The Cultural Context of Plant Domestication in Eastern North America

by Bruce D. Smith

The timing and sequence of the independent domestication of indigenous eastern North American seed plants (*Cucurbita pepo*, *Helianthus annuus*, *Iva annua*, *Chenopodium berlandieri*) and the subsequent development of a crop complex are discussed within a broader environmental and cultural context. The settlements that have yielded the earliest record of eastern domesticates are all small and situated in resource-rich lower-order river valley corridors within oak-savannah and oak-hickory forest regions. Well-preserved floral and faunal assemblages indicate continued substantial reliance on a wide range of wild species with no evidence of resource depletion. Similarly, there is no indication of landscape packing in terms of high site density in these resource-rich river valleys, calling into question developmental models of domestication and agricultural origins that rely on population pressure or resource imbalance as causal factors.

Our archaeology is that of hunting and gathering groups, no more complex than a simple band or bands . . . that late in the Archaic period began to experiment with simple gardening.
(Kay 1983:64)

Introduction

Over the past 2 decades, geneticists and archaeologists have made impressive advances worldwide in documenting the temporal and spatial context of domestication of a growing variety of different species of plants and animals, as well as identifying their wild progenitors (Zeder et al. 2006). When combined at regional scales of analysis, these species-level initiatives have in turn significantly increased our understanding of the pace and sequence of domestication of different species within the world's independent centers of domestication and agricultural origin, including eastern North America (Smith 2006*a*).

Even though eastern North America temporally lags behind many of the world's other centers of agricultural origin and only witnessed the domestication of a few species that remain important in today's world economies (e.g., sunflower and *Cucurbita pepo* squash), it nonetheless provides an important comparative case study situation in a number of respects, primary among these being that the spatial and temporal parameters of two developmental milestones are reasonably well established: first, the initial domestication of the region's four domesticated seed plants and, second, the formation of a distinctive crop complex based on these indigenous domesticates. This well-defined temporal and spatial framework for initial plant domestication and the formation of a distinctive crop complex provides a good foundation for a regional-scale consideration of the general environmental and cultural context within which domestication and the initial transition to food production occurred. In this article I briefly outline the temporal and spatial parameters of initial plant domestication and the subsequent establishment of a distinctive crop complex in eastern North America and then employ this spatial-temporal framework to focus on a consideration of the general environmental setting and sociocultural characteristics of the societies that made the initial transition from hunting and gathering to food production in the region by looking at their levels of technology, settlements and subsistence economies, and regional-scale networks of interaction.

The Temporal and Spatial Context of Plant Domestication in Eastern North America

Based on several morphological changes (e.g., seed size increase, reduction in seed coat thickness) that are associated with the "adaptive syndrome of domestication" and that have been documented in well-preserved seed specimens recovered from a number of archaeological sites in eastern North Amer-

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Table 1. Earliest occurrence of indigenous domesticated seed crops in eastern North America

Domesticated plant species	Age (AMS-calibrated calendar years BP)		Age (radiocarbon years BP)	Laboratory sample no.	Archaeological site and provenience
	Intercept	1σ age range			
Pepo squash (*Cucurbita pepo* ssp. *ovifera*)	5025	5290–4870	4440 ± 75	β47293	Phillips Spring (unit K2)
Sunflower (*Helianthus annus*)	4840	4860–4830	4265 ± 60	β45050	Hayes (level 14)
Marshelder (*Iva annua*)	4400	4420–4290	3920 ± 40	β216463	Napoleon Hollow (feature 20)
Chenopod (*Chenopodium berlandieri*):					
"Naked"	3800	3830–3700	3490 ± 40	β253114	Riverton (feature 1)
Thin testa	3700	3900–3490	3450 ± 150	β11348	Cloudsplitter (F. S. 1361)
Thin testa	3690	3810–3640	3440 ± 40	β253117	Riverton (feature 8A)
Thin testa	3640	3840–3460	3400 ± 150	β11347	Newt Kash (El 1114)

ica, at least four indigenous seed-bearing plants were brought under domestication in the region over a span of about 1,300 years, from 5000 to 3700 BP (table 1; fig. 1). Maize (*Zea mays*), the first Mesoamerican domesticate to reach eastern North America, did not arrive for another 1,200 years, at ca. 200 BC (Riley et al. 1994).[1] In addition to these four seed plants that exhibit morphological changes, three other species that lack such changes have also been identified as probably having been the subject of deliberate planting and harvesting of stored seed stock based on their relative abundance in seed assemblages of this time period: erect knotweed (*Polygonum erectum*), little barley (*Hordeum pusillum*), and maygrass (*Phalaris caroliniana*; Smith 2006*a*; Yarnell 2004).

The genetic and archaeological evidence for the domestication of these eastern seed plants has been discussed at length by a number of researchers over the past several decades (Reisberg and Harter 2006; Smith 2006*a*, 2006*b*; Yarnell 2004), but in comparison, relatively little attention has been given to what the societies were like that brought these plants under domestication. The general temporal and spatial parameters of initial domestication and the emergence of early low-level food production economies in the region, as indicated in table 1 and figure 1, provide a good starting point for such a consideration.

As shown in table 1, morphological changes indicating the initial domestication of three of the four eastern crop plants are first documented in assemblages dated to between 5000 and 4400 BP, with the earliest evidence for domestication of the fourth species (*Chenopodium*) not appearing for another 6 centuries, at 3800 BP. Earlier evidence for chenopod domestication will quite likely be recovered in the future, however, and I expect that initial domestication of the four eastern domesticates identified so far in terms of morphological changes as well as perhaps others will fall into the 5-century span between 5000 and 4500 BP. Rather than restricting this discussion to the societies and settlements of this 500-year period, however, it is worthwhile to expand the time span of consideration another 11 centuries, from 5000 to 3400 calibrated calendar years BP, in order to both increase the number of archaeological sites that have yielded domesticates and include several sites that provide substantial information. This time span also correlates closely with the cultural period often termed the "Late Archaic" (Emerson, McElrath, and Fortier 2009; Sassaman and Anderson 1996; Smith 1986).

