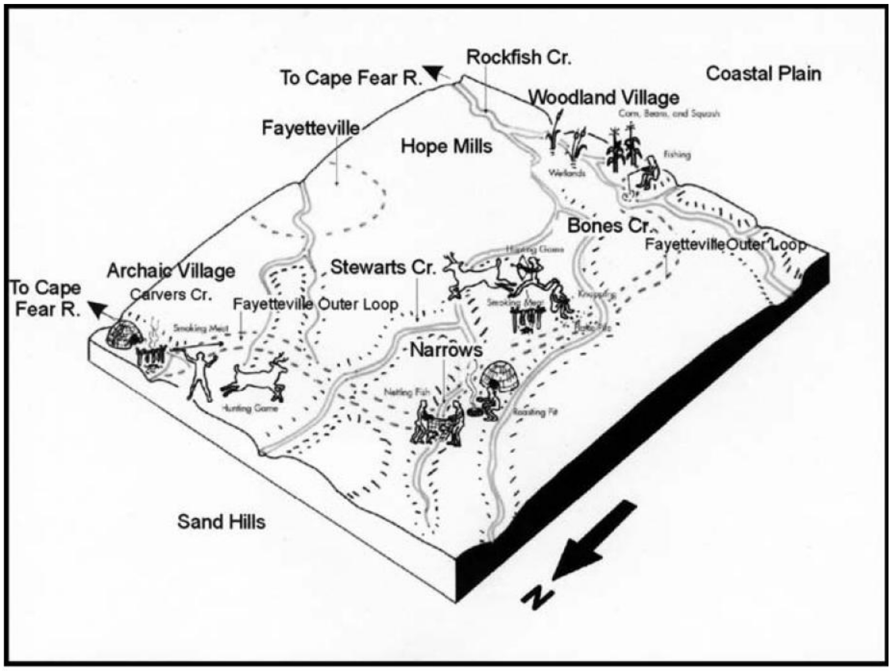


Figure 6. Site Clusters along the Fayetteville Outer Loop and the Hope Mills Sand Mounds.

accretional mound populations, suggested by at least three researchers to be the Pee Dee settlement 92 km to the west (Irwin et al. 1999:62). In other words, they were probably in the Coastal Plain during conditions ideal for horticulture as it was practiced at Town Creek. Without appreciable fish runs, they would have been dependent on horticulture for the population density and stability to construct mounds. Limited fish runs would have confined occupation to major streams such as the Cape Fear River and Rockfish Creek below the fall line, the highest reach of the streams the runs could reach in dry, low discharge years. This inference is supported by findings during the Fayetteville Outer Loop project, which transects a wide swath around the north, west, and southwest of Fayetteville (Gunn and Sanborn 2002, see Figure 6). An Archaic village was found in the Sand Hills, and horticultural villages were found in the Coastal Plain. Probable fishing stations followed the Sand Hills-Coastal Plain boundary, appearing at narrows such as on Stewarts Creek.

Based on ceramics and other artifacts (e.g., points, pipes, beads) included with burials in the sand mounds, Irwin et al. (1999:79) judged the sand mound phenomenon to have begun about A.D. 800–1000 during the transition from late Middle Woodland to early Late Woodland. Three radiocarbon dates now define McLean Mound's span of use to A.D. 770– 1270 (Herbert et al. 2002:105–106). However, most of the ceramics in the sand mound core area around Rockfish Creek date to Herbert et al.'s (2002:104) Hanover II between A.D. 1000 and 1400. This is a period when grog is a more prevalent feature of Hanover temper than sand. It marks a separation from Hanover I, which had more sand than grog; Hanover I continues through the Medieval Maximum but appear as early as A.D. 500. The termination of Hanover II ceramics at around A.D. 1400 may indicate that the major activity at the sand mounds was confined to the Medieval Maximum. This approximates the period within which McClean Mound dates (A.D. 770–1270) (see Figure 5).

