CLIMATE AND CULTURE CHANGE IN PREHISTORIC AND EARLY HISTORIC EASTERN NORTH AMERICA

David G. Anderson

The archaeological and paleoclimate records spanning the period of human occupation in Eastern North America are becoming linked with greater and greater precision. Researchers examining both culture change and paleoclimate make use of similar temporal and geographic scales, and collaborative multidisciplinary efforts are, as a result, highly productive. Climate change, both abrupt and gradual, played a major role in the development of prehistoric and early historic cultures in the region. Initial human colonization and settlement > 13,450 cal. BP/11,500 rcbp was constrained by the location of climate-linked terrain features such as glacial lakes and ice sheets. The onset of the Younger Dryas cold interval, which lasted from ca. 12,900–11,650 cal. BP/10,800–10,100 rcbp, closely corresponds to the demise of the continental-scale Clovis cultural adaptation, the completion of the late Pleistocene megafauna extinctions, and the emergence of distinct regional cultural traditions. During the Mid-Holocene warm interval from ca. 8900–5700 cal. BP /8000–5000 rcbp major changes in vegetation and precipitation regimes are evident, leading to population relocations over large areas. Portions of the lower Eastern Coastal Plain appear to have been largely depopulated, and large sites appear along some of the major river systems further into the interior and, somewhat later, along portions of the coast. These factors, when coupled with regional population growth, contributed to the emergence of monumental construction, warfare, and long-distance exchange networks, and hence the development of organizational complexity. During later prehistory, as agricultural food production increased in importance, fluctuations in climate and hence potential crop yields had varying impacts on societies at both local and regional scales. During the initial European colonization of the region, isolated events like hurricanes as well as longer term phenomena like extended periods of drought or favorable rainfall shaped how settlement proceeded. The combined archaeological/paleoclimate record from the past 15,000 years has significant implications for understanding how climate change may affect our own society.

INTRODUCTION

I propose to start at the beginning, at the time of presumed initial human entry near the end of the last ice age, and run up through the early historic contact period. I conclude with some observations about the relevance of these studies for the modern world. While a pan-regional perspective is employed, my emphasis is on developments in the Southeast and lower Midwest, areas I know better than the Northeast, Middle Atlantic, or Upper Great Lakes. Relationships between climate and culture in these latter areas during the later Holocene are admirably discussed in the paper herein by Fiedel (2001).

Calendar years before present (cal. BP), will be used unless otherwise noted, taking advantage of the recent extended radiocarbon (rcbp) calibration (Stuiver et al. 1998). Increasingly sound calibrations are being developed linking these two time scales well back into the Late Pleistocene, to the limits of the radiocarbon dating technique (Hughen et al. 2000; Kitigawa and van der Plicht 1998; Stuiver et al. 1998). Given the absence of a direct relationship between the two time scales, as well as the presence of plateaus, jumps, and even reversals in the radiocarbon time scale at various times in the past, calendar years should be used whenever possible in interpretations and analyses (e.g., Fiedel 1999a; Sherratt 1997:271–272; Taylor et al.

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1996:520). In general, the further back in time we go, the greater the difference between these scales, with radiocarbon time increasingly too young, or recent, by up to two thousand and more years during the Paleoindian era, with profound consequences for our interpretation of the archaeological record. Cultural historical sequences and, indeed, most archaeological writings, I predict, will increasingly employ the more accurate calendar dates in the years to come. The radiocarbon-based subdivisions in use today, furthermore, will become increasingly less and less used, until they are ultimately abandoned. The charts accompanying this paper make use of this new approach to chronology, providing dates in both calendar and radiocarbon years (Tables 1 and 2).

Climate change has attracted considerable attention and interest in recent years. The popular press runs articles about climate change, politicians argue about it, and the world's top scientific journals like *Science* and *Nature* run papers on the subject in almost every issue (e.g., Barber et al. 1999; Blunier and Brook 2001; Fischer et al. 1999; Hu et al. 1999; Monnin et al. 2001; Wagner et al. 1999). Global climate change and its impact on human society is a subject attracting increasing interest, by both the scientific community as well as the general public. Over the past century our knowledge of paleoclimate has grown tremendously, and there has been an explosion of research into this subject in the past few decades. Much of this has been brought about by the dawning realization by policy makers, the people who ultimately fund scientific research, that it is becoming increasingly possible to do more than just talk about the weather, we can anticipate its impacts. Daily weather forecasts now are received with great credibility, something that was certainly not the case a generation ago. Weather forecasts, in fact, are now made with impressive accuracy days in advance. For some parts of the world, broad trends in climate can be predicted weeks or months ahead, information that has tremendous value when the likely economic impacts are considered. Climatological studies now receive serious attention from the insurance and energy industries, and those speculating in futures markets (e.g., Easterling et al. 2000; Solow et al. 1998).

Concepts like global warming, greenhouse gas emissions, and ozone depletion are certainly before the public eye and are shaping national debates on energy policy and industrialization. We have all read reports that recent years are among the warmest on record, or in recent earth history. Is this true, how do we know, and what does it all really mean for a technologically advanced society like ours? Climate research can help us understand what the future will be like, or at least what the possibilities might be. How, for example, might major or even comparatively minor increases or decreases in average global temperature effect human cultures? At a smaller geographic scale, what are the possible impacts of localized changes in rainfall patterns, numbers of cloudy versus clear days, or the length of the growing season? How do plant and animal communities respond to these changes?

Archaeology and history have much to offer in this enterprise, since they provide a means of examining the impact of climate change on human populations over long spans of time, and in a wide array of circumstances. Our ancestors had to deal with sudden and dramatic changes in climate, as well as longer, more imperceptible but still cumulatively great changes. Our knowledge of prehistory and history, of course, has grown tremendously over the past century, to the point where we have a fairly detailed understanding of cultural developments in many parts of the world. Eastern North America, the focus of extensive archaeological research, is one such area, and the broad outlines of human occupation are fairly well known, at least for the past 10,000 to 12,000 years or so. Thanks to radiocarbon and other absolute dating methods, as well as improvements in stratigraphic methods and artifact analyses, in some parts of the region we are able to date events in the past fairly tightly, to within a few decades to a few hundred years. Generally, the closer we get to the present, and the greater the amount of fieldwork and reporting that has occurred, the better our understanding and temporal resolution.

Likewise, the data on paleoclimate that we have to work with, both globally and from within the region itself, are growing more precise and detailed all the time. High resolution proxy or indirect measures of past climate are obtained from sources as varied as ice cores, tree rings, lake varve deposits, pollen profiles, and

Table 1. Radiocarbon/Calendrical Timescale for Eastern Paleoindian Assemblages.
Calibrations adopted from Stuiver et al. 1998.

Calendar BP	Radiocarbon rcbp	Stage	Culture Complex	Climatic Event
8986, 8874, 8825, 8819	8,000			
			Bifurcate	
10,189	9,000	Early Archaic		Boreal
10,736, 10,708, 10,702	9,500		Corner Notched	
11,254, 11,253, 11,234	9,900			
11,545, 11,512, 11,400, 11,391, 11,340	10,000			
11,687, 11,677, 11,642	10,100			Younger Dryas
11,930, 11,804, 11,768	10,200	Late Paleoindian	Early Side Notched	
12,622 12,472, 12,390	10,500		Dalton	
			Quad/Beaver Lake	
12,899	10,800			
			Cumberland/Folsom	
12,944	10,900			Younger Dryas begins
		Middle		Inter-Allerød Cold Period
13,132	11,100	Paleoindian		ends
13,155	11,200		Clovis widespread	
				Inter-Allerød Cold Period
13,411	11,400			begins
13,455	11,500			
			Clovis beginnings??	
13,811	11,750			Allerød
14,043, 13,923, 13,858	11,950			Older Dryas ends
14,065	12,000		Little Salt Springs/	
		Early Paleoindian	Page-Ladson	
14,100	12,100			Older Dryas begins
			Monte Verde	
15,084, 14,731, 14,382	12,500			
15,231, 14,606, 14,449	12,600			Bølling begins
			Meadowcroft (?)	
19,091	16,000		Cactus Hill (?)	
21,392	18,000		Initial Colonization (?)	Glacial maximum

even depositional layers in speleothems (e.g., Dorale et al. 1992; Grafenstein et al. 1999; Stahle et al. 1998). To give one example, deep ice cores obtained from Greenland (GRIP and GISP2) and Antarctica (Vostok, Byrd, Dome C) provide direct measures deep into the past on such things as global temperature and the extent of continental ice sheets, atmospheric gas composition, and particulate matter arising from volcanic

Table 2. Radiocarbon/Calendrical Timescale for Eastern Holocene Assemblages. Calibrations adopted from Stuiver et al. 1998.

Calendar BP	Radiocarbon rcbp	Stage	Culture Complex	Climatic Event
				Pronounced Warming
50	0	Modern		
			Industrial	Little Ice Age Ends
298	250	US National		
524	500		European	Little Ice Age Begins
			Mississippian	
929	1000			Medieval Warm Period
		Late	Coles Creek	
1388, 1358, 1354	1500			Subatlantic
1948, 1936, 1934	2000	Middle	Hopewell	
				Sub-Boreal
2710, 2629, 2617, 2562, 2542, 2518,	2500	Early	Adena	
3208, 3179, 3169	3000		Poverty Point	
4500, 4490, 4440	4000	Late Archaic	Stallings Island	
5728	5000		Watson Brake	Hypsithermal Ends
6850, 6838, 6825, 6824, 6800, 6764	6000	Middle	Morrow Mountain	Atlantic
7820, 7807, 7792	7000			
			Stanly	Hypsithermal Begins
8986, 8874, 8825, 8819	8000			
			Bifurcate	Cold Episode
10,189	9000			
		Early Archaic		
10,736, 10,708, 10,702	9500		Corner Notched	Boreal
11,254, 11,253, 11,234	9900			
11,545, 11,512, 11,400, 11,391,	10,000			
11,687, 11,677, 11,642	10,100			
				Younger Dryas
11,930, 11,804, 11,768	10,200	Late	Early side Notched	
12,622 12,472, 12,390	10,500		Dalton	

eruptions or anthropogenic sources (e.g., Petit et al. 1999; Zielinski et al. 1994). The closer we get to the present in the cores, the finer the resolution, with decadal or even annual measures possible. Some proxy measures of climate offer annual or even seasonal resolution, such as tree-rings, which can provide indirect measures of rainfall. Lake varve deposits are another example of this kind of high resolution data, since soil or plant macrofossil inclusions can provide annual scale data on local runoff or vegetation conditions, while pollen and carbonates can be used to develop broader, regional views of vegetation and climate (e.g., Grafenstein et al. 1999; Kitigawa and van der Plicht 1998). Archaeologists and historians are becoming increasingly aware that this high resolution climate data exists, and that there are colleagues in many disciplines that can help us to explore the human past (e.g., Gunn, ed., 2000; McIntosh et al., eds., 2000).

There are some schools of thought within archaeology and anthropology, of course, that minimize the importance of environmental factors on culture change, claiming such an approach is too simplistic and deterministic, and ignores the very real capability of people and societies to respond to external stimuli in many ways. Cultural responses to change can be varied, of course, and we must examine how and why human actors respond in the way they do to the range of possibilities before them, that is, how their actions or practice can transform culture. As will become obvious as this paper progresses, however, this does not mean we can ignore major variables. Climate must always be considered a possible external source of change when examining past human societies. Climate is an important variable, as are physiography, resource distributions, and biotic structure and, in fact, climate helps shape these other variables. The best explanations are those that accommodate the greatest array of data, and any explanation of culture change must consider the overall physical matrix within which change is taking place.