The currently available evidence of indigenous domesticated plants for the 5000–3400-BP time period has been recovered from a total of seven archaeological sites, all of which are located within the resource-rich oak-savannah and oak-hickory forest regions of eastern North America (Delcourt and Delcourt 1981; fig. 1).[2] These small settlements, which are scattered across five states and are separated by up to 1,000 km, represent the primary data sets for considering the early history of low-level food production in the region. Information regarding these seven sites, however, is relatively limited, and an expanded consideration of a larger sample of

1. Discussions of the independent domestication of plants in different regions of the New World rarely consider the bottle gourd (*Lagenaria siceraria*) because it was a "utilitarian" domesticate rather than a food plant. Highly prized for its strong, lightweight fruits that made excellent containers and vessels of various shapes and sizes, the bottle gourd was carried from Asia to the Americas either by ocean currents or more likely by Paleoindian colonists (along with another utilitarian domesticate, *Canis familiaris*), reaching the New World by 10,000 BP (Erickson et al. 2005). It reached eastern North America by 7300 BP (Doran, Dickel, and Newsom 1990) and is frequently recovered in association with eastern North American domesticates, particularly before the development of ceramic vessels in the region.

2. Of the seven archaeological sites in eastern North America that have provided early evidence of domesticated plants, only six are profiled here in detail. Newt Kash Hollow is not discussed, given the limited amount of information that is currently available regarding the site. The domesticated *Chenopodium berlandieri* documented for Newt Kash (table 1) consisted of thin-testa fruits extracted from an unprovenienced but directly dated human coprolite from the site (Smith and Cowan 1987). A number of other sites that date to this time period and that have been identified as having produced domesticates (Yarnell 2004)—for example, Jernigan II, Peter Cave, and Iddens—are not included in this discussion either because the species in question was the bottle gourd, a utilitarian domesticate with deep time depth, or because the specimens recovered did not exhibit morphological markers of domesticated status (e.g., thin-rind wild *Cucurbita* gourd rind fragments and maygrass, sunflower, and chenopod seeds that fall into the wild size range).

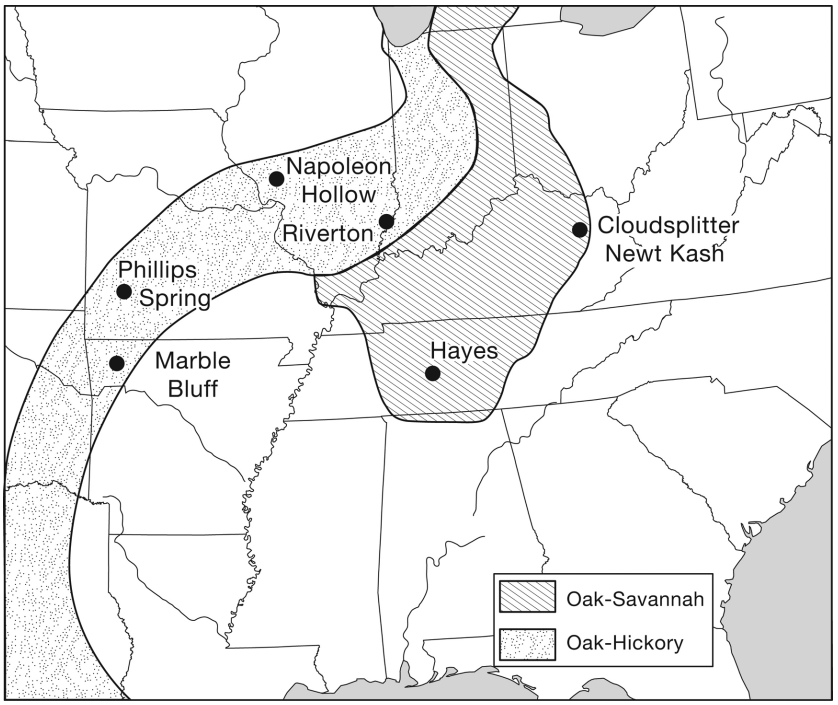

Figure 1. Oak-savannah and oak-hickory forest regions of eastern North America at ca. 5000 BP (after Delcourt and Delcourt 1981). The Late Archaic settlements that have provided the earliest evidence of domesticated plants in eastern North America are shown.

Late Archaic period sites from the oak-savannah and oak-hickory forest zones will provide a broader and clearer general profile of the societies that initially domesticated plants in eastern North America. The numerous small-scale societies that populated the blank portions of figure 1 were similar in many respects to those represented by the seven sites shown, and while excavations at many of these other sites have not yielded domesticates, they have produced considerable material cultural evidence of technology, subsistence and settlement patterns, and likely mechanisms and networks of broadscale regional interaction (Jefferies 1996).

The Late Archaic Settlements That Have Yielded the Earliest Evidence of Domesticates

Scattered across the interior riverine midlatitudes of the oak-savannah and oak-hickory forest zones between 5000 and 3400 BP, the seven sites shown in figure 1 are often thought of as comprising two distinct groups based on their environmental setting and the factors that contributed to the preservation of archaeobotanical specimens. Marble Bluff at the western end of this distribution of sites and Cloudsplitter and Newt Kash at the eastern end are dry rockshelters situated in rugged upland settings in proximity to small streams. Preservation of plant remains in these sites is excellent because of an absence of soil moisture in the archaeological deposits. Between them, Phillips Spring, Napoleon Hollow, Riverton, and Hayes are all located in river valley settings, with preservation of early domesticates resulting from either carbonization or, in the case of Phillips Spring, wet rather than dry soil conditions.