As can be seen in Figure 5c, McLean Mound and Hanover II co-occur with an extended period of relatively stable spring-summer moisture between A.D. 950 and 1250. As is frequently the case in the construction of more complex societies, which the accretional mounds imply, they require a period of at least 100 years or more of favorable conditions to become archaeologically visible. The stability is broken around A.D. 1100 by the Medieval Maximum sudden change. For life on the Cape Fear arch, it implies that there should have been an interlude of disrupted cultural continuity at around A.D. 1100. The hypothesized interrupted interlude can serve as a testable hypothesis when sufficient numbers of dates are obtained on early Late Woodland occupations to show a statistical decline at that time. Herbert (personal communication 2002) believes the area around Fort Bragg may have been all but deserted during the late Medieval Maximum.

In somewhat similar conditions along the Savannah River, Anderson et al. (1995) used tree rings to establish that Mississippian Coastal Plain groups were sensitive to droughty conditions. These groups are on another geologic arch, the Yamacraw arch (Horton and Zullo 1991:7; see Figure 3). In the case of the Cape Fear arch, one might suppose that the region and its inhabitants were even more sensitive to drought because of it being more elevated and therefore more exposed to droughty episodes.

Conclusions

The modeling of cultural and environmental change on the Cape Fear arch is clearly a question of margins and centers of ecological zones. Margins and centers have been a central question in anthropology and archaeology since Wissler proposed the Age-Area hypothesis early in the last century (Freed and Freed 1983). Wissler thought that new technologies were likely to originate in the centers of ecological zones. Dixon proposed in a counter argument that new ideas were more likely to originate in marginal areas, a perspective that was examined in depth by later authors (Freed and Freed 1983:816). The back-and-forth between the two points of view has provided anthropology with productive model to the present. The peculiar cultural chronology of the Cape Fear arch promises to provide poignant insights into the processes that influence cultures in unstable marginal regions and how they impact surrounding regions. Perhaps most promising are the Hanover ceramic series. The process of the cultural anvil imposes a respiration of cultural traits. It exhales traits to environmentally appropriate, adjacent regions at a sudden change, and inhales them when stable and appropriate conditions compare favorably with pre-adaptations in a surrounding region. The Hanover ceramic technique seems to have been both exhaled and inhaled. The period of Hanover ceramics overlaps in part with the annual climate data of the Black River tree rings.

Irwin et al. (1999) argue that the cultural efflorescence of Mississippian culture on the southern Coastal Plain was a function of social forces, most likely stemming from a chiefdom located at Town Creek to the west. Although this culture and its forward position in the Mississippian advance up the Atlantic Slope is a reasonable and likely potent factor, the information presented in this article suggests that landscape influences, especially geology and climate, also played vital roles in this Mississippian episode. Geology marked the spatial boundaries of the manifestation with an uplift between the Neuse and the Pee Dee rivers, while climate tendered the temporal boundaries by providing periodic, favorable circumstances for occupation by horticultural people. This pattern is especially detectable during the Woodland period; whether so in the Archaic remains to be determined. It also appears likely, based on repeated incidents of regionally bounded intrusions of cultural traits from adjacent areas, that the Mississippian influx was a member of a class of cultural manifestations that occurred repeatedly during prehistory, or in other words, a process. The drought-prone character of the Cape Fear valley and the cyclical nature of global climate change could have sponsored the process. The particular form of each individual manifestation was entirely unique to the technological initial conditions at the time of its inception.

Notes

Acknowledgments. The NCDOT Fayetteville Outer Loop Project supported research that led to this article. Joe Herbert, Erica Sanborn, and Lea Abbott were generous with their time in discussions of southern Coastal Plain ceramics and cultures. Lea Abbott, Belinda Hardin, and Steve Davis commented on the manuscript. Alan May, John Mintz, and Dolores Hall helped find mound locations. John Frierson was generous beyond the call of academic duty with his time and contacts concerning South Carolina Mound locations.