How do archaeologists and historians explore relationships between climate and culture change? Determining associations is not enough. That is, simply demonstrating that a change in climate occurred at the same time that a change in a cultural system occurred doesn't really tell us whether and how these events are linked. Correlation, quite simply, does not prove causation. To assess the impact of climate on cultural systems, explicit models must be developed detailing how the two are interrelated, and these models must be subject to testing with as many kinds of evidence as possible (DeVries 1980:606).

The impact of climate change on societies dependent on agricultural food production has received the most study. Interruptions or reductions in food supplies can lead to rapid changes in human society, over time spans of no more than a few months or years. Short-term climate *extremes*, which are irregular in occurrence and are for the most part unpredictable, through their effect on harvests, can have an immediate economic impact (Flohn 1981:310–311; Lamb 1984, 1995; Wigley 1985; Wigley et al. 1981). Longer term, weaker climatic trends (perhaps more predictable, or at least initially more easily addressed), however, may be cumulatively as critical. That is, successive crop shortfalls or, in the extreme case, repeated crop failures, are far more serious than isolated shortfalls or failures. Most agricultural societies have mechanisms in place to buffer shortfalls or even occasional failures, but conditions that lead to the exhaustion of both food reserves and seed grain can be disastrous (Anderson 1981:352; Ingram et al. 1981:13; Jones 1964; Parry 1981:327; Post 1977, 1980).

Social unrest is a common response to food shortage, as any reading of history will testify. The poor harvests during the years 1315 and 1316, among the worst of the second millennium in Western Europe, led to "panic and frustration, famine and widespread death" (Le Roy Ladurie 1971:47; see also Jordan 1996). Le Roy Ladurie (1971:74–77) observed that poor harvests in France in 1788 led to "scarcity, high prices, [and] food riots" which helped shape the traumatic events of the following year, which saw the beginnings of the French Revolution. As these examples indicate, however, social turmoil or even widespread famine need not lead to a complete organizational collapse over entire regions. In fact, only when truly catastrophic conditions occur is this the case; there are almost always some surviving societies. A hallmark of chiefdoms and states is the ability of their ruling elites to marshal subsistence and other resources, and use them to advance their personal agendas, of which survival and the maintenance of power are the most fundamental.

Complex societies overcome periods of adversity by buffering food shortfalls through the use of adequate appropriation and storage technologies, and employing the physical force necessary to maintain control over these resources. While suffering may be profound among commoners, and individual elites and their families may perish, unless events are truly catastrophic, some elites and their supporters, and hence the organizational systems they form, will continue, albeit perhaps in a weakened condition. Thus, only the most extreme conditions would cause all of the chiefdoms or states to disappear from a region. Effects on the character or operation of a society or group of societies, rather than the very existence of these societies, are what should typically be considered when assessing the impacts of climatic fluctuation, such as evidence for periods of increased or decreased warfare, exchange, or collective ceremony.

While agriculturalists and complex societies are thought to be particularly vulnerable to the effects of climate change, it is not at all true that hunter-gatherers are immune to such changes. Hunter-gatherers appear to be highly vulnerable to climatic perturbations, particularly in those societies where one or a few key resource types are either subject to predation or harvested in great quantity for bulk storage (DeBoer 1988; Jones et al. 1999:141; Testart 1988:173). Climate changes that led to crashes or relocations of food resources would have had an impact on the societies that exploited these resources. The Archaic populations of the Eastern Woodlands made extensive use of nuts from a few tree species and, after the demise of the Pleistocene megafauna, were highly dependent upon white-tailed deer as a source of food and hides (Gramly 1977). As populations grew and the landscape became increasingly saturated, sudden declines in these resources could lead to demographic and organizational change, particularly if secondary fall back resources were overwhelmed. The disappearance of a number of Late Archaic societies around 1000 BC may have been brought about by climate-induced resource stress (see Fiedel 2001, herein).

It has been known for some time that settlement patterns and technological organization in hunter-gatherer societies worldwide can be loosely correlated to average annual temperature values, as demonstrated in a classic paper by Lewis Binford (1980) two decades ago entitled "Willow Smoke and Dog's Tails: Hunter Gatherer Settlement Systems and Archaeological Site Formation", and followed up by Robert Kelly (1983, 1995) and others. This is, of course, no great surprise; we all know that Arctic hunters pursue very different lifestyles than Amazonian foragers. What is interesting, however, is that fundamental changes in organizational strategies tend to occur above an effective annual temperature of about 14 degrees C, about that of present day Virginia and Kentucky. At higher temperatures, plant resources become increasingly important in the diet, and settlement organization is increasingly directed to their procurement. The diachronic and spatial implications of this model have seen little exploration, however, but will likely prove a critical area of study in the future. As global temperatures changed over the course of the Holocene, we should expect to see changes over time and space in hunter-gatherer technological organization. As we shall see, this is exactly what is indicated in the early post-glacial archaeological record from the Eastern Woodlands (Cable 1982, 1996; Claggett and Cable 1982).

The Eastern Woodlands were the home of hunter-gatherers for upward of 10,000 years, and agriculturalists for 2,000 to 3,000 years after that, before European contact occurred. By the standard of our modern technological civilization, these were relatively uncomplicated societies. We now know, however, that even these societies were not immune to the world around them, and specifically the effects of climate change, any more than we are. Understanding the effects of climate, and climate change, is crucial to understanding the archaeological record of this region.

ANALYTICAL SCALES

A number of temporal and geographic scales can and should be considered when examining the impacts of climate change on human culture (e.g., Dean 2000:94ff; McIntosh et al. 2000:12ff; Mörner and Karlén

1984). Different cultural or historical processes occur at differing scales, such as the *Annales* historian Fernand Braudel's (1972, 1980) *longue durée*, *conjuntures*, and *evenments*, which for simplicity's sake might be considered the examination of historical trends at century to millennial, decadal to century, and momentary to annual scales, respectively (Cobb 1998:170–171; Sherratt 1992). Short of Pompeii-like situations, archaeology is perhaps best suited to documenting intermediate to long term patterns of land use and change (Binford 1982, 1983:109–143). Likewise, over space, cultural or historical processes may act at super-regional, regional, subregional, locality, and site/locational scales, all of which should be considered, in a multiscalar analytical perspective (Neitzel and Anderson 1999). Climatic processes, like the archaeological and historical record, must thus be considered at a variety of temporal and spatial scales.

Short-Term Processes (seasonal–annual–interannual scale)

What are the kinds of climate change we are interested in? In the short term, or annual to interannual trends, we are interested in fairly mundane things like variation in rainfall, temperature during the growing season, snowfall, and so on, usually for their effect on crop yields. Interannual variation in rainfall had a significant effect on crop yields and, through that, on the history of settlement at Spanish Santa Elena in South Carolina, Roanoke Island in North Carolina, and the Jamestown colony in Virginia (Anderson et al. 1995:266–269; Stahle et al. 1998). All were established during unusual periods of drought, as reconstructed by local bald cypress tree rings. The first colony was abandoned, the second lost, and the third struggled precariously during its first decade.

Volcanic eruptions are an important, short term, and unpredictable source of dramatic climate change (Robock 2000), and are known to have disrupted past societies, such as the eruption of the Santorini volcano on the island of Thera in the eastern Mediterranean ca. 1628 B.C. (Doumas 1978, 1980, 1983; Hardy 1990; Manning 1999), or the eruption of Mount Tambora on Sumbawa Island, Indonesia in 1815, leading to the so-called "year without summer" (Simkin and Siebert 1994; Stothers 1984).

More massive short term events, such as a large meteor impact, can also suddenly and dramatically effect global climate. The discovery of the Chicxulub impact crater in the northern Yucatan has been particularly sobering (Hildebrand et al. 1991; Penfield and Camargo 1981), since it verified the central premise of the Alvarez hypothesis, that a giant meteor hit the earth about the same time that much of life on the planet, including the dinosaurs, went extinct (Alvarez et al. 1980). While this may be considered too rare an event to worry much about, we now know that smaller objects hit the Earth much more frequently, and can have lesser but still dramatic effects. A 1 to 2 km diameter asteroid hit the southern Pacific some 2.15 million years ago, for example, with apparent dramatic effects on climate and biota in the Pacific basin, in what has been called the Eltanin event (Gersonde et al. 1997). The relationship between the size of the object and the periodicity, or probability of an impact occurring, in fact, appears to be roughly linear (Shoemaker et al. 1990). Even a small object no more than a hundred meters in diameter could cause severe climatic disruptions, and such impacts are calculated to occur every few thousand to few tens of thousand of years. A major climatic downturn and associated worldwide social disruptions that occurred in the mid-sixth century A.D has been attributed to either a volcanic eruption or the impact of a small meteor (Baillie 1994, 1995, 1999; Gunn 2000; Keys 1999). Fortunately, such cataclysmic events appear to be comparatively rare.

A classic example of the effect of climate on culture in the short term is the El Niño/Southern Oscillation, which has received extensive media attention in recent years. Warmer than average surface waters in the western Pacific create El Niño events, while colder than average waters create La Niña events, whose impacts are the subject of increasingly detailed research using both historical and archaeological data (e.g., Fagan 1999). El Niño, in fact, is sometimes blamed for just about everything under the sun. We do know that it is a major cause of short term climate change.

Not surprisingly, historic and late prehistoric El Niño effects have been examined in particular detail in Peru and Chile, where these processes were first noticed. Examination of Spanish archival data has shown that a number of periods of major flooding, catastrophic erosion, and famine over the past five centuries in that region are a direct result of El Niño/La Niña conditions (Fagan 1999; Quinn and Neal 1983; Quinn et al. 1987). The collapse of the anchovies fisheries in El Niño years in particular had devastating short term impacts on local South American cultures dependent on pelagic resources. Prehistoric El Niño periodicity and effects have been explored in western coastal South America, back as far as the Mid-Holocene (Sandweiss et al. 1996). Using multiple lines of evidence, Sandweiss and his colleagues have argued that El Niño effects were milder during the Mid-Holocene than afterwards, or possibly even shut down, a hypothesis that appears to be holding up well in light of subsequent research (Rodbell et al. 1999). El Niño may have been operating much further back in time, in the terminal Pleistocene (Rittenour et al. 2000).

In the Eastern United States, El Niño/La Niña effects include extended periods of somewhat above and below average rainfall and temperature, hurricane and tornado frequency, and wildfire incidence (Bove et al. 1998; Brenner 1991; Diaz and Markgraf 1992; Easterling et al. 2000; O'Brien et al. 1996; S. Smith et al. 1999). Such predictions are of great economic importance, since they provide clues about such things as future crop yields (e.g., Legler et al. 1999; Solow et al. 1998), heating/cooling costs, and storm damage. Much of this research includes analyses of recent historical records, typically from the mid-to-late 20th century to the present. It is not a great step to employ climate data from much further back into the past in these kinds of studies, to explain changes observed in local societies.