The recovery of early domesticates from both riverine and more upland settings has engendered a very interesting and ongoing discussion regarding the specific habitat setting of initial plant domestication in eastern North America: is the presence of early domesticates in more upland sites largely a function of good preservation of plant remains in dry rockshelters, or does it indicate in fact that the initial domestication of *Cucurbita* gourds, marshelder, and chenopod—all early successional floodplain colonizers (see discussion below)—occurred outside of their natural riverine habitats? At the present time the available archaeological evidence best supports a river valley context of initial domestication, with the earliest evidence for all four eastern domesticates recovered from sites in stream valley settings. Rather than being situated along the main trunk of the Mississippi Valley, however, or any of its major tributaries (e.g., the Missouri, Ohio, and White rivers, etc.), all seven of the sites discussed here are instead situated in proximity to smaller primary (Illinois),

secondary (Wabash, Buffalo), and tertiary (Pomme de Terre, Duck, Red) tributaries of the Mississippi. In addition, although the seven sites that have produced the earliest domesticates all share a generally similar river valley setting, they are dispersed across a broad area of the interior midlatitudes.

While acknowledging the challenges inherent in determining the geographical range of wild progenitor populations at 5000 BP, genetic profiling of modern wild populations of both *Cucurbita pepo* var. *ovifera* squash and sunflower indicate that initial domestication of these two species probably occurred along the western end of the oak-savannah and oak-hickory forest zone (Reisberg and Harter 2006; Smith 2006*a*). Because neither of the other two eastern domesticates—*Iva annua* and *Chenopodium berlandieri*—is cultivated today in the region, any effort through genetic analysis to determine more specifically where they were brought under domestication will necessitate comparison of modern wild populations with domesticated specimens from archaeological contexts.

While future genetic and archaeological research may establish with greater spatial resolution those geographical locations where marsheleder, chenopod, and other eastern crop plants were most likely initially domesticated, it is possible now to identify with considerable confidence the specific habitats within which domestication occurred. Four and perhaps more local seed-bearing plants—all aggressive river valley colonizers of disturbed soil settings—were initially domesticated and were being cultivated in stream valley and upland settings across a broad area of the Mississippi drainage catchment (midlatitude oak- and hickory-dominated forest zones) by 5,000–3,500 years ago. At the same time, it is surprising that if you look past the dating and documentation of the early domesticates from these seven sites, there is relatively little additional published information that is currently available regarding the actual settlements or their inhabitants. This relative absence of information regarding the seven sites in question is the result of a number of factors, including the limited nature of excavations, complex stratigraphy, substantial disturbance and mixing of habitation layers in multicomponent sites (see Cowan 1984:323; Fritz 1986), and lack of published site reports. Drawing from available primary references, brief cameo descriptions of each of the Late Archaic settlements that have yielded early domesticates are provided below.

Marble Bluff (*3SE1*)

Excavated by a University of Arkansas crew in 1934, Marble Bluff is a 7-m-wide habitation zone that extends for about 120 m along a west- to southwest-facing overhanging bluff located just above Mill Creek, a tributary of the Buffalo River, which in turn flows into the White River, in Searcy County, Arkansas (Fritz 1986:11, 24, 27; 1997). A large alluvial terrace is located less than 0.5 km from Marble Bluff, and an estimated 30 ha of arable land was available within 2 km of the settlement (Fritz 1986:30, 36).

Although cultural deposits at Marble Bluff are described as reaching 47 inches in depth and producing a "full range" of artifact types and 405 catalog numbers (Fritz 1986:27, 1997), the long time span of likely occupation of the site, the low frequency of temporally diagnostic material culture, and the often disturbed nature of Ozark rockshelter deposits in general have made it difficult to either distinguish Archaic materials and features from those of subsequent occupational episodes or to accurately characterize the nature of the Late Archaic occupation of the settlement. In addition, most of the domesticated sunflower, chenopod, marshelder, and *C. pepo* squash specimens recovered from Marble Bluff came from an isolated charred storage deposit located in a crevice against the back wall of the shelter and could not be easily associated with other cultural features or artifact assemblages. In general, Late Archaic small-scale societies in the Ozarks have been characterized as being largely autonomous, with settlement systems centered on multiseasonal multiple-activity base camps that are situated on the terraces of major streams and smaller shorter-term seasonally occupied rockshelters in smaller tributary drainages and upland settings (Fritz 1986:39; Sabo, Waddell, and House 1982:64). Subsistence economies centered on white-tailed deer (*Odocolieus virginianus*) and smaller species (raccoon, turkey, squirrels), as well as on hickory nuts and acorns.

Phillips Spring (*23Hi16*)

Located in Hickory County, Missouri, the Phillips Spring site centers on a small artesian spring situated on the 1b terrace of the Pomme de Terre River, a tributary of the Osage, which in turn flows into the Missouri River. Excavation units in the water-saturated anaerobic sediments adjacent to the spring exposed a "squash and gourd zone" (unit K2) that contained abundant plant remains (hickory, walnut, abundant acorns, grape, elderberry, ragweed), including bottle gourd rind fragments and 125 uncarbonized *C. pepo* seeds and seed fragments (Kay 1983, 1986; Kay, King, and Robinson 1980). Based on their size and a direct date of 5025 calibrated calendar years BP on one of the seeds (table 1), this large assemblage provides the earliest evidence for the domestication of this species in eastern North America.

This unit K squash and gourd zone, which is the oldest of the six stratified living surfaces documented at Phillips Spring, was exposed to only a very limited horizontal extent during excavation, and little information is available regarding architectural features and patterns of artifact distribution. The subsequent six Sedalia-phase occupational episodes at Phillips Spring, which occurred over a period of about 500 years (Kay 1983:54–55), however, yielded abundant artifacts, pit features, hearths, and discrete residential-area midden scatters, which Kay (1983:61) considers to represent a series of warm-season (spring to fall, and perhaps through the winter) base encampments that centered around the artesian spring. Along with more or less sedentary river valley settlements like Phillips Spring, smaller family groups occupied outlying sites,

including caves and rockshelters, on an intermittent seasonal basis. Although squash and bottle gourd were grown, oak mast and hickory nuts played a major dietary role, with white-tailed deer, mussels, and fish being the most important prey species.