References Cited

Abbott, Lawrence E., Erica E. Sanborn, Mary Beth Reed, and John S. Cable
1995 *Archaeological and Historical Background Research Report: Fayetteville Outer Loop, I-95 to NC 24.* NCDOT TIP No. U2519, Cumberland, Hoke and Robeson Counties, North Carolina: Archaeological Survey within the Cape Fear River Valley. Submitted to H.W. Lochner Incorporated, Raleigh.

Anderson, David G.
1996 *Indian Pottery of the Carolinas: Observations from the March 1994 Ceramic Workshop at Hobcaw Barony*. Council of South Carolina Professional Archaeologists, Columbia.
2000 The Middle to Late Woodland Transition in the Savannah River Basin and Adjacent Subregions: Refining Time Scales. In *The Years Without Summer: Tracing A.D. 536 and Its Aftermath*, edited by J. Gunn, pp. 154–158, British Archaeological Reports 872, Oxford.
Anderson, David G., David W. Stahle, and Malcom K. Cleaveland
1995 Paleoclimate and the Potential Food Reserves of Mississippian Societies: A Case Study from the Savannah River Valley. *American Antiquity* 60:258 –286.
Baillie, M. G. L.
1994 Dendrochronology Raises Question about the Nature of the AD 536 Dust-Veil Event. *The Holocene* 3:212–217.
Bell, Barbara
1975 Climate and the History of Egypt: The Middle Kingdom. *American Journal of Archaeology* 79:223–269.
Bennett, Stephen H., and John B. Nelson
1991 *Distribution and Status of Carolina Bays in South Carolina*. South Carolina Wildlife and Marine Resources Department, Columbia.
Cable, John S.
1998 Ceramic Analysis: A Study of Taxonomy and Systematics in the North Coastal Zone. In *Data Recovery Excavations at the Maple Swamp (38HR309) and Big Jones (38HR315) Sites on the Conway Bypass, Horry County, South Carolina: Prehistoric Sequence and Settlement on the North Coastal Plain of South Carolina*, edited by J. Cable, K. Styer, and C. Cantley (1998), submitted to the South Carolina Department of Transportation, New South Associates Technical Report 385, Stone Mountain, Georgia.
Claggett, Stephen R., and John S. Cable
1982 *The Haw River Sites: Archeological Investigations at Two Stratified Sites in the North Carolina Piedmont*. Commonwealth Associates Report R-2386 prepared for the U.S. Army Engineer District, Wilmington Corps of Engineers, Wilmington, North Carolina.
Crumley, Carole L., editor
1994 *Historical Ecology: Cultural Knowledge and Changing Landscapes*. School of American Research Advanced Seminar Series, Santa Fe.
Dean, Jeffrey S.
2000 Complexity Theory and Sociocultural Change in the American Southwest. In *The Way the Wind Blows: Climate, History, and Human Action*, edited by R. McIntosh, J. Tainter, and S. Keech McIntosh, pp. 89–120, Columbia University Press, New York..
Dunham, Gary H.
1994 *Common Ground, Contesting Visions: The Emergence of Burial Mound Ritual in the Late Prehistoric Central Virginia*. UMI Dissertation Services. Ann Arbor, Michigan.
Eddy, John A.
1994 Solar History and Human Affairs. *Human Ecology* 22:23–36.
Esper, Jan, Edward R. Cook, and Fritz H. Schweingruber
2002 Low-Frequency Signals in Long Tree-Ring Chronologies for Reconstructing Past Temperature Variability. *Science* 295:2250–2253.
Fenneman, Nevin M.
1938 *Physiography of the Eastern United States*. McGraw-Hill, New York.
Fischer, David Hackett
1989 *Albion's Seed: Four British Folkways in America*. Oxford University Press, Oxford.
Fitzhugh, William W.
1972 *Environmental Archeology and Cultural Systems in Hamilton Inlet, Labrador: A Survey of the Central Labrador Coast from 3000 B. C. to the Present*. Smithsonian Contributions to Anthropology, Number 16, Washington D.C.
Freed, Stanley A., and Ruth S. Freed