Intermediate Term Processes (decadal to century scale)

Intermediate or decadal to century scale trends include periods of increased warmth or cold, or greater seasonal variability. Periods of slightly increased or decreased global temperature can result in decreased or increased ice masses on land, and produce minor sea level fluctuations. Recent research has shown that pronounced and extended cold or warm intervals, such as the onset and end of the Younger Dryas, can occur within a few years to at most a few decades. These episodes, called "Dansgaard–Oeschger events" (Dansgaard et al.1989, 1993), undoubtedly had profound impacts on the peoples of the time, as appears to be the case during the Younger Dryas in Eastern North America. Our modern world may be experiencing a comparable event, given the dramatic rise in global temperature in recent years, albeit for quite different reasons, and with an as-of-yet uncertain outcome (Broecker 1975, 1997).

Longer, yet still intermediate term, climate processes are the century to millennial scale global temperature fluctuations within the longer glacial/interglacial cycles. The climate record of the interglacial we have been in for the past ca. 15,000 years is more complex than a gradual warming to a Mid-Holocene peak, followed by gradual cooling. Instead, throughout the Holocene there have been longer and shorter periods of slightly above- and below-average temperature, with occasional pronounced digressions lasting from a few years to a few centuries. The best known recent deviation, the Little Ice Age from ca. A.D. 1300 to 1850, was unusually cold, at least compared to the centuries preceding it (Fagan 2000; Grove 1988). These multi-century warming and cooling trends are usually associated with comparatively minor sea-level fluctuations, on the order of 1-2 meters, at least over the past 5000 years or so (e.g., Colquhoun and Brooks 1986; Fairbridge 1992; Tanner 1992; Walker 2000; Walker et al. 1994).

There may be longer term processes influencing or underlying these shorter oscillations. A 1500 year cycle from warmer to colder temperatures is believed to exist based on ice rafting episodes found in north Atlantic ocean bottom sediment cores, including one dating back 130,000 years taken off Newfoundland (Bianchi and McCave 1999; Bond et al. 1997; Campbell et al. 1998; DeMenocal et al. 2000; O'Brien et al. 1995). Major ice rafting episodes are inferred to have occurred at ca. 850 B.C. and A.D. 550 and may be associated with fairly dramatic changes observed in Late Archaic/Early Woodland and Late Woodland societies in northeastern North America (Fiedel 2001; Gunn 2000).

Intermediate and longer term climatic fluctuations may be tied to changes in solar activity. The sun is known to be a variable star, with energy output changing by small amounts. A decrease in sun spots during the middle part of the Little Ice Age, the so-called "Maunder minimum" from A.D. 1645–1715, was associated with cold winters, and suggests decreased solar energy output could lead to global cooling, although this specific association is somewhat tenuous (Overpeck et al. 1997). Paleoclimate data, however, does appear to offer the potential to explore long term variation in solar activity, and vice versa.

We have to be very careful about how we interpret broad scale climate change, of course. An increase or decrease in average global temperature has very different effects around the world. The Medieval Warm period (ca. A.D. 800 to 1300), for example, has been inferred to be a time of severe disruptions in local societies in the western United States (Jones et al. 1999), while in the Eastern Woodlands it witnessed the development of complex societies, such as Mississippian chiefdoms (B. Smith, ed., 1990); a great deal of cultural variability is evident within each area during this period as well.

Long Term Processes (thousands to tens of thousands of years or more)

Truly long term processes operate at scales of thousands or tens of thousands of years. These include the roughly 110,000 year Pleistocene glacial-interglacial cycles brought about by changes in the Earth's orbital inclination and eccentricity, and the effect this has on the distribution of solar radiation the planet receives (e.g., Hays et al.1976; Imbrie and Imbrie 1980; Milankovitch 1920, 1941; Muller and MacDonald 1997). The paleotemperature record in the Greenland and Antarctic ice cores, as well as in other sediment sources, reveals a classic saw tooth pattern of rapid temperature fluctuations (Petit et al. 1999). The rapid onsets and terminations characteristic of major glacial cycles undoubtedly had profound effects on the human cultures of the time, as have longer term trends within the Pleistocene and Holocene. The pronounced global warming and concomitant glacial retreat beginning about 15,000 cal. BP, for example, is thought to have led to population expansion into new areas, such as the Magdalenian re-colonization of western Europe (Housley et al. 1997; Jochim et al. 1999:130) and possibly facilitated the permanent settlement of the New World, by opening areas to movement (Anderson and Gillam 2000; Fiedel 2000; Haynes 1969; Martin 1973; Meltzer 1995). The extensive experimentation with plants and animals leading to domestication and ultimately settled life also began within this warm interval, leading some to suggest that our present civilization may owe its existence, in part, to the extended period of warm interglacial climate we currently find ourselves within (Binford 1968; Sherratt 1997).

Of particular interest, climate models based on orbital parameters (i.e., solar insolation) and atmospheric (i.e., greenhouse) gases have been run forward in time, with glacial peaks predicted some 50,000 and 100,000 years into the future (e.g., Berger and Loutre 1996, 1997; Loutre and Berger 2000). Such models are useful for exploring the possible effects of global warming on ice sheet melting and recovery. It appears that ice sheets, once melted, may take thousands or tens of thousands of years to re-form. These studies also suggest that the melting of the Greenland ice sheet may be unavoidable over the next several thousand years, even if anthropogenic gases emissions are eventually brought under control, and that once gone, the ice sheet may take 50,000 or more years to completely re-form. If the remaining continental ice sheets do eventually melt, the resulting changes in climate and sea-level are likely to have profound impacts on human culture.

Finally, there are also hints of even longer term cycles, on the order of hundreds of thousands or even millions years, operating to influence climate, although research on the existence and causes of these is still in its infancy (e.g., Rial 1999). What effect these may have had on human culture and evolution is unknown. Humanity emerged and expanded during a period when global climate cooled dramatically, in the Pleistocene era, although how and whether this may have facilitated our development as a species remains unknown.

CLIMATE AND CULTURE CHANGE IN THE EASTERN WOODLANDS

The Paleoindian Era (>11,450 cal. BP/10,000 rcbp)

The glacial maximum, or period of most intense cold and greatest ice sheet extent in the last glacial cycle, occurred roughly 21,400 cal. BP/18,000 rcbp. So much water was tied up in ice on the land that sea levels were 100 m below where they are at present. Soon thereafter, by ca. 15,000 cal. BP, post glacial warming was underway, and progressed rapidly for the next two thousand years, during the Bølling and Allerød, with only brief and comparatively cold reversals, known as the Older Dryas (ca. 14,100–13,950 cal. BP/12,100–11,950 rcbp) and the Intra-Allerød cold period (ca. 13,400–13,100 cal. BP/11,400–11,100 rcbp) (e.g., Allaby and Allaby, eds., 1999; Bjork et al. 1996; Yu and Eicher 1998). Many of the terms used for periods in the late glacial and post-glacial era, parenthetically, come from the Scandinavian paleoclimate and palynological sequences developed earlier last century. Sometime during this late glacial period the initial colonization of the New World probably occurred, since this is when human populations are first recognized across much of the hemisphere. Any earlier arrivals, predating the Bølling warming, apparently did not reproduce sufficiently to leave a widespread recognizable (and hence incontrovertible and uncontroversial) archaeological record.

In Eastern North America, boreal conifers like spruce and jack-pine dominated forests over much of the northern part of the region during the full glacial, from north of latitude 33, about the vicinity of central South Carolina across to the Arkansas-Louisiana line, to south of a narrow periglacial tundra zone immediately in front of the ice sheets (Delcourt and Delcourt 1981, 1987; Jackson et al. 2000; Webb 1987, 1988; Webb et al. 1993:448–450). With the onset of rapid deglaciation in the Bølling, mixed hardwood forests with oak and hickory as major constituents began to move northward from refugia in the lower southeast. By 11,450 cal. BP/10,000 rcbp, sea levels were within 20 m vertical elevation of their present stand. Hardwood and mixed hardwood-pine forests were present south of the Great Lakes, an expansion that does not appear to have been much affected by the Younger Dryas cold reversal from ca. 12,900 to 11,650 cal. BP/10,800–10,100 rcbp (cf., Maenza-Gmelch 1997; Peteet et al. 1990; Shane 1994; Yu and Eicher 1998). With lowered sea levels, many Late Pleistocene river systems would have been much narrower and more deeply incised than at present. With post glacial sea level rise, silting would have occurred along many channels, burying potential locations for early sites, which in the larger systems may have lost subsequently to meander scouring (Faught 1996; Goodyear 1999; Knox 1983).

As Late Pleistocene climatic events become better dated and their impacts better understood, it is crucial that this information is used to interpret the archaeological record (e.g., Bonnichsen and Turnmire 1999; Fiedel 1999a; Haynes 1993; Taylor et al. 1996). During the period of initial human settlement, presumably some time after the glacial maximum, the Coastal Plain in many areas was almost twice its present size due to lowered sea levels. Assuming human colonization or initial settlement occurred during the period of glacial retreat, these groups would have been faced with slowly rising sea-levels, possibly with minor reversals or slow downs triggered by colder intervals like the Older Dryas and the Intra-Allerød Cold Period (Faught 1996; Fiedel 2000; Taylor et al. 1996). Early populations may have found the Coastal Plains attractive settings, possibly replete with plant and animal populations, but they would have also been eventually forced into the interior (i.e., the "off the shelf" or "toothpaste" [getting squeezed] models of Paleoindian expansion, after Faught and Anderson 1996). In recent years, archaeologists have begun to locate Paleoindian and Archaic sites well out on the continental shelf on the Atlantic seaboard and in the Gulf of Mexico, the kind of data that should eventually help us understand when and how early peoples reached the continental margins (Blanton 1996; Dunbar et al. 1992; Faught 1996; Faught and Carter 1998).

The location of shorelines, ice-sheets, and periglacial lakes would have profoundly influenced the routes and means by which early populations could have entered into and moved through the New World, and Eastern North America in particular (Anderson and Gillam 2000; Dincauze 1993a:281). When the two currently favored entry points south of the ice-sheets were even accessible—the ice-free or Alberta corridor between the Laurentide and Cordilleran ice sheets, and the northwest coastal area—is the subject of extensive debate (e.g., Bonnichsen and Turnmire 1999; Dixon 2000, 2001; Fladmark 1979; Jackson and Duk-Rodkin 1996; Mandryk 1992, 1996; Mandryk et al. 2001; Wilson and Burns 1999). How the Late Pleistocene settlement of the continent may have proceeded, given the changes in physiography and vegetation that were occurring, in fact, has been the subject of extensive modeling in recent years (Anderson and Gillam 2000; Steele et al. 1998). Least-cost movement pathway analyses of possible colonization routes are critically dependent, for example, upon ice sheet extent, and hence climatic conditions, at various times. The early emergence of hardwood forests across much of the East, and particularly the midsouth, with their great mast yields, might have made the region attractive to early populations, who could have gravitated there, something clearly indicated by existing Clovis distributions, presumably representing occupations dating to ca. 13,450 to 12,900 cal. BP (Steele et al. 1998).

Rivers may have served either as barriers or special avenues to movement by these early peoples. As the major river system draining the midcontinent, for example, the Mississippi carried vast amounts of glacial meltwater during this initial warming interval, and may have been a much greater obstacle to passage than at present, unless watercraft were in use, as appears certain later in the Paleoindian period (Engelbrecht and Seyfort 1994; Dixon 2000; Jodry 1999; Morse and Morse 1983:78; Walthall and Koldehoff 1998). The volume of water led to the creation of braided stream channels in the lower Mississippi valley, which were abruptly replaced by a meander regime once meltwater discharge ceased in the early Holocene (Saucier 1994:45, 93–98). Given the concentration of later Paleoindian sites and artifacts along major river systems, it appears that waterways were generally favorable for movement and settlement, and not barriers (Anderson 1990:187; Dincauze 1993a:281–285; Jodry 1999).