Napoleon Hollow

Located where a small tributary valley known as Napoleon Hollow joins the Illinois River, which in turn flows into the Mississippi, this large, deeply stratified site is known primarily for its extensive and well-documented middle woodland occupations (Wiant and McGimsey 1986). A block excavation into the colluvial fan emanating from the bluff on the north side of the hollow where it joins the Illinois Valley, however, also exposed a series of stratified Middle and Late Archaic period occupations (Wiant, Farnsworth, and Hajic 2009).

One of the pit features associated with a Late Archaic Titterington phase (feature 20) contained abundant artifacts and plant remains, including *Cucurbita* rind fragments and *Chenopodium berlandieri*, sunflower, and ragweed seeds, along with 44 carbonized marshelder achenes. Based on their large size and a direct date of 4400 calibrated calendar years BP, this substantial assemblage of *Iva annua* achenes provides the earliest evidence for the domestication of this species (Asch and Asch 1985:161; table 1).

Given the number and variety of stone tools and the amount of debris recovered during excavation, the Titterington component at Napoleon Hollow is considered to have been a seasonally occupied river valley base camp (Wiant, Farnsworth, and Hajic 2009). In a broad regional consideration of the Titterington phase and other neighboring and generally contemporaneous Late Archaic societies, Cook (1986:175) characterizes their subsistence system as having a heavy reliance on white-tailed deer, shellfish, fish, waterfowl, small mammals, hickory, walnut, and oaks, with seed plants—including chenopod, ragweed, sunflower, marshelder, and *Cucurbita*—playing only a minor role. Their annual cycle involved seasonal multigroup nucleated base camps and smaller single-group settlements dispersed across a range of environments:

> many Titterington-phase sites with preserved feature populations have a recurrent pattern: either there is a single cluster of nonoverlapping shallow-basin hearths, or large roasting pits or there are linear clusters of such features. I assume that the single-cluster sites are occupied by one or more extended families while the multiple-cluster sites represent simultaneous use by several extended families. (Cook 1986:184)

Riverton (*Cw-170*)

In his landmark study of the Late Archaic Riverton culture, Howard Winters (1969) excavated three large shell-midden sites (Robeson Hills, Swan Island, and Riverton) located along a 20-mi stretch of the Wabash River, a tributary of the Ohio River, in Crawford and Lawrence counties, Illinois. One of these, the Riverton site, yielded evidence of four domesticated plants: sunflower, chenopod, *C. pepo* squash, and bottle gourd.

The Riverton site is a large, deeply stratified midden that extends over an area of about 2 acres (ca. 470 ft × 220 ft) on a T-0 terrace of the Wabash River. In 1961, five 5 × 5-ft excavation units in three separate locations exposed 44 inches of cultural deposits, including abundant features and well-preserved material culture assemblages. In 1963, a large block excavation unit (unit X) exposed, just below the plow zone, a group of 10 clay floors, along with associated pit and hearth features, artifacts, and extensive midden lenses (fig. 2). Roughly rectangular in shape, the Riverton clay floors ranged in size from about 100 to 200 ft^2 and from 4 to 6 inches in depth, and they are thought to have been built within a short time of each other. Like the numerous similar features documented in Late Archaic contexts across the eastern woodlands (Sassaman and Ledbetter 1996; Smith 1986:27), these clay floors are thought to be prepared house floors even though associated post holes are not always observed.

A series of eight radiocarbon dates from unit X indicate a relatively short-term occupation dating to ca. 3800–3700 calibrated calendar years BP (Smith and Yarnell 2009; Winters 1969). The Riverton material culture assemblage included a wide range of chipped and groundstone lithic tools (projectile

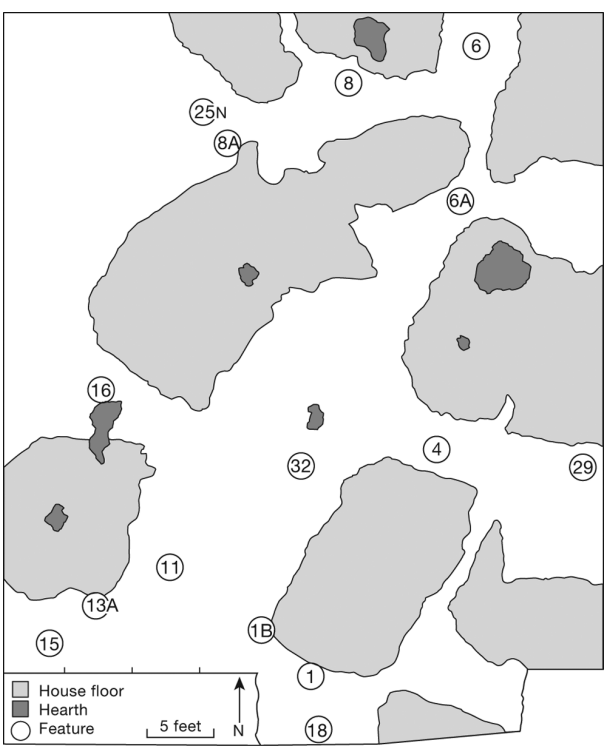

Figure 2. Clay house floors and other features uncovered in unit X of the Riverton site (after Winters 1969:96).

points, knives, side and end scrapers, hammerstones, manos, metates, axes, etc.), along with a variety of well-preserved bone tools (antler projectile points, awls, gravers, fleshing tools, etc.; Winters 1969).

Soil samples taken from features associated with the clay floors at Riverton by Richard Yarnell subsequently yielded domesticated sunflower, *C. pepo* squash, bottle gourd, and two distinct cultigen varieties of domesticated chenopod (Smith and Yarnell 2009; Yarnell 2004). Although seeds of a small number of wild species were also recovered (e.g., persimmon, elderberry, *Polygonum*), the archaeobotanical assemblage primarily consisted of carbonized fragments of black walnut and hickory nuts and acorns (Yarnell 2004). A diverse faunal assemblage was dominated by white-tail deer, with significant representation of raccoon, beaver, and turkey, along with waterfowl and other birds, 13 species of fish, and 37 species of freshwater mussels (Parmalee 1969).