1983 Clark Wissler and the Development of Anthropology in the United States. *American Anthropologist* 85:800–825.
Fries, Adelaide L.
1947 *Records of the Moravians in North Carolina*. Volume VH, 1809–1822. State Department of Archives and History, Raleigh.
Frierson, John L.
2002 *South Carolina Prehistoric Earthen Indian Mounds*. M.A. Thesis, Department of History, University of South Carolina, Columbia.
Gardner, William M.
1993 Early/Middle Woodland Mounds in the Upper Shenandoah Valley and Contiguous Regions in West Virginia: Observations on Distribution and internal Structure. Paper presented at the Middle Atlantic Archaeological Conference, Ocean City, Maryland.
Gunn, Joel D.
1979 Occupation Frequency Simulation on a Broad Ecotone. In *Transformations: Mathematical Approaches to Culture Change*, edited by C. Renfrew and K. Cooke, pp. 257 –274. Academic Press, New York.
1991 *Phase II Archaeological Investigations of Site 38DR149 at the Oakridge Landfill, Dorchester County, South Carolina*. Garrow & Associates, Inc., Raleigh. Submitted to Chambers of South Carolina, Inc., Columbia.
1994*a* Global Climate and Regional Biocultural Diversity. In *Historical Ecology*, edited by C. Crumley, pp. 67–97, School of American Research, Santa Fe.
1994*b Historical Character of the Lower Shenandoah Valley: Clarke County Archaeological Assessment.* Garrow & Associates, Inc., Raleigh, submitted to Clarke County Historic Preservation Commission, Berryville, Virginia.
1994*c* Introduction: A Perspective from the Humanities - Science Boundary. Global Climate-Human Life: Physical Contexts of Historical Ecology. *Human Ecology* 22:1–22.
1997 A Framework for the Middle-Late Holocene Transition: Astronomical and Geophysical Conditions. *Southeastern Archaeology* 16:134–151.
2000*a* Prologue: A.D. 536 and Its Aftermath—The Years Without Summer. In *Tracing A.D. 536 and Its Aftermath: The Years Without Summer*, edited by J. Gunn, pp. 5–20, British Archaeological Reports 872, Oxford.
2000*b* Sub-Regional Perspectives from Radiocarbon Dates: Spatio-Temporal Distributions of First Millennium A.D. Radiocarbon Dates in the Eastern United States. In *Tracing A.D. 536 and Its Aftermath: The Years Without Summer*, edited by J. Gunn, pp. 99–108, British Archaeological Reports 872, Oxford.
Gunn, Joel D., David S. Leigh, Irwin Rovner, Bruce Idol, Tracy Millis, John Byrd, and Linda Kennedy
1998 *Red Hawk Run: Archaeological Excavation of Three Early Woodland Sites at Wakefield Plantation and School Site, Wake County, North Carolina*. TRC, Inc., Chapel Hill, North Carolina. Submitted to Wakefield Plantation Developers and Wake County School Board, Raleigh.
Gunn, Joel D., and William Stanyard
1999 *Neuse Levee: Archaeological Excavation of a Late Archaic and Woodland Site in the Upper Neuse River Basin, Wake County, North Carolina*. Report submitted to North Carolina Department of Transportation, Raleigh.
Gunn, Joel D., and Erica E. Sanborn
2002 *Dimensions of Fall Line Site Function: Surveingy and Testing the West Fayetteville, North Carolina Outer Loop***.** Report submitted to North Carolina Department of Transportation, Raleigh.
Herbert, Joseph M.
1999 Prehistoric Pottery Taxonomy and Sequence on the Southern Coast of North Carolina. *North Carolina Archaeology* 48:37–58.
Herbert, Joseph M., and Mark A. Mathis
1996 An Appraisal and re-evaluation of the Prehistoric Pottery Sequence of the Southern Coastal North Carolina. In *Indian Pottery of the Carolinas: Observations from the March 1994 Ceramic Workshop at Hobcaw Barony*, edited by D. Anderson. Council of South Carolina Professional Archaeologists, Columbia.
Herbert, Joseph M., James K. Feathers, and Ann S. Cordell