Late Pleistocene fauna in the East encompassed a wide range of extinct and modern animal species. In addition to megafauna such as mammoth, mastodon, horse, giant sloth, saber-toothed tiger, and camel, modern fauna were also present such as white tailed deer, raccoon, and rabbit. The extent to which megafauna were exploited remains unknown, although there is no question they were at least occasionally targeted. At the end of the Pleistocene over 30 genera of large mammals went extinct, including all of the members of *Equidae*, *Camelidae*, and *Proboscidea* in North America (Martin 1984:361–363). The late Pleistocene extinctions were complete by ca. 12,900 cal. BP/10,800 rcbp, as best we can determine from radiocarbon dates (Mead and Meltzer 1984; Meltzer and Mead 1983), after which time local human populations had a much narrower array of animal resources to choose from. While the hunting, butchering, and working of bone and ivory from megafauna has been documented at a number of locations, the extent to which human predation contributed to these extinctions is unknown. Given that upwards of ten previous glacial cycles occurred earlier in the Pleistocene without any comparable animal extinctions, however, it is hard to imagine that humans did not play a major role, whether through hunting, or by introducing new diseases (Geist 1999:85–86; Martin and Klein, eds., 1984).

Early Paleoindian (Pre-Clovis) Occupations in the East (> ca. 13,450 cal. BP/>11,500 rcbp)

A number of Early Paleoindian (Pre-Clovis) sites are reported in the literature from Eastern North America, but populations appear to have been small, and activities somewhat enigmatic. Artifacts dated to this period have been found at a number of locations, such as Cactus Hill (44SX202) and Saltville (44SM37) in Virginia, Little Salt Spring and Page-Ladson (8JE591) in Florida, Topper (38AL23) in South Carolina, and Meadowcroft Rockshelter (36WH297) in Pennsylvania (Adovasio et al. 1978, 1990; Clausen et al. 1979; Goodyear 1999, 2000, n.d.; McAvoy and McAvoy 1997; McDonald 2000). When the first people arrived in the East thus remains unknown, although a number of sites have yielded evidence suggesting initial occupation could have begun up to several thousand years prior to 13,450 cal BP/11,500 rcbp. Beginning about 13,450 cal. BP or shortly thereafter, Clovis assemblages are found across the region, suggesting reproductively viable populations were in place; remains dating prior to this may represent small groups that died without issue, so-called "failed migrations" (Anderson and Gillam 2001). Traditionally, sites occurring prior to the widespread appearance of Clovis fluted points are called "pre-Clovis," a term that can continue to be used quite effectively to describe pre-13,450 cal. BP/11,500 rcbp occupations in the East, at least until specific assemblages can be recognized and named.

Our sample of Early Paleoindian sites in Eastern North America is extremely limited. That human colonization and settlement of the East occurred prior to 13,450 cal. BP/11,500 rcbp, however, must be considered probable, given the widely accepted placement of human occupation at the Monte Verde site in Chile at ca. 14,000 to 14,750 cal. BP/12,000 to 12,500 rcbp (Dillehay 1989, 1997; Meltzer et al. 1997; but see Fiedel 1999b for a skeptical assessment). If people had reached the southern cone of South America by some time prior to 14,000 cal. BP/12,000 rcbp, they could probably have just as easily reached the Eastern United States by this time or soon thereafter. While diagnostics remain elusive, the evidence from sites like Cactus Hill, Meadowcroft Rockshelter, and Topper suggests that large and small blades, and possibly unfluted triangular and Miller lanceolate point forms, will come to be recognized as diagnostic indicators of at least some Early Paleoindian Eastern occupations (Adovasio et al. 1978, 1990; Goodyear n.d.; McAvoy and McAvoy 1997).

Middle Paleoindian (Clovis) Occupations in the East
(ca. 13,450–12,900 cal. BP/11,500–10,800 rcbp)

The first unequivocal evidence for widespread human occupation in the New World dates to shortly after 13,450 cal. BP/11,500 rcbp, when assemblages characterized by fluted points appear in many areas. Clovis points have long been assumed to be the markers of the first populations to enter, explore, and settle into the region. Since it now appears likely that at least some people were in the region prior to the widespread occurrence of Clovis technology, what may instead be represented is the radiation of a superior technological tradition. Clovis points have been dated to between ca. 13,150–12,900 cal. BP/11,200–10,800 rcbp at a number of locations in the Southwest and southern Plains (Fiedel 1999a, 2000; Haynes 1987, 1992, 1993; Roosevelt et al. 1997; Taylor et al. 1996).

Clovis technology spread widely during and just after the Inter-Allerød Cold Period, and was replaced by a number of subregional cultural traditions by soon after the start of the Younger Dryas at ca. 12,900 cal. BP/10,800 rcbp (Anderson and Faught 2000:512; Fiedel 1999a:105–106, 2000; Taylor et al. 1996). The Younger Dryas was a time of pronounced colder conditions, changes in the distribution of floral and faunal communities, and a possible moderate lowering of sea level. Onset occurred almost instantaneously in both geological and human terms, with pronounced cold conditions appearing within a human lifetime (Alley et al. 1993; Bjorck et al 1996:1159; Dansgaard et al. 1989; Hughen et al. 1998). If sea-level dropped suddenly (something subject to debate), it would have exposed large areas of the previously submerged continental shelf, an area that may have taken some time to revegetate. These changes could have rendered immediate coastal settings unattractive, again possibly prompting movement into the interior (Faught 1996; Faught and Anderson 1996).

The Middle Paleoindian/Clovis era is now viewed as the time when populations expanded rapidly over Eastern North America, and settled permanently in a number of areas. These people were highly mobile, ranging over large areas, and targeting a wide range of biota, including megafauna. Some areas were highly favored, particularly the major rivers of the Midsouth and Midwest, including the Mississippi, Ohio, Cumberland, and Tennessee, and portions of Florida and the Atlantic Coastal Plain. These areas are assumed to have been rich in game, plant foods, and other resources of value to these early populations, staging areas from which the settlement of the larger region occurred, and from which subregional cultural traditions emerged (Anderson 1990:187–189, 1991a:9, 1995a:5, 1995b:148, 1996a:34–39; Dincauze 1993a:283–285, 1993b:51–56; Spiess et al. 1998:246–249). Clovis settlement also appears to have been shaped, to some extent, by the occurrence of high quality chert sources, raw materials these populations preferred for their toolkits, which include some of the finest chipped stone artifacts ever made in prehistoric North America.

By the close of the Middle Paleoindian period, shortly after 12,900 cal. BP/10,800 rcbp, a diversification of projectile point forms occurred across North America, indicating a probable fragmenting of the widespread Clovis tradition, and the emergence of more geographically circumscribed subregional or regional cultural traditions. In the Plains, the Folsom culture appears to have emerged by or shortly after 13,000 cal. BP/11,000 rcbp, and certainly by 12,900 cal. BP/10,800 rcbp (Fiedel 1999a:101–106; Stanford 1999:296; Taylor et al. 1996:522–524). It is probably safe to assume that similar successor cultures to Clovis were emerging in Eastern North America about this same time. The end of the Middle Paleoindian period is also the time of the sudden onset of the Younger Dryas, a period of intense cold worldwide that continued through much of the ensuing Late Paleoindian period. The fragmentation of the Clovis culture and the emergence of more localized regional and subregional cultural traditions, it is argued below, was brought about in part by the rapid and unexpected onset of these harsh conditions.

Late Paleoindian (Post-Clovis) Occupations in the East
(ca. 12,900–11,450 cal. BP/10,800–10,000 rcbp)

The Late Paleoindian, post-Clovis-era is a time of tremendous cultural and climatic change, trends that were probably closely related. The Clovis culture came to an end about 12,900 cal. BP, and after this regional and subregional cultural traditions became widely established, population levels grew dramatically, and technological organization changed to accommodate Holocene climate and biota. The terminal Pleistocene extinctions were largely complete at the start of this period and human populations were likely quite low in many areas, while at its end, people were present in large numbers across the region, who appear to have been fully adapted to Holocene biota and environmental conditions. The Younger Dryas occurred during this time, from ca. 12,900–11,650 cal. BP/10,800–10,100 rcbp, a major return to cold conditions whose onset appears to have occurred quite quickly, within a few years or decades, and probably had a major impact on local cultures. The interval within the Late Paleoindian dated from ca. 10,500–10,100 rcbp, furthermore, is a major radiocarbon plateau, encompassing almost 1000 calendar years. Thus, the 800 radiocarbon "years" of the Late Paleoindian era are actually closer to 1500 calendar years, a more realistic span to accommodate the dramatic changes that took place (Fiedel 1999a:106–107).

Late Paleoindian projectile point forms exhibit appreciable stylistic variability and in some cases fairly restricted spatial distributions, something interpreted as evidence for increasing regionalization or isolation of groups as population levels rose and group mobility decreased. During the initial part of the Late Paleoindian, identifiable point forms in the southern part of the region include both fluted, basally thinned, and unfluted forms, including some or all of the following types: Beaver Lake, Clovis Variant, Cumberland, Dalton, Quad, Suwannee, and Simpson, as well as a number of Plains Paleoindian forms such as Folsom, Plainview, Midland, and Angostura, primarily in the western part of the region (Anderson and Sassaman, eds., 1996; Johnson 1989; Munson 1990). In the Upper Great Lakes and the Northeast, a range of related forms are present, including deeply indented-base fluted points of the Barnes, Bull Brook and Vail/Debert phases, and later weakly fluted and Plano-like forms (Ellis and Deller 1997; Ellis et al. 1998; Lepper 1999:377–383; Spiess et al. 1998:232–238). Sometime around or after ca. 12,500 cal. BP/10,500 rcbp, Dalton points become common over much of the East south of the Great Lakes and the Northeast, with a number of distinct named subtypes or variants occurring in specific areas. The wide range of projectile point forms that appeared and disappeared across the region was all but inexplicable prior to the recognition of the vast amount of time (some 1500 years) making up the Late Paleoindian subperiod. The dramatic climate changes that were occurring during this interval also likely played a role.

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The tremendous cultural diversification that occurred during the Late Paleoindian era was closely associated with the rapid and unexpected onset and long duration of the Younger Dryas from ca. 12,900–11,650 cal. BP. This was a return to cold conditions that took place within a few years or decades, and that lasted for 1300 years, with dramatic temperature fluctuations within the interval as well (Grafenstein et al. 1999). The sudden and quite probably substantial disruptions in climate and biota brought about by the rapid onset of the Younger Dryas likely created subsistence stress among Paleoindian populations (Fiedel 1999a; Grayson 1987; Mead and Meltzer 1984:447; Meltzer and Mead 1983; Taylor et al. 1996). The demise of the Clovis way of life, the emergence of subregional cultural traditions, and the extinction of megafauna, all occur about the time of the onset of the Younger Dryas. The megafaunal extinctions would have forced peoples to intensify the procurement of animal resources in smaller package sizes, assuming larger animals were indeed targeted previously in some numbers. This may have lessened the need for long-distance movement; that is, patterns of group movement over great distances to exploit presumably widely dispersed large sized prey packages (i.e., megafauna) changed to more localized movements directed toward a wider range of smaller prey packages, such as deer and birds (Meltzer and Smith 1986; Morse and Morse 1983:71; Walker 1997, 2000).