Given the floodplain location of Swan Island and Riverton, along with seasonality indicators, Winters (1969:137) identified them as spring-fall and summer occupations, respectively, while Robeson Hills, with its higher elevation above the Wabash Valley, was characterized as a winter settlement. Alternatively, all three sites could be considered as generally comparable in terms of representing larger river valley multiseasonal macroband base camps linked to numerous outlying shorter-term, more limited activity sites (Smith 1986).

Hayes (*40ML139*)

Situated on a T-1 terrace at the confluence of Caney Creek and the Duck River, a tributary of the Tennessee River, in Marshall County, Tennessee, the Hayes site is a large (ca. 900-m^2) stratified multicomponent midden with up to a 1.7-m-thick Middle Archaic stratum of freshwater gastropod shells (stratum III) overlaid by more than 1 m of Late Holocene alluvial deposits, including a Late Archaic shell-free habitation layer (stratum II; Crites 1987; Klippel and Morey 1986). A flotation sample recovered from square 989N920E, level 14 (130–140 cm below ground surface), in a small block excavation unit located on the T-1 terrace (Crites 1987:16), contained six complete domesticate-size sunflower seeds, one of which yielded an AMS radiocarbon date of 4840 calibrated calendar years BP (Crites 1993; table 1). Although both Benton and Ledbetter projectile point/knives were also recovered from the same natural stratum as the sunflower seeds (Crites 1993:146), a fuller description or characterization of the Late Archaic occupation of the Hayes site is not available.

Cloudsplitter (*15Mf-36*)

Situated about 100 m upslope from a semipermanent stream that flows 250 m southward to join the Red River in Menifee County, Kentucky, the Cloudsplitter rockshelter extends 55 m along a westerly facing overhang that protects an area of about 15 m in width (Cowan 1984:315; Cowan et al. 1981). Although relatively few intact Late Archaic deposits were uncovered during the site's excavation in 1978 because of disturbance both by subsequent Early Woodland period occupations and modern vandalism, a 35-m^2 area along the back wall of the shelter yielded evidence of a number of intermittent occupational episodes between 4500 and 3000 BP. A surface hearth, a basin-shaped pit, and a few ash lenses were uncovered, along with three post molds that suggested a small enclosed area near the rear wall of the overhang.

The archaeobotanical assemblage from Late Archaic contexts at Cloudsplitter is dominated by nuts, with various hickory species and black walnut accounting for 90% of the nuts recovered (Cowan 1984:338). In addition to the seeds of a range of wild plant species, five domesticates are represented in low numbers: bottle gourd, *C. pepo* squash, marshelder, sunflower, and chenopod. Several uncarbonized and well-preserved thin-testa fruits of domesticated chenopod recovered during excavation yielded a direct AMS calibrated intercept of 3700 BP (Smith and Cowan 1987; table 1). White-tailed deer dominated the faunal assemblage, followed by turtles, small to medium mammals (e.g., raccoon, squirrel, opossum), and turkey. With lithic debris reflecting retouch of tools rather than manufacture, a relative lack of formal tools, a limited number of features, and the absence of any evidence of forest clearance, Cloudsplitter was identified as reflecting a pattern of repeated short-term seasonal (likely fall) occupational episodes during the Late Archaic as part of a seasonal round that involved larger and longer-occupied river valley settlements (Cowan 1984:359–364).

Setting the Stage: Middle Holocene Environmental Change and River Valley Stabilization

The Late Archaic sites briefly described above span more than 1,500 years and are scattered across a large geographical area of eastern North America. In addition, with the exception of Riverton, they have yielded only limited information regarding the way of life of their inhabitants. At the same time, however, they all do reflect a range of shared characteristics and fit a general overarching profile that comes into clearer focus when viewed within a broader environmental and cultural context.

To a considerable extent, the answer to why plant domestication in eastern North America lagged behind a number of the other centers of domestication worldwide by 4,000 years or more can be found in the "prerequisite" Mid-Holocene climatic and environmental changes that reshaped the interior river valley landscapes of the region. By about 6500–6000 BP, many of the river systems across the interior midlatitudes had shifted from an Early Holocene pattern of episodic pulses of sediment removal and river incision to a sustained phase of aggradation and stabilization (Knox 1983; Schuldenrein 1996: 3, 9–10; Smith 1986:22–23; Styles 1986), resulting in the for-

mation of river valley meander belt topography with associated oxbow lakes and backswamps along some stream courses and shallow-water and shoal habitats in others. This shift in seasonal stream flow patterns and the stabilization of river valley landscapes in turn resulted in a significant increase in the abundance and diversity of floodplain plant and animal resources available for human exploitation, while at the same time an apparent decrease in effective precipitation resulted in a deterioration of upland resources (Schuldenrein 1996; Smith 1986:24). Not surprisingly, these changes in river valley and upland environments were accompanied by a broadscale intensification of human occupation of river and stream valley corridors (Brown 1985). As Joseph Schuldenrein (1996:3) notes, the Mid-Holocene was the "'window of adjustment' during which postglacial environments stabilized, stream channels adjusted to renascent floodplains, hill and slope sedimentation rates diminished, and critical resource zones emerged," and human societies "mapped onto" these favorable resource and subsistence zones.

The stabilization and resource enrichment of river valley corridors was not uniform across the eastern woodlands, however, and outside of this interior midlatitude riverine zone, Mid-Holocene climatic and environmental changes were quite different (Schuldenrein 1996; Smith 1986). While meander belt systems were established in many of the tributaries of the Mississippi River by 6000 BP, for example, such is not the case in the lower alluvial valley of the Mississippi, where open swamps emerge on the margins of prograded deltas (Schuldenrein 1996:9). In addition, within the interior midlatitude riverine zone, substantial and sustained "mapping" onto river valley corridors does not appear to have been universal, nor does it reflect any filling in or "packing" of these enriched resource zones (Claassen 1996:240–242; Smith 1986: 22).