2002 Building Ceramic Chronologies with Thermoluminescence Dating: A Case Study from the Carolina Sandhills. *Southeastern Archaeology* 21:92–108.
Hill, James N, and Joel Gunn
1977 *The Individual in Prehistory: Studies of Variability in Style in Prehistoric Technologies*. Academic Press, New York.
Horton, Wright J., and Victor A. Zullo
1991 Introduction to the Geology of the Carolinas. In *The Geology of the Carolinas*, edited by J. Wright Horton, Jr., and Victor A. Zullo, pp. 1–10, University of Tennessee Press, Knoxville.
Irwin, Jeffrey D., Wayne C. J. Boyko, Joseph M. Herbert, and Chad Braley
1999 Woodland Burial Mounds in the North Carolina Sandhills and Southern Coastal Plain. *North Carolina Archaeology* 48:59–86.
Jones, David C., Christopher T. Espenshade, and Linda Kennedy
1997 *Archaeological Investigation at 31ON190, Cape Island, Onslow County, North Carolina*. Garrow and Associates, Atlanta. Submitted to the Island Development Group, Inc., Ringgold, Virginia. Manuscript on file at the North Carolina Office of State Archaeology, Raleigh.
Kirchen, Roger W.
2001 *The E. Davis Site: Technical Change at the Archaic–Woodland Transition*. M.A. thesis, Department of Anthropology, Wake Forest University, Winston-Salem.
Lawson, John
1967 *A New Voyage to Carolina*. Edited by H. Lefler. The University of North Carolina Press, Chapel Hill.
Lean, Judith, Andrew Skumanich, and Oran White
1992 Estimating the Sun's Radiative Output during the Maunder Minimum. *Geophysical Research Letters* 19:1591–1594.
Levy, Janet, J. Alan May, and David G. Moore
1990 From Ysa to Joara: Cultural Diversity in the Catawba Valley from the Fourteenth to the Sixteenth Century. In *Columbian Consequences: Archaeological and Historical Perspectives on the Spanish Borderlands East, vol. 2*, edited by D. H. Thomas, pp. 153–168. Smithsonian Institution Press, Washington, D.C.
Loftfield, Thomas C.
1988 Prehistoric Oystermen of the Central North Carolina Coast. In *Sea & Land: Cultural and Biological Adaptations in the Southern Coastal Plain*, edited by J. Peacock and J. Sabella, The University of Georgia Press, Athens.
Mathis, Mark A.
2000 The Middle and Late Woodland Shift on the Central Coast of North Carolina. In *The Years without Summer: Tracing A.D. 536 and Its Aftermath*, edited by J. Gunn, pp. 111–118, British Archaeological Reports International Series 872, Oxford.
Millis, Tracy L.
1998 Anadromous Fish Life History. In *Red Hawk Run: Archaeological Excavation of Three Early Woodland Sites at Wakefield Plantation and School Site, Wake County, North Carolina*, edited by J. Gunn, pp. 11–21. TRC Garrow Associates, Inc., Chapel Hill. Submitted to Wake County School Building Program, Raleigh, and Wakefield Developers LLC, Wake Forest.
Myer, William E.
1971 *Indian Trails of the Southeast*. Blue and Gray Press, Nashville.
Phelps, David S.
1983 Archaeology of the North Carolina Coast and Coastal Plain: Problems and Hypotheses. In *The Prehistory of North Carolina, An Archaeological Symposium*, edited by M. Mathis and J. Crow, pp. 1–51. North Carolina Division of Archives and History, Department of Cultural Resources, Raleigh.
Pigeon, William
1853 *Traditions of De-coo-dah and Antiquarian Researches*. Thayer, Bridgeman, & Fanning, New York.
Powell, William S.
1989 *North Carolina Through Four Centuries*. The University of North Carolina Press, Chapel Hill.
Ray, Celeste