Increased use of plant foods are also likely to have been brought about by these inferred changes in hunting strategies. If prey packages were smaller, they may have been more unreliable on a regular basis, mandating experimentation and use of a wide array of resources, including both plants and animals. When first line resources were unavailable for whatever reason, Paleoindian populations likely ate whatever was available, necessitating experimentation and the gradual expansion of knowledge about subsistence opportunities. Finally, if climate was colder and perhaps more unpredictable during the Younger Dryas, this may have also necessitated the development of an increased awareness of local resources, something that in turn may have served to restrict mobility. All of these factors, operating in combination, could have led to the increased differentiation in assemblages observed at this time. While it has long been assumed that changes such as these developed gradually over the course of the Archaic period, after ca. 11,450 cal. BP/10,000 rcbp (e.g., Caldwell 1958), it is now apparent that they were underway well back in the Paleoindian era, at least as early as during the Younger Dryas.

A fundamental reorganization in culture and technological organization characterizes the Middle-to-Late Paleoindian transition across much of Eastern North America, at least in the southern and central parts of the region, something reflected in the appearance of notched and resharpened points, greater use of local lithic raw materials, and a marked increase in the number of sites scattered widely over the landscape, including in rockshelters (Anderson 1990:198–201, 1996b:160–163; Dunbar and Webb 1996:352; Walthall 1998:227–231). The change in point forms from lanceolate to serrated and notched types during the Late Paleoindian era is thought to reflect a change from the occasional procurement of very large animals, such as elephant, to the processing of large numbers of much smaller and more dispersed game animals, such as deer. Only in the Upper Great Lakes and the Northeast was a more traditional technology seemingly maintained throughout the era, possibly due to a greater reliance on caribou herds (Spiess et al. 1998).

The Archaic Era (ca. 11,450–3200 cal. BP/10,000–3000 rcbp)

Initial Holocene/Early Archaic Adaptations in the East (ca. 11,450–8900 cal. BP/10,000–8,000 rcbp)

The Early Archaic period corresponds, roughly, to the period from the end of the Younger Dryas to the onset of the Middle Holocene Hypsithermal warming episode (Anderson et al. 1996:14–15; I. Brown 1994:48; Stoltman 1978:714). While a 10,000 rcbp starting date makes for a distinctive and convenient number, no great changes in either climate or culture occur at this time. The return to warmer conditions that occurred about a century or two prior to this, at the end of the Younger Dryas, I believe, makes for a better starting point. The end of the Younger Dryas, like the onset, occurred in a remarkably short period of time, from roughly 10 to 40 years (Alley et al. 1993; Dansgaard et al. 1989). Global temperatures rose ca. 7

degrees C, one of the most rapid warming periods of the current interglacial, with impacts that, as they come to be better understood, might hold some lessons for our modern era (Lowe 1995; Lowe et al. 1995). The overall amplitude of the glacial-interglacial temperature change at a global scale is 8 degrees C at the atmospheric inversion level, where precipitation forms, and ca. 12 degrees C at the surface (Petit et al. 1999:430).

Early Archaic components across much of Eastern North America are recognized by the occurrence of successive side- and corner-notched and bifurcate-based points (e.g., Anderson and Sassaman, eds., 1996; Bense 1994:65–67; Chapman 1985:146–148; Coe 1964; Ellis et al. 1998:161–162), although in the Northeast, Upper Great Lakes, and the western part of the region lanceolates and Plano-like forms reminiscent of Plains types such as Agate Basin, Scottsbluff, Cody, Eden, and Angostura are also present (Ellis et al. 1998:160; Jeter and Williams 1989:84, 87–89; Johnson 1989:27–49; Lepper 1999:378–380; Spiess et al. 1998:235–238). A contemporaneity of notched and lanceolate forms is indicated in many areas, save perhaps for the eastern half of the Southeast, where notched forms are seemingly ubiquitous.

Fairly high populations are assumed to have been present across much of the region during the Early Archaic period, as evidenced by the large numbers of sites and artifacts that occur widely over the regional landscape (Anderson 1996b:160–163). Band level groups are assumed to have been present, making use of resources over most if not all parts of the landscape. Elaborately made scraping, cutting and piercing chipped stone tool forms continued to be used, although this highly formal toolkit was gradually replaced by less well made and more expedient tool forms. Lower quality raw materials were increasingly utilized in stone tool manufacture.

Over time, and as human populations grew, group ranges are thought to have became progressively smaller, first perhaps along one or more river systems, then to within a single drainage, and finally to within portions of single drainages. Existing models of settlement during the Early Archaic period, at least those developed in the lower Southeast, emphasize appreciable seasonal movement of small band-level societies (i.e., groups of ca. 25–50 people related by kinship and marriage ties), with annual fall aggregation events by multiple bands for trade and marriage purposes (Anderson and Hanson 1988; Daniel 1998). Wild plant and animal foods made up the entire diet, although local populations were undoubtedly becoming increasingly familiar with their natural environment, and some plant species that were later domesticated may have begun to be intensively collected at this time.

The gradual abandonment of the highly curated Paleoindian toolkit is believed directly related to the emergence and increasing importance of foraging, generalist strategies over the region in response to post-glacial warming, specifically increases in effective temperature. Why did this technological change occur? The most sophisticated explanation we currently have is Cable's (1982, 1996) "Effective Temperature/Technological Organization" model, that examined how Paleoindian and Early Archaic technological organization shifted from logistical to residential mobility (and associated curated and expedient technologies, respectively) in response to post-glacial warming, specifically increases in effective temperature (Anderson and Sassaman 1996:27–28; Cable 1982, 1996; Claggett and Cable 1982; effective temperature is a measure of annual temperature distribution and intensity [Bailey 1960, see also Kelly 1995:66]). The theoretical foundation for this model is based on analyses of hunter-gatherers from around the world, whose technological organization, diet, and mobility strategies have been found to be closely linked to local effective temperature (Binford 1980:13–16; Kelly 1983, 1995:66–72, 117, 128–130). Changes in technological organization over both space and time among hunter-gatherers, accordingly, can to some extent be predicted by examining effective temperature isotherms. This forces us to consider the possibility that there was appreciable variation in Paleoindian and Archaic adaptations over time and in different parts of the continent, particularly moving from north to south, and from lower elevations to higher.

Why was the highly curated Middle Paleoindian toolkit retained for millennia after the demise of the Late Pleistocene megafauna, and a highly mobile lifestyle, if that is how these tools were originally used?

In part because the curated toolkit of high quality stone with predictable working characteristics offered a means to overcome subsistence uncertainty for populations that were still fairly mobile, ranging considerable distances from stone sources (Goodyear 1989). The Younger Dryas was a severe cold event, furthermore, and also a time of extensive climate fluctuation between cold and warm extremes (von Grafenstein et al. 1999; Lowe 1995; Lowe et al. 1995). It would make little sense to give up a reliable, proven hunting technology in the face of such uncertainty. Following the Younger Dryas, as climate ameliorated and became more predictable, technology might have shifted in line with the warmer temperature regimes. And even then the change did not occur overnight, but only over another two thousand years. As regional population levels grew, and group mobility strategies changed, the need for a highly curated chipped stone toolkit diminished over the region. The Late Pleistocene stone toolkit was an important part of the lives of these early peoples, however, and was only gradually replaced.

Middle Holocene/Middle Archaic Adaptations in the East
(ca. 8900–5700 cal. BP/8,000–5000 rcbp)

The Middle Archaic is a period of dramatic cultural change in Eastern North America. During this period ceremonial shell/earthen mound construction is initiated, long-distance exchange networks spanning much of the region appear, new tool forms are adopted, such as bannerstones and grooved axes, and there is increased evidence for interpersonal violence or warfare (Brown 1985; Brown and Vierra 1983; Dye 1996:140; Griffin 1967:178; Jefferies 1995, 1996; Johnson and Brookes 1989; Marquardt 1985; Milner 1999; Sassaman 1996; B. Smith 1986:18–27; M. Smith 1996). While fairly simply organized foraging groups were still present, they increasingly come to be found in geographically marginal areas (e.g., Anderson 1996b:164–165; Sassaman 1983, 1991, 1995:191). By 5500 cal. BP, large shell middens appear along the coast as well (Russo 1996b). All of these factors indicate local cultures were growing in scale and organizational complexity.

To archaeologists in Eastern North America, the Middle Holocene as defined here is considered synonymous with the Middle Archaic period, from 8900–5700 cal. BP/8000–5000 rcbp (Sassaman and Anderson, eds., 1996:xvii–xviii; Anderson et al. n.d.; B. Smith 1986:18). The period is widely viewed as the time of human adaptation to the climate interval variously known as the Hypsithermal, Altithermal, Atlantic, or Climatic Optimum (Sandweiss et al. 1999). From calculations based on Earth's orbital parameters, and supported by paleoclimatic data, we now know that this era was not one of appreciably greater overall global temperature than today, as has been long thought. Instead, temperatures were warmer in the summer and winters colder than at present in the northern hemisphere (Ganopolski et al. 1998). Ice core data, in fact, shows no great decrease in continental ice volume as might be expected, if a major increase in global temperatures had occurred (Hu et al. 1999).

Middle Holocene climate in Eastern North America was not like that of today, however, regardless of how similar global temperatures may have been to the present. Seasonal temperature extremes were greater, which may have stressed local populations. Lake levels were at low stands or dry over large areas, which would have made locations with permanent water more favorable for settlement (Webb et al. 1993:454). El Niño episodes may have been milder and less frequent (Sandweiss et al. 1996, see also Hamilton 1999:350–351). Across the lower Southeast, pine forests began to re-expand dramatically, from a low in the Initial Holocene, replacing oak, and cypress swamps began to develop along the slowing river systems (Jacobson et al. 1987; Watts et al. 1996:32–36; Webb et al. 1993:448–450). In the lower Midwest and Midsouth, at the onset of the Middle Archaic, Middle Holocene climate appears to have been hotter and dryer than at present, leading to a reduction in upland vegetation, increased surface erosion, and aggrading floodplains (Knox 1983:32–34; Schuldenrein 1996:9–10, 26–27; Wright 1992). Formation of backwater slough habitat enhanced floodplain productivity, while shoal environments promoted freshwater shellfish. These warming and drying trends may have rendered riverine areas more favorable, and upland areas less favorable, to human populations (Brown 1985:219–221; Brown and Vierra 1983:167–168; Sassaman 1995:182).

As early as 8000 cal. BP, shellfish began to be collected in significant numbers in the interior of the midcontinent, a trend that continued through the Initial Late Holocene (Dye 1996). Archaic shell and earthen mound sites are unevenly distributed across the Southeast and lower Midwest, however, and shell mounds are absent in some areas where mollusks were likely prevalent (Claassen 1991a, 1991b; 1996:240–242). This indicates that regional political conditions, as well as population levels, played a major role in shaping shellfish exploitation patterns and settlement in general. Mound construction of shell and/or earth may have been necessary only where population levels were high and competition for resources was particularly intense, if this activity was a means of binding people together or to demarcate territories. An even simpler explanation may be that shellfish were only used where other, more readily exploited or preferred resources were not easily available. As domesticated plant foods became increasingly important in the Late Archaic and particularly the ensuing Woodland and Mississippian periods, for example, the use of shellfish appears to have declined in some areas (but see Peacock 1998, n.d.). The mounding of shell and earth in the midsouth at this time parallels comparable developments in other parts of the region, in coastal areas and in the Lower Mississippi Valley, and indicates collective ceremonial behavior on a fairly large scale had emerged in many parts of the region (Claassen 1996; Russo 1996a, 1996b; but see Hensley [1994] and Milner and Jefferies [1998:130], who argue that the large interior shell sites were true middens, and not purposively built monumental or ceremonial architecture).