The Geographical Range and Floodplain Niche of Eastern Domesticated Seed Plants

Just as the Mid-Holocene emergence of stable and enriched river valley landscapes within the Mississippi River catchment plays a significant prerequisite role in the timing of the initial domestication of seed plants in eastern North America, the geographical range and habitat of their wild ancestors is also of obvious importance in delineating the region where initial domestication took place. In general, the present-day geographical range of the wild species from which the eastern domesticates were derived is fairly well established. Using modern distribution data to estimate the ca. 5000-BP geographical range of the wild ancestors of the eastern lineage of *Cucurbita pepo* squash, sunflower, marshelder, and *Chenopodium berlandieri* is complicated, however, by a range of factors. Principal among these is the extent to which natural river valley habitats and plant communities have been altered because of post-Columbian human impacts and introductions of exotics on the one hand and the well-documented propensity of the species in question to both hitch a ride on human transport and to invade and colonize both natural and anthropogenic disturbed soil situations (Smith 2006*b*) on the other. In addition, the taxonomies of *Chenopodium*, *Iva*, and *C. pepo* in eastern North America remain challenging at the species level, making the use of modern distribution studies sometimes problematic.

Surveys carried out in the 1980s document the present-day distribution of *C. berlandieri* and *Iva annua* in riverine habitats across much of the oak-savannah and oak-hickory forest regions shown in figure 1 (Smith 2006*b*), and neither species grows today with any frequency south of the fall line onto the Atlantic coastal plain, west into the plains, east into the Appalachians, or very far north into the Northeast or Great Lakes. Similarly, free-living populations of *C. pepo* var. *ovifera* have been located growing in riverine settings in many areas of the oak-savannah and oak-hickory forest regions, as well as down onto the coastal plain (Smith 2006*b*), and the extent to which the distribution of this wild cucurbit extended into the Northeast remains a topic of considerable interest (Fritz 1999). Although the sunflower has a geographical range that encompasses a broad area of North America, present-day wild populations along the western edge of the oak-savannah forest zone in figure 1 have been identified as the specific and sole source of all modern domesticated sunflowers (Rieseberg and Harter 2006).

At the same time that Mid-Holocene river valley stabilization and enrichment were important in determining when plant domestication occurred in eastern North America and the geographical distribution of wild progenitors within the resource-rich river valley corridors of the oak-savannah and oak-hickory forest regions played a role in determining where domestication occurred, the answer to why some plants were domesticated and not others can be found, to a considerable degree, in the functional ecological profile of the wild progenitors (Bogaard et al. 1999; Charles, Jones, and Hodgson 1997). Three of the four species brought under domestication in eastern North America—marshelder, chenopodium, and *C. pepo* gourds—are floodplain "weeds," aggressive pioneers of the disturbed and exposed soil situations created on an annual basis by spring floods (Smith 2006*b*). Their abundant seeds (a single *C. berlandieri* plant can produce 50,000 seeds; a single *C. pepo* plant can produce 5,000) are dispersed by floodwaters, and they colonize the sandy banks and backwater margins that are exposed each year by receding floodwaters within the constantly shifting landscape of river floodplains. Early successional species, they cannot compete with other plants for long in undisturbed locations, but frequently they can be found in recently disturbed floodplain soil situations, both natural and man-made (e.g., construction sites, backyard gardens, dumps, fields lacking herbicides, etc.). As a result, all three are preadapted in a number of respects to both flourish in garden plots created for them and provide a sub-

stantial return at minimal cost if humans play the role of dispersal agent and scatter their seeds in areas naturally exposed by receding floodwaters (Smith 2009*b*). The substantial expansion of "natural" stands by casual scattering of seeds of all three of these floodplain weeds into appropriate exposed soil settings, described up into the 1700s in Louisiana (Smith 2006*b*, 2009*b*), may have considerable time depth in the region, along with a number of other niche construction efforts by human societies in eastern North America (Smith 2011), and may have paved the way to the establishment of more permanent and stable garden plots.

In contrast, while the sunflower frequently grows in disturbed soil settings in river valley landscapes and generally conforms to the floodplain weed profile of the other three eastern domesticates in that it is also an early successional species favoring open disturbed soil settings, it can be found thriving in many locations where the other three would not grow. Like marshelder, chenopod, and *C. pepo*, however, sunflower was well adapted to take full advantage of the new growing opportunities that humans would offer.

The Societies That Domesticated and Cultivated Eastern Seed Plants between 5000 and 3400 BP and Developed a Crop Complex by 3800 BP

Briefly described above, the seven archaeological sites that have yielded all of the archaeobotanical evidence for the domestication and cultivation of seed-bearing plants in eastern North America before 3400 BP extend over a considerable span of time and a sizable geographical area. They also vary considerably in terms of the amount of information each has provided regarding the way of life of the societies that occupied them. In spite of these challenges of space and time and variable archaeological information, however, it is possible to develop a general profile of these Late Archaic period societies.

In large part, this is possible because of the broadscale patterns of continuity in material culture assemblages, settlement types, and subsistence patterns that characterize the Late Archaic societies that occupied the midlatitude riverine environments of the oak-savannah and oak-hickory forest regions (Emerson, McElrath, and Fortier 2009). These societies are often partitioned in space and time by phase designations (e.g., the Riverton phase, the Titterington phase), which group together sites that are geographically and temporally close to each other and that have similar material culture assemblages. As more sites are excavated and larger material culture inventories become available for comparative analysis, phase designations often become more tightly bounded in terms of the geographical areas and the time spans they encompass. In the oak-savannah and oak-hickory forest regions during the Late Archaic, phase designations at the present time are rather large in scale, and opinions differ regarding how and where to draw phase boundaries in both space and time (McElrath 1993:150). To some extent, the relatively large size of these Late Archaic phases and the different opinions regarding where to draw phase boundaries is a reflection of limited available archaeological information. But it also indicates that while exhibiting geographical variation in diagnostic artifact categories (primarily projectile points), these societies were also generally quite similar in terms of their stable long-term adaptation to eastern deciduous forest ecosystems: their technology, their economies, their annual cycle, and their settlements all follow the same general pattern.