2001 *Highland Heritage: Scottish Americans in the American South*. University of North Carolina Press, Chapel Hill.
Robinson, Kenneth W.
1986 *Archaeological Survey of Selected Areas in Cumberland County, North Carolina*. Manuscript on file, Office of State Archaeology, Raleigh.
Rogers, Rhea
1993 *A Re-Examination of the Concept of the Tribe: A Case Study from the Upper Yadkin Valley, North Carolina*. Ph.D. dissertation, University of North Carolina, Chapel Hill.
Sanborn, E. E., and L. E. Abbott, Jr.
1999 Early Ceramic Traditions on the Southern Coastal Plain of North Carolina: Radiocarbon Data from 31CB 114. *North Carolina Archaeology* 48:3–17.
Sohl, Norman F., and James P. Owens
1991 Cretaceous Stratigraphy of the Carolina Coastal Plain. In *The Geology of the Carolinas*, edited by J. Horton, Jr., and V. Zullo, pp. 191 –220, University of Tennessee Press, Knoxville.
Soller, David R., and Hugh H. Mills
1991 Surficial Geology and Geomorphology. In *The Geology of the Carolinas*, edited by J. Wright Horton, Jr., and Victor A. Zullo, pp. 290–308. Carolina Geological Society Fiftieth Anniversary Volume, University of Tennessee Press, Knoxville.
South, Stanley
1960 *An Archaeological Survey of Southeastern Coastal North Carolina*. Ms. on file, North Carolina Office of State Archaeology, Raleigh.
1976 *An Archaeological Survey of Southeastern North Carolina*. Institute of Archaeology and Anthropology, University of South Carolina, Notebook 8, Columbia.
Stahle, David W., John G. Hehr, and Malcolm K. Cleaveland
1988 North Carolina Climate Changes Reconstructed from Tree Rings: A.D. 372–1985. *Science* 240:1517–1519.
Stine, Linda F., Martha Zierden, Lesley M. Drucker, and Christopher Judge
1997 *Carolina's Historical Landscapes: Archaeological Perspectives*. University of Tennessee Press, Knoxville.
Stommel, Henry, and Elizabeth Stommel
1979 The Year Without a Summer. *Scientific American* 240:176–186.
Ward, H. Trawick, and R. P. Stephen Davis, Jr.
1999 *Time Before History: The Archaeology of North Carolina*. The University of North Carolina Press, Chapel Hill.
Ward, Lauck W., Richard H. Bailey, and Joseph G. Carter
1991 Pliocene and Early Pleistocene Stratigraphy, Depositional History, and Molluscan Paleobiogeography of the Coastal Plain. In *The Geology of the Carolinas*, edited by J. Wright Horton, Jr., and Victor A. Zullo, pp. 274–289. Carolina Geological Society Fiftieth Anniversary Volume, University of Tennessee Press, Knoxville.
Willey, Gordon R.
1966 *An Introduction to American Archaeology, vol. 1 (North and Middle America)*. Prentice-Hall, Inc., Englewood Cliffs.
Willey, Gordon R., and Philip Phillips
1958 *Method and Theory in American Archaeology*. University of Chicago Press, Chicago.
Woodall, J. Ned
2000 The Northwest Carolina Piedmont: Possible Effects of the A.D. 536 Event. In *The Years Without Summer: Tracing A.D. 536 and Its Aftermath*, edited by J. Gunn, pp. 154–158, British Archaeological Reports 872, Oxford.