Sea level rise also slowed markedly, suggesting fairly minimal melting of the remaining ice sheets. During the Initial Holocene, sea levels in the Southeast rose rapidly, at a rate of as much as 1 cm a year until about 9000 cal. BP, after which the rate slowed to as little as 25 mm per year in the Middle Holocene. From ca. 6800 cal. BP/6000 rcbp to about 3200 cal. BP/3000 rcbp, in the Initial Late Holocene, sea level rose even slower, at a rate of no more than 3 mm a year (Colquhoun and Brooks 1986). It has been thought for many years that this later Holocene decrease in the rate of sea level rise permitted estuarine and barrier island formations to have stabilized somewhat, allowing shellfish beds to form, and hence only then making the coast an attractive area for prehistoric settlement (DePratter and Howard 1980; Russo 1996a:177). An alternate and more recent viewpoint holds that coastal resources were exploited from a very early time, but that evidence for this has been submerged and hence will be difficult to locate (Russo 1996a:177–178, 196–197). At 9000 cal. BP for example, the coast was over 25 km from the present shoreline in the vicinity of Charleston, South Carolina, while by 5750 cal. BP it was still about 3 to 5 km farther out. It is beginning to appear that coastal resources were indeed exploited earlier than once thought. Archaic sites have been found on the continental shelf in the Gulf of Mexico and along the Atlantic seaboard, and extensive shell ring and midden sites 5000 years old have been found recently in Florida, in some cases fairly deeply buried in marsh deposits (Blanton 1996; Faught 1996; Russo 1996a, 1999).

Surprisingly, the onset of the Middle Holocene in Eastern North America did not begin with great warmth, but with a minor cooling trend that occurred from ca. 8900 to 8400 cal. BP. This was followed between ca. 8400 to 8000 cal. BP by what has been described as "the most abrupt and widespread cold event to have occurred in the past 10,000 years" (Barber et al. 1999; see also Alley et al. 1997); this event was the coldest since the Younger Dryas, including the recent "Little Ice Age." This cooling trend and subsequent sudden cold snap appear to have been brought about by the final melting of the remnant Laurentide Ice Sheet, followed by the sudden and catastrophic drainage of the massive glacial lakes Agassiz and Ojibway (Hu et al. 1999). These events affected both atmospheric and ocean circulation patterns, and resulted in a drop in temperatures of from 1.5 to 3.0 degrees Celsius in the northern part of Eastern North America. The early to mid-Holocene transition was thus a period of fairly pronounced climate change recognized on a global scale, that had essentially concluded by ca. 7800 cal. BP (Stager and Mayewski 1997).

Unfortunately, our knowledge of archaeological developments from ca. 9000 to 7000 cal. BP is fairly limited. In the lower Southeast, the retraction of bifurcate (ca. 9500–8600 cal. BP/8500–7800 rcbp [Chapman 1985:146) projectile point-using peoples from the Coastal Plain occurred roughly at this time, a depopulation that may have continued through much of the Middle Holocene, through the Morrow Mountain phase (ca. 6300–5700 cal. BP/5500–5000 rcbp). The decreased use of the Coastal Plain during the Middle Holocene has traditionally been attributed to an expansion of pine forests and a corresponding decrease in the incidence of more productive mast producing species (Anderson 1991b:96–97, 1996b:164–165; Chapman 1975: 265–268, Sassaman 1995:181–183; Sassaman and Anderson 1994:149–150;). Whether the ca. 8900 to 8000 cal. BP cold events helped trigger these movements of biota and people is unknown. There is some evidence of renewed, albeit still fairly minor use of the Coastal Plain in the Carolinas during the Stanly phase (ca. 8600–8350 cal. BP/7800–7500 rcbp [Chapman 1985:146; Stuiver et al. 1998:1143–144]), about the start of the more intensive cold interval (Anderson 1991b:100–101). The region's peoples had, however, been through far worse in the Younger Dryas and persevered, indeed, Dalton occupations during the Younger Dryas have been described as a "efflorescence" in the Central Mississippi Valley (Morse and Morse 1983:71). The low visibility of terminal Early Archaic/initial Middle Holocene occupations in the East may simply be because they fall in a time that has received little attention by archaeologists, at the end and just after the era when elaborate and well made stone tool assemblages reward the patient excavator, and before dramatic shell and earthern mound sites began to be constructed.

With the (comparative) amelioration in climate that occurred after ca. 8000 cal. BP, there is evidence for more restricted group mobility in many parts of the region, something likely brought on, in part, by increasing population levels. Post-glacial warming is thought to have reached something of a peak although, again, global temperatures do not appear to have been much different than today (O'Brien et al. 1995). Some areas appear to have been lightly populated (Anderson 1996b:164–165), or at least have comparatively few sites, particularly large portions of the southeastern Gulf and Atlantic Coastal Plains. This appears to be a continuation of the trend that began during the period when bifurcate points were in use. The expansion of pine forests at the expense of oaks, when coupled with increased seasonal temperature extremes and clear evidence of widespread aridity, has long been thought to have led to a consolidation of peoples in areas where hardwood forests and wetlands were maintained, like the river valleys of the Midsouth and lower Midwest, or into resource-rich areas like the coastal margins (Chapman 1975: 265–268; Jefferies 1983; B. Sassaman 1995; Smith 1986:22–23).

Conditions varied over the region. The general lack of surface water in peninsular Florida encouraged settlement around sinks and ponds. By shortly after 9000 cal. BP, these occupations involved the interment of humans in pond/bog settings at places such as Windover (Doran and Dickel 1988, Doran et al. 1988). Archaic basketry, canoes, carved wooden sculpture, tools, utensils, and clothing, and well preserved human tissue have all been found in wet sites, of which cemeteries like Windover and Little Salt Springs in Florida are perhaps the best known examples (Clausen et al. 1979; Doran et al. 1988; Purdy 1988, 1991).

Why did complex societies first emerge in parts of Eastern North America during the Middle Archaic, and not before or after? The Middle Holocene appears to have been a time of interrelated environmental stress and population pressure. Climatic stress is indicated by widespread evidence for aridity and the expansion of pine forests (Webb et al. 1993:448–450, 454), while group circumscription into comparatively resource-rich riverine zones may have placed pressure on, and generated competition for, these resources. As populations grew and mobility decreased, competition and interaction between groups appears to have increased, probably because people were forced closer and closer together on the landscape. This competition was held in a number of arenas, encompassing personal status items as indicted by the growth in exchange networks; for food or other natural resources as suggested by the increased evidence for warfare; and in collective ceremonial behavior, as reflected in the construction and use of elaborate mound centers in several areas. Critical population density and spacing thresholds were thus reached at a time when climatic uncertainty was exacerbated. Hamilton (1999:350) has noted that the increase in the occurrence and intensity of El Niño that appears to have occurred toward the end of the Middle Holocene (e.g., Rodbell et al. 1999; Sandweiss et al. 1996, 1999) could have resulted in highly variable climatic conditions in Eastern North America, and possibly greater and more serious flooding. These changes could have prompted greater cooperative efforts among the region's peoples, directed to elaborate mound-building, exchange, and ceremonial behavior.

That is, the complex shell and earthern mound centers of the Middle Archaic may reflect the actions of many band-sized groups, or tribal segments, bound together into a new social formation by the collective ceremonial activity represented by the construction of these complexes, and the communal feasting, ritual and other behavior that likely took place at them. Mound construction and presumably associated exchange and ritual, in this view, helped create pan-tribal social institutions linking tribal segments from across large areas (Bender 1985a, 1985b). Besides enhancing the status of tribal leaders, interaction and exchange likely helped reduce the possibility of warfare and alleviate subsistence stress, by creating ties between groups, bonds of alliance rather than enmity (Braun and Plog 1982; Brose 1979; Hamilton 1999; Saitta 1983). When resources in one area grew scarce, the existence of alliances would facilitate temporary group relocation into more favored areas, and reduce the possibility of conflict, until the shortfall passed.

Initial Late Holocene/Late Archaic Adaptations in the East (5700–3200 cal. BP/5000–3000 rcbp)

All of the trends initiated in the Middle Archaic continued to grow in scale over the course of the Late Archaic, which is dated from 5000–3000 rcbp or 5700 to 3200 cal. BP, and is here called the Initial Late Holocene (roughly comparable to B. Smith's [1986:24] initial late Holocene era, which he dated from 5000–2500 rcbp/5700–2600 cal. BP). During this interval, essentially modern climate, sea level, and vegetation emerged. Mound construction, long-distance prestige-goods exchange, and warfare expanded, culminating in dramatic cultural expressions like Poverty Point, Stallings Island, Green River/Indian Knoll, and Old Copper. Shellfish use in the interior continued, and use of coastal resources became widespread. A major increase in regional population levels is indicated, with sites found in all parts of the landscape (Anderson 1996b:165–166; Griffin 1967:178–180; B. Smith 1986:28–35). An amelioration in climate that appears to have contributed to these developments occurred during the Initial Late Holocene, with temperature, precipitation, and lake levels reaching conditions similar to those at present (Webb et al. 1993:454–457). Precipitation and flooding increased, as did channel migration in major river systems (Knox 1983:33, 39; Schuldenrein 1996:7–10).

The intensive collection of a wide range of wild plants is documented during the Initial Late Holocene in the Midsouth and lower Midwest, and morphological changes indicative of domestication, such as an increase in seed size or a decrease in seed coat thickness, are evident in several local species by the end of the Late Archaic period, from ca. 4500–3200 cal. BP/4000 to 3000 rcbp (B. Smith, ed., 1992). Local plant species of this "Eastern Agricultural Complex" include sunflower (*Helianthus annus*), sumpweed (*Iva annua*), goosefoot (*Chenopodium berlandieri*), maygrass (*Phalaris caroliniana*), knotweed (*Polygonum erectum*), little barley (*Hordeum pusillum*), and local cucurbits or gourds. This was a true independent domestication of local plants by indigenous populations, who had been collecting them for millennia prior to this in their wild state.

Tropical species like maize, tobacco, and beans appear to have come into the East appreciably later, well into the Woodland period after ca. 3200 cal. BP. These introductions occurred well after local domestication had occurred, and represented crops added onto an existing agricultural system. The nutritional value of the Eastern Agricultural Complex plants is extremely high, with some "oily seeds" like sunflower and marshelder proving to be excellent sources of fat, and other "starchy seeds" like goosefoot, maygrass, and knotweed excellent sources of carbohydrates. Harvest yields comparable to those for maize can be obtained from some of these plants, on the order of 500 to 1000 or more kg of seeds per hectare (B. Smith, ed., 1992:177). As these crops increased in importance, climate change affecting their production would have potentially had severe consequences. These societies also made extensive use of wild nuts, like hickory and acorn, and as dependency on these resources grew, so too did their vulnerability to resource fluctuations.