Technology

With the exception of the Mount Nebo phase of northwestern Missouri and adjacent states at the western edge of the oak-savannah forest zone, which has yielded small sherds of fiber-tempered ceramics of uncertain vessel forms (Reid 1983:29–32), none of the Late Archaic (5000–3400 BP) societies of the oak-savannah and oak-hickory forest regions had pottery vessels. Cooking was done over open fires or in pits using heated stones (as reflected by abundant fire-cracked rock and basin-shaped features). Artifact assemblages are dominated by chipped-stone tools and debitage, with chert and quartzite raw material used to manufacture a wide range of formal and expedient hunting and processing tools, including bifacially flaked knives, drills, and spear points (the bow and arrow was not present in the east during the Late Archaic), along with unifacial end scrapers and side scrapers. Groundstone tools include heavy-duty three-quarter-grooved axes; manos; and hammer, grinding, and nutting stones. Bone-tool assemblages, when preserved, are dominated by white-tailed deer skeletal elements, including ulna awls, metatarsal and humerus fleshing tools, antler projectile points and flakers, and bone pins. Of the seven sites briefly described above, Riverton provides one of the largest and most comprehensively described artifact assemblages; Howard Winters's (1969) landmark functional analysis of both lithic and bone-tool categories offers an excellent general profile of Late Archaic technology. Numerous other more recent comprehensive analyses of assemblages from Late Archaic sites have also been published (e.g., Cook 1976; Emerson, McElrath, and Fortier 2009; Fortier 1984). Other material culture categories, including basketry and cordage, are preserved only occasionally in dry rockshelters and caves (Fritz 1986; Scholtz 1975).

Settlements

Riverton also provides one of the best windows on what the settlements of the societies that cultivated seed plants in eastern North America between 5000 and 3400 BP looked like. The unit X block excavation exposed a grouping of 10 roughly rectangular clay floors ranging in size from 100 to 200 ft^2 that are thought to have supported small house structures (fig. 2).

Numerous shallow-basin-shaped pit features, a few hearths, and sheet-midden deposits were associated with the Riverton clay floors, along with abundant artifact assemblages. Clay floors of similar size and suspected function have been described at Middle and Late Archaic period sites across the eastern United States, and, along with more infrequently documented post mold patterns, they provide evidence of habitation structures that were relatively small and that did not reflect a substantial investment of labor (Sassaman and Ledbetter 1996).

In the far more frequent absence of any evidence at all of house structures in Late Archaic contexts, the spatial signature of basic domestic units (likely extended families) usually consists of a cluster of pit and hearth features (Fortier 1983). Determining the number of such family units that made up a settlement is complicated by a number of factors. Frequently, as was the case at Phillips Spring, Napoleon Hollow, Riverton, and Hayes, excavation does not expose the full extent of the occupation. In addition, even when there is little overlap or superposition of feature clusters, it is difficult to determine which features (and family units) were present contemporaneously as opposed to reflecting sequential habitation episodes over a number of years. At the same time, the overall areal extent of Late Archaic settlements can be misleading in that river valley topography can play an important role is determining site boundaries. The overall size of the Riverton site, for example, may in large part be dictated by the areal extent of Groundhog Hill, on which the settlement was located. In contrast, the Go Kart North site, just east of St. Louis, dating to 4000 BP and like Napoleon Hollow, assigned to the Titterington phase, was situated on a topographically unconstrained bank of what was an active stream channel and extends linearly for more than 175 m, leading Thomas Emerson to suggest that, floodplain topography permitting, Late Archaic groups moving through an annual cycle may return not to specific points on the landscape but to more general "locales" (Emerson 1984:343–344; Emerson and McElrath 1983).

Go Kart North, which is the only fully exposed Late Archaic settlement in the interior Riverine midlatitudes, also provides clear evidence of Late Archaic settlement structure (Fortier 1983). Even though it extended for more than 175 m along the edge of the Hill Lake Meander and included 131 discrete hearth and pit features and lithic activity areas organized into four discrete and "socially segmented" clusters, it is characterized not as a large settlement of any duration but rather as a short-term seasonal occupation involving a relatively limited range of activities, including animal butchering, food preparation, and lithic manufacture.

To add to the difficulties often inherent in establishing the number of basic domestic units that make up a Late Archaic settlement at any one point in time, it is also difficult to establish whether settlements were occupied year round on a permanent basis or annually during certain seasons of the year. There are a wide variety of different seasonality indicators that can be employed to establish what part of the year a site was occupied, but other than substantial evidence of cold-season house structures (which are lacking at Late Archaic sites), there are no good indicators of a settlement being occupied during the winter.

Taking into consideration all of these potential complications in describing any individual Late Archaic settlement in detail (including the seven sites that have provided the earliest evidence of domesticated plants in the region), a number of generally similar settlement pattern models have been proposed over the past 4 decades that, while relatively low in resolution, are still of considerable interpretive value and are reasonably applicable to many of the Late Archaic phases of the oak-savannah and oak-hickory forest regions (Smith 1986: 24–25). These settlement systems encompass two different settlement types, the larger of which can be labeled the "river valley base camp." Situated on lower terraces of river and stream valleys, base camp settlements are sometimes characterized as permanent year-round settlements or more frequently as semipermanent to permanent, summer-fall, low-water seasonal occupations reoccupied on an annual basis over long periods of time by a number of related extended families. Phillips Spring, Napoleon Hollow, Riverton, and Hayes could be placed in this general settlement category based on their river valley location and occupational history.