While steps toward domestication were being taken in some parts of the region, and cultigens were assuming increasing importance in the diet, in other areas the hunting and gathering of wild foods continued well into the Woodland period. Evidence for the use of domesticates during the Archaic and Woodland periods is rare on the Atlantic and Gulf Coastal Plain and in Florida, in the Northeast, and in the Lower Mississippi Valley. Why this is the case is uncertain, although it is thought that in areas of low population density such resources were not needed, while in ecologically rich areas they were unnecessary.

As Middle Holocene and Initial Late Holocene population levels grew, competition and interaction between groups appears to have likewise increased, as indicted by the growth in exchange networks, warfare, and collective ceremonial behavior, as reflected in the construction of complex mound centers. One of the most exciting archaeological discoveries to occur in recent years is the recognition that mound construction has great antiquity in the Eastern United States, extending well back into the Middle Holocene some 6000 years ago (Russo 1994a, 1996b). Until the last decade, mound building had been thought to date primarily to the terminal Archaic and Woodland period, after about 3500 cal. BP (e.g., Griffin 1967:180).

An exceptional and poorly understood precursor of the Woodland burial mound tradition was the Poverty Point culture of northeast Louisiana and vicinity, dating to about 3600–3100 cal. BP. So unusual was this complex of pre-Woodland sites with elaborate mounds that researchers openly acknowledged that it did not "fit" with archaeological understanding of Eastern prehistory (Ford and Webb 1956:14; Gibson 1994, 1996:288). The Poverty Point type site is one of the largest earthen mound complexes ever built in North America, and includes a massive putative bird effigy mound some 70 feet high, a number of smaller mounds, and six semi-circular rings some 1200 meters across. A number of contemporaneous mound centers are also present in this part of the Lower Mississippi Valley, making up an extensive interaction network that made use of raw materials from across much of the lower southeast and up the Mississippi River into the Midwest. How such large and complex mound centers could arise among presumably preagricultural, egalitarian hunting-gathering populations was a puzzle for many years.

Massive earthen mound construction predating Poverty Point by up to three millennia has now been documented at a number of locations in the Lower Mississippi Valley. Early mound complexes dating between ca. 5500 and 5000 cal. BP include Frenchmen's Bend, Hedgepeth, and Watson Brake (Russo 1994a, 1994b, 1996b; Saunders et al. 1994, 1997). These are not isolated small mounds, but vast complexes presumably requiring the cooperation of large numbers of people in their construction. Watson Brake, for example, which was built between ca. 5400 and 5000 cal. BP, includes 11 mounds up to 7 m in height connected by a circular earthen embankment some 300 m across (Saunders et al. 1997). As at Poverty Point, extensive occupational debris is evident, although paleosubsistence analyses suggest seasonal rather than year-round occupation. No evidence for long distance exchange has been found, although so far only limited excavations have been conducted.

Early mound construction has also been identified in several other parts of Eastern North America, notably in coastal areas where, as in the Midsouth, both shell and earth were commonly used. At Horr's Island in southwest Florida, for example, a complex arrangement of shell mounds was built between 4600 and 5000 cal. BP (Russo 1991, 1994b, 1996a). Paleosubsistence analyses as well as evidence for structures indicate occupation of the site was year round, the earliest evidence for sedentism found to date in Eastern North America. Other complex later Archaic cultures include the Shell Mound Archaic cultures of the Midsouth, the Benton Interaction Sphere in the lower Midsouth, the Nebo Hill culture of the lower Missouri River valley, the Stallings Culture of Georgia and South Carolina, the Mount Taylor culture of northeastern Florida, the Helton and Titterington phase cultures of Illinois and Missouri, and the Old Copper culture of the upper Great Lakes. These societies participated to varying degrees in the long distance exchange networks present at this time, and it is clear that some individuals within them had higher status than others, as evidenced by the existence of elaborate grave goods.

Poverty Point is now no longer an enigma, but rather a high point in a lengthy and widespread tradition of mound building in the eastern woodlands (Gibson 1996). Why did this form of activity emerge, and why did it disappear in some areas? Competition for status between individuals and groups may have driven some of this construction activity. Another factor may have been a need to create ties between large numbers of people during periods of climatic deterioration or uncertainty, to create allies in the event of food shortages or warfare (Braun and Plog 1982; Brose 1979; Hamilton 1999; O'Shea 1981). The mound complexes reflect the involvement of peoples from across a large area, and may demarcate the emergence of more complex forms of social organization, such as tribal-level entities, rather than the band-level groupings of 25 to 50 people that are assumed to have been the primary social grouping up to this time (Anderson 1999; Bender 1985a, 1985b).

The Woodland Era (3200–1000 cal. BP/3000–1000 rcbp)

The end of the Late Archaic period and the onset of the Early Woodland period witnessed the collapse of exchange networks across Eastern North America, and the abandonment of construction and in many cases occupation at formerly dominant centers like Poverty Point. Long distance interaction declined markedly, and across the region people appear to have been living in small, more-or-less egalitarian groups, with community size on the order of a few dozen people, or several families. Pottery, which had appeared about 1000 years earlier along the South Atlantic Coastal Plain, spread widely across the region. Small earthen burial mounds and associated mortuary facilities were built in many areas, and served to bring together peoples from a number of communities (Clay 1998).

By the Middle Woodland period, which in the Southeast and lower Midwest spans the interval from about 300 B.C. to A.D. 400, long distance exchange networks had reemerged, spectacular mounds and earthwork complexes were built in many areas, similarities in iconography and ritual behavior are evident across much of the region, and at some centers key individuals were buried in elaborate and sumptuously provisioned tombs within or under massive mounds. This behavior has come to be known as Hopewellian interaction, after the type site in Ohio where spectacular remains were found late in the last century (Brose and Greber 1979; Pacheco 1996). Many differing societies were present within the region, of course, whose participation in this interaction network varied greatly. Native cultigens are thought to have played a major role in the diet in some areas, although this remains to be well documented. Pollen analyses suggest that fairly extensive forest clearing was taking place in some areas by the Middle Woodland, suggesting the cultivation of plants was increasingly important (B. Smith, ed., 1992:108–111). Maize, while present in some areas, was not used extensively until the Late Woodland and Mississippian eras.

During the Late Woodland period in the Southeast and lower Midwest, from ca. A.D. 400 to 1000, a marked decline in interaction occurs, evidence for warfare increases dramatically, and major population growth is indicated, with populations found both scattered over the landscape and, for the first time in many areas, in nucleated villages. The bow and arrow comes in and spreads rapidly over the region. By the end of the Woodland period, chiefdoms are thought to have emerged in the central and lower Mississippi Valley, and intensive maize agriculture was being practiced in some areas. Major civic–ceremonial centers characterized by temple/mortuary mounds arranged around plazas appear at this time in some areas. This site type is the hallmark of chiefly centers in the ensuing Mississippian period, from ca. A.D. 1000 to 1550, when they occur widely across the East and lower Midwest.

What was behind the collapse, reemergence, and subsequent collapse of these pan-regional patterns of interaction, exchange, and monumental construction during the later Archaic and Woodland periods? Archaeological explanations for these broad trends have taken several forms (e.g., Cobb 1998:178–181). The impact of new technologies has been variously suggested. Mound construction and pottery use were once thought to signal the onset of the Woodland, but we now know these activities have great antiquity in the region. The widespread adoption of pottery that admittedly did occur after ca. 3200 cal. BP is thought to have undercut previous exchange networks that included exotic container goods, such as soapstone vessels (Sassaman 1993). The only problem with this argument is that soapstone vessel use peaked and declined some 300 to 500 years before the end of the Late Archaic era and the widespread occurrence of pottery, and soapstone appears to have been only rarely exchanged in large quantities in any event. The spread of ceramic technology widely over the East that characterizes the onset of the Woodland period may have instead been facilitated by the increased use of small seed crops, which may have been processed through extended simmering or boiling (Braun 1987; Fiedel 2001; Goodyear 1988), or else the increased use of direct cooking of all food types (i.e., with the vessel directly over the fire [Sassaman 1993]). At the same time, decreases in group mobility would have facilitated the use of this comparatively fragile technology—people wouldn't have to carry it as far. The spread of the bow and arrow was likewise once thought to have brought about the end of Hopewell, by encouraging warfare at a previously undreamed of scale of effectiveness. The problem with this argument is that the bow came into the East several centuries after Hopewellian interaction had ceased (Blitz 1988, Nassaney and Pyle 1999).

Demographic and subsistence arguments have also been raised. The great subsistence potential of Eastern Agricultural Complex domesticates is thought to have provided the economic basis for Hopewellian monumental construction and exchange (B. Smith, ed., 1992). The Middle Woodland was thus a period of peace and plenty, whose end only came about when population growth outstripped these resources, ushering in a new era of conflict in the Late Woodland. The only problem with this admittedly very plausible argument is the limited data we currently have on hand to test it. We simply don't know the dietary contribution the native domesticates of the Eastern Agricultural Complex provided during the Woodland, or before or after, for that matter. Fecal and stomach content samples found in caves and dating to the Woodland era indicate this contribution may have been substantial, but these samples are small and restricted to a few areas (Gremillion 1996, n.d.; B. Smith, ed., 1992). Corn, which leaves an identifiable stable carbon isotope dietary signal in the bones of organisms that ingest it in appreciable quantity, was not consumed extensively until the very end of the Woodland era; unfortunately, comparable analytical techniques are not available to determine the role of native Eastern domesticates.

Climate, of course, has long been implicated in Woodland cultural developments. In the early 1960s, for example, in a classic series of papers, James B. Griffin (1960a, 1960b, 1961) argued that many of the broad outlines of Eastern North American prehistory, at least over the past 2000 years or so, were shaped by changes in global climate. Griffin (1960a, 1961:712–713) argued that the Middle Woodland florescence from roughly 300 B.C. to A.D. 300 was a period of climate presumed favorable for agriculture. The Middle Woodland is now known to be roughly cotemporaneous with the comparatively mild Subatlantic climate episode, the so-called Roman Optimum, which may well have been characterized by conditions conducive to agriculture in the East, although this remains to be determined. Further back into the past, the data were too sketchy to make much of a case for climate-and-culture associations at the time Griffin was writing.

We now know, however, that there were fairly dramatic climatic downturns at the start of the Woodland era and at the Middle/Late Woodland transition, but whether they were ultimately causal or contributory to the collapse of the Late Archaic and Hopewellian worlds is unknown. The onset of the Early Woodland closely corresponds to what is known as the "1159 BC event" (Baillie 1988, Fiedel 2001; this corresponds to ca. 2900 rcbp), a severe global temperature downturn indicated in the Irish oak tree ring sequence by two decades of minimal growth. Upheavals are reported in a number of cultures worldwide about this general time, including the collapse of many Mycenaean centers, as well as social unrest in China and Mesopotamia (e.g., Bryson et al. 1974; Fiedel 2001; Kuniholm 1990). Whether this event, near the end of the Sub-Boreal, itself a period of somewhat colder and fluctuating climate, was enough to bring about the collapse of complex hunter-gatherer societies of the Late Archaic like those centered on Poverty Point is unknown. It would have likely been a period of stress, however, and perhaps more than these societies typically had to buffer against (Braun and Plog 1982; Brose 1979; Gunn 1997).

Two to three centuries later, another cold event occurred at 2850 cal. BP/2750–2450 rcbp, at the Subboreal/Subatlantic transition, a time corresponding to a major period of ice-rafting noted in cores from the north Atlantic (Bond et al. 1997; van Geel et al. 1998, 1999). The radiocarbon curve is characterized by minor plateaus and jumps over the next several centuries, and a period of decreased solar output comparable to the Maunder Minimum is inferred, with this and colder ocean waters reducing the amount and absorption of atmospheric radiocarbon. The first several centuries of the Woodland period were thus fairly cold in Eastern North America, within which were two fairly dramatic short term cold events (O'Brien et al. 1995). While it is unlikely that these climatic developments could have, in and of themselves, brought about the collapse of Late Archaic exchange networks, they may have played a part, and made the Early Woodland a difficult time for local populations, as Fiedel (2001) has argued for the Northeast.

As Griffin (1960a, 1961:712–713) noted many years ago, the Sub-Atlantic climatic amelioration, after ca. 400 B.C. (ca. 2450 cal. BP), likewise may have facilitated the development of Hopewell Culture and its variants across Eastern North America. Rapid fluctuations in climate were not as common or extreme during this period, placing less stress on subsistence systems. If agricultural food production was increasingly important, the reduced variability and more moderate conditions may have allowed for the more regular production of surpluses, which could have helped fuel the monumental construction, ceremony, and exchange observed at this time. The mild decline in average global temperature from ca. A.D. 400 to 800, the Vandal Minimum, in contrast, has been suggested as a contributing factor in the decline of Hopewell, by stressing existing agricultural systems (e.g., Griffin 1960a:713).

A fairly dramatic climatic event appears to have occurred in the mid-sixth century, in the two decades after A.D. 536, accentuating what appears to have been a broad global cooling trend (Baillie 1999; Gunn, ed., 2000). Growth rings in the Irish oak dendrochronological record suggest that whatever occurred at this time was actually greater in magnitude than the 1159 B.C. event, and indeed comprised the most restricted period of growth in that 6000 year sequence (Baillie 1988, 1994, 1995). The mid-sixth century appears to have been a period when human societies in many parts of the globe experienced great stress, from Western Europe to China to the Mayan Lowlands. The ensuing three centuries prior to the onset of the Medieval Warm episode ca. A.D. 800 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 (e.g., Baillie 1999; Broecker 2001; Gunn, ed., 2000; Hughes and Diaz 1994; Jones et al. 1999). The effects of the A.D. 536 event on southeastern cultures have been the subject of some examination recently (e.g., Anderson 2000a, 2000b; Lilly and Webb 2000; Mathis 2000; Walker 2000; Wetmore et al. 2000; Woodall 2000). In the South Appalachian area there is evidence for changes in many local cultures at this time, but whether climate had a role is unknown. In the western part of the lower Southeast along the Gulf Coastal and lower Mississippi Valley, in contrast, there is little evidence for disruption. Given that Hopewell culture was gone for some two centuries prior to the mid sixth century, its demise was due to factors other than the A.D 536 event; the mild global cooling that began ca. A.D. 400, however, may have been contributory in some way.

The Late Prehistoric/Early Historic Era (1000–400 cal. BP/950–350 rcbp)

During the late prehistoric era, complex societies employing intensive maize agriculture were present in many parts of the Southeast, lower Middle Atlantic slope, and lower Midwest, long distance exchange networks re-emerge, and warfare appears to have been endemic in many areas. These societies emerged, expanded, and collapsed across the region, with the expansion of one society typically at the expense of others. Regional maps constructed covering this interval at century by century intervals show whole areas being occupied and abandoned, in pattern akin to blinking Christmas tree lights (Anderson 1991b, 1996c;

Milner et al. n.d.). Few of these societies appear to have lasted more than a century or two (Hally 1993). How did chiefdoms emerge and why did they spread? Theories about the emergence of complex societies in the eastern Woodlands have emphasized the importance of population pressure, intensive agriculture, warfare, the pivotal role specific individuals might have played, historical conditions, and the control over the exchange of desired items or "prestige goods." A massive literature, in fact, explores this question, and grows yearly (e.g., Anderson 1994a; Brown et al. 1990; Milner 1998; Muller 1997; Pauketat and Emerson 1997; B. Smith, ed., 1990; Welch 1991).

These societies are thought to have spread peacefully through a process known as competitive emulation (e.g., Clark and Blake 1994) and, in a less tranquil manner, through the threat of warfare (Carneiro 1981). That is, attractive characteristics of chiefdoms may have been copied by neighboring societies. In the Eastern Woodlands, the most dramatic Mississippian society in terms of size and complexity was also the earliest, at Cahokia in the central Mississippi Valley. It undoubtedly attracted a great deal of attention, and exerted a lot of both direct and indirect influence on other societies in the region (Anderson 1997; Pauketat and Emerson 1997). At the same time, the military advantage a chiefdom would have over a less complex society likely prompted a defensive reaction and reorganization among its neighbors, who would have had to adopt or be absorbed.

It is probably no coincidence that the spread of Mississippian culture from ca. A.D. 800 to 1300 corresponds to the Medieval Warm Period (Broecker 2001; Hughes and Diaz 1994), a time thought favorable for agriculture, with peak warm temperatures in the northern hemisphere comparable or only slightly less than those at present (Crowley 2000; DeMenocal et al. 2000). Likewise, it is also probably no coincidence that the later part of the era, after the onset of the Little Ice Age, when agriculture would have been more difficult, is a time of increased warfare and settlement nucleation, and decreased long distance exchange and monumental construction (Grove 1988). Griffin (1961:711–713) noted the disruptions in Eastern cultures marked by the onset of the Little Ice Age after ca. A.D. 1300. Milner (1999:125) has documented a substantial increase in the fortification of settlements at this time in the upper Midwest and Northeast, which he attributes to climatic-induced stress on crop yields brought about by the onset of the Little Ice Age.

During the Medieval Warm Period, complex agriculturally-based societies spread widely over the East, eastern Great Plains, and in the Southwest. For societies heavily dependent on agriculture, repeated crop failures brought on by prolonged bad weather could have had disastrous effects. Most of these societies, however, appear to have developed elaborate cropping and storage strategies to reduce the effects of drought, but it is comparatively straightforward to demonstrate that they were not always successful (Anderson et al. 1995). We now have excellent year by year paleoclimate information from many areas of Eastern North America derived from tree rings. Bald cypress 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; numerous reconstructions exist from across the southeast, dating back to ca. 1500 years ago (Stahle and Cleaveland 1992, 1994; Stahle et al. 1985a, 1985b, 1985c, 1988). Eastern white cedar ring width appears correlated with summer temperature, and a chronology developed in Ontario now extends back to 2800 cal. BP (Kelly et al. 1994; see also Fiedel 2001).

Tree-ring derived paleoclimate data have been used to calculate possible crop yields and stored food reserves during the Mississippian era, for example, in the Savannah River valley and adjoining areas, where excellent long-term dendroclimatological reconstructions exist (Anderson 1994a; Anderson et al. 1995). These crop/storage estimates were then compared with the political history of the late prehistoric societies in this area. 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 relative tranquility 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.

Tree-ring derived rainfall measures have also been used to explore developments in the 1565–1587 Spanish colony of Santa Elena on the South Carolina coast, the 1585–1587 English settlement at Roanoke Island in coastal North Carolina, and events associated with the initial settlement of Virginia two decades later (Anderson et al. 1995; Stahle et al. 1998). The Spanish settled Santa Elena in 1565, during the worst decade of drought of the sixteenth century. The difficulties the colony faced in its early years, particularly the trouble it had supporting itself (it was abandoned briefly in the mid 1570s), no doubt played at least some part in the decision to abandon the settlement, and relocate the capitol of Spanish Florida to Saint Augustine in 1587, something that occurred at the end of another severe drought. Probably not coincidentally, 1587 was apparently the same year that the settlers at the English colony to the north, at Roanoke vanished, creating the enduring legend of the "lost" colony. A few years later the initial settlement at Jamestown in 1607 was imperiled by drought-induced crop failures and starvation, although the colony was able to hang on (Stahle et al. 1998). Several Indian revolts during the subsequent colonial period also occurred during or immediately following periods of reconstructed drought, such as the Guale revolt of 1597, the Yamassee war of 1715, and the Cherokee War of 1760. Early Spanish efforts at colonization in the Southeast ran into appreciable climatically-induced vicissitudes, from the hurricanes that destroyed the fleets of the 1528 Narvaez and 1559 Luna expeditions, to the multi-year-long periods of drought that characterized the initial and final periods of settlement at Santa Elena. Given all this, one could mount the argument that climatic fluctuations, as much as anything, explain why the people in the southeastern United States speak English rather than Spanish.

CONCLUSIONS

The relationship between climate and culture needs to be taken seriously when examining cultural change in Eastern North America. To better explore these relationships using archaeological data, of course, our chronological resolution leaves much to be desired, and we need to move toward achieving temporal precision closer to 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 prehistoric period in the East, yet to document fine-grained climatic events and their impacts, we often need to have annual or at most decadal scale data. Research by paleoclimatologists should be of help in refining our archaeological time scales, particularly if we can correlate well dated climatic events with changes in past cultural systems. The systematic examination of such events, through the cooperation of scholars in numerous disciplines, can greatly improve our understanding of the past.

The record archaeologists can bring to the table is itself extensive and improving constantly. Thanks largely to the rise of cultural resource management (CRM) archaeology, there are now close to half a million recorded archaeological sites in the Eastern United States, a dramatic increase from the ca. 20,000 or so recorded in 1970. The data in these records can and have been used to plot where people or at least sites were located on the landscape at various times in the past. Many thousands of sites have been excavated, telling us even more about the past. These data are shaping new models and explanations for what we see in the past, enabling us to better evaluate the effects of climate change. Correlation (positive or negative) does not equate with causation, however, and certainly does not constitute adequate explanation for cultural change. Nonetheless, there appear to be significant relationships between climate and culture over the period of human occupation in Eastern North America that are worthy of exploration.

A critically important lesson that we must learn is that sudden changes in global climate can occur, and that these can have profound effects on human cultural systems. The Younger Dryas shows that the onset of pronounced cold or warm intervals can occur almost instantaneously, within a few years to at most a few decades. Archaeology and history must come to grips with the possibility of punctuated and dramatic change, just as paleontology had to in the decade following the publication of the Alvarez hypothesis. Whether our global and regional climate will change dramatically in the future is not an issue. It will. Earth's orbital dynamics, for example, will inexorably produce conditions ripe for another major glaciation. The previous interglacial ca. 125, 000 years ago, the Eemian, lasted about 15,000 years, and was a time of climatic instability much like the Holocene (Maslin et al. 1998). Our own interglacial era has lasted about that long. The ice sheets will return, unless massive human intervention occurs (Berger and Loutre 1996, 1997; Loutre and Berger 2000).

Another lesson is that climate change does not need to be sudden or dramatic to have a long-term and far reaching effect. Gradual warming or cooling trends over decades or centuries can profoundly shape vegetational communities and crop yields, and hence the probability of famine or warfare. These same global climate trends can also effect sea level stands, and hence human settlement over broad areas. Our civilization, while resilient, is not invulnerable to the effects of dramatic climate change. Basic questions that will occupy many scientists and planners in the years to come include:

(1) what kinds of changes might we expect to occur in global climate over the short, intermediate, and long term?
(2) how vulnerable are our current cultural and political systems to climate change?
(3) how can we minimize or at least anticipate any possible negative consequences of climate change?

The past offers a vast record for comparison, and archaeology and history can make major contributions to the answering of these questions, and planning for a more stable future.

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