During the season of the year when the lower terrace location of these base camps was subject to flooding or isolation by rising waters, groups are thought to have moved into the uplands, either to nearby functionally distinct valley-edge wet-season residential base camps (e.g., Robeson Hills; Winters 1969) or smaller dispersed short-term occupation sites occupied by a single extended-family unit. Marble Bluff, Cloudsplitter, and Newt Kash fit this settlement profile. Short-term limited activity settlements could also, of course, be located in river valley locations (e.g., Go Kart North), and both base camps and shorter-term sites could vary considerably in duration, range of activity sets, and number of domestic units from year to year.

One of the most interesting aspects of the larger semipermanent to permanent multifamily river valley base camp settlements is the lack of any internal organizational structure above the level of extended-family domestic units. Artifact assemblages, feature clusters, and structural evidence (clay floors, post mold patterns, when present) all show little differentiation across settlements, and while some linearity and adjacency can be discerned in the patterning of domestic unit placement, there is no evidence of centrality (e.g., integration around a central shared or corporate open area), nor is there any indication of storage above the extended-family level. This picture of associated but largely autonomous extended-family units is also reflected in corporate mortuary sites (Charles and Buikstra 1983:121–122), which when present both indicate sustained long-term shared "ownership" of a society's resource catchment area and the absence of any within-group ascribed status differentiation.

This is a rather homogeneous picture of generally similar technology, societal organization, settlements, and seasonal rounds over a broad geographical area and with phase boundaries defined largely in terms of variation in the shape of projectile points and the presence or absence of other distinctive tool types. It is also evident in the subsistence economies of Late Archaic societies within the oak-savannah and oak-hickory forest regions.

Subsistence Economies

The Late Archaic societies that first domesticated and cultivated eastern seed-bearing plants in the interior midlatitudes of eastern North America between 5000 and 3700 BP shared what was in many respects a very similar basic subsistence economy. White-tailed deer was the single most important prey species, and it invariably dominates faunal assemblages from Late Archaic sites. This is not surprising in that this species combines large body size with a very high reproductive potential (Smith 2009*b*), and it is the primary prey species in faunal assemblages in the region throughout the Holocene. In sites with good bone preservation, smaller mammals—including raccoons, opossums, rabbits, and squirrels—are also frequently present in Late Archaic faunal assemblages, as well as turkey. Not surprisingly, river valley settlements with good preservation also contain abundant evidence of fish and freshwater bivalves, as well as waterfowl. In situations where preservation and recovery are good, this basic pattern of faunal utilization can be expanded, and the finer-grain differences between Late Archaic economies in different parts of the oak-savannah and oak-hickory forest zones come into clearer focus (Phillips and Brown 1983; Styles and McMillian 2009).

In a similar manner, Late Archaic sites throughout these oak- and hickory-forest regions have archaeobotanical assemblages invariably dominated by carbonized acorns and nut fragments of hickory and black walnut (Simon 2009). Representing an abundant and highly nutritious food source that can be stored for a year or more, hickory and black walnuts and acorns occur in varying frequency in plant assemblages across the region, with acorns more abundant at Phillips Spring, for example, in the oak-savannah forest zone and black walnut predominating at Riverton, with Yarnell (2004) discussing the excellent habitat the Wabash River Valley represented for this species. As Munson (1986) suggested more than 3 decades ago, it is possible that human niche construction efforts involving the selective culling of forest trees to encourage nut- and mast-bearing species, which is well documented in the early historic period (Foster, Black, and Abrams 2004), may have deep time depth in eastern North America (Smith 2009*b*, 2011) and may extend into the Late Archaic.

Although seeds of a wide variety of different species have been recovered from Late Archaic contexts—particularly of fruits, including grape, persimmon, hackberry, and plum—overall seed counts are invariably low. Differential preservation likely plays a role to some extent in the low seed-to-nut ratios documented in Late Archaic archaeobotanical assemblages across the interior midlatitudes (Johannessen 1984), but it is also clear that human utilization of plant resources was relatively narrowly focused, with a concentration on hickory and walnuts, along with acorns, which could be gathered, processed, and stored over long periods with a minimum of effort (Ash, Ford, and Asch 1972:27–28).

Regional Interaction

Given the relatively limited importance of seeds generally in the diet of Late Archaic societies in the interior midlatitudes and the substantial distances that separated the settlements that have yielded early evidence of domesticated plants, it would be reasonable to wonder how, exactly, the seeds of domesticates were moved from society to society. There is no clear answer to this question beyond the simple suggestion that

> the exchange networks that moved information, innovations, various raw materials, and finished artifacts around the Southeast [and adjacent areas] during the 5000–2500-BP time period apparently consisted of innumerable multidirectional, reciprocal, down-the-line exchanges between trading partners (often lineage leaders) of both nearby and distant communities. (Smith 1986:30)

The extent to which settlements within the oak-savannah and oak-hickory forest regions were linked by these complex webs of interaction is reflected in the broad geographical distribution of a range of different artifact forms, most notably projectile points but also including a number of other categories of objects. By mapping the geographical distribution of distinctively carved and engraved bone pins, for example, Richard Jefferies (1996:228) has recently outlined a "lower Ohio–central Mississippi Valley interaction network" that he argues "defines a socially bounded area extending over several hundred kilometers of the midcontinent, within which groups of increasingly sedentary hunter-gatherers interacted and exchanged information that facilitated their survival." While the area outlined by Jefferies includes both the Riverton and Napoleon Hollow sites (fig. 3), a similarly regionally scaled discussion by Cook (1986) outlines an area of interaction based on shared hafted biface types that in turn encompasses three archaeological phases (Titterington, Sedalia, and Nebo Hill; fig. 3) and includes the Napoleon Hollow and Phillips Spring sites. Dale McElrath (1993:150) concludes that "it seems likely that the Titterington-Sedalia-Nebo Hill cultural entities interacted to a significant degree and can be viewed as representing a culture (TSN culture)." McElrath (1993:150) also notes the occurrence of the distinctive Benton projectile point at the Titterington phase Go Kart North site in the American Bottom, indicating a clear link to other Late Middle Archaic and Late Archaic sites across the Southeast that have yielded Benton points, including the Hayes site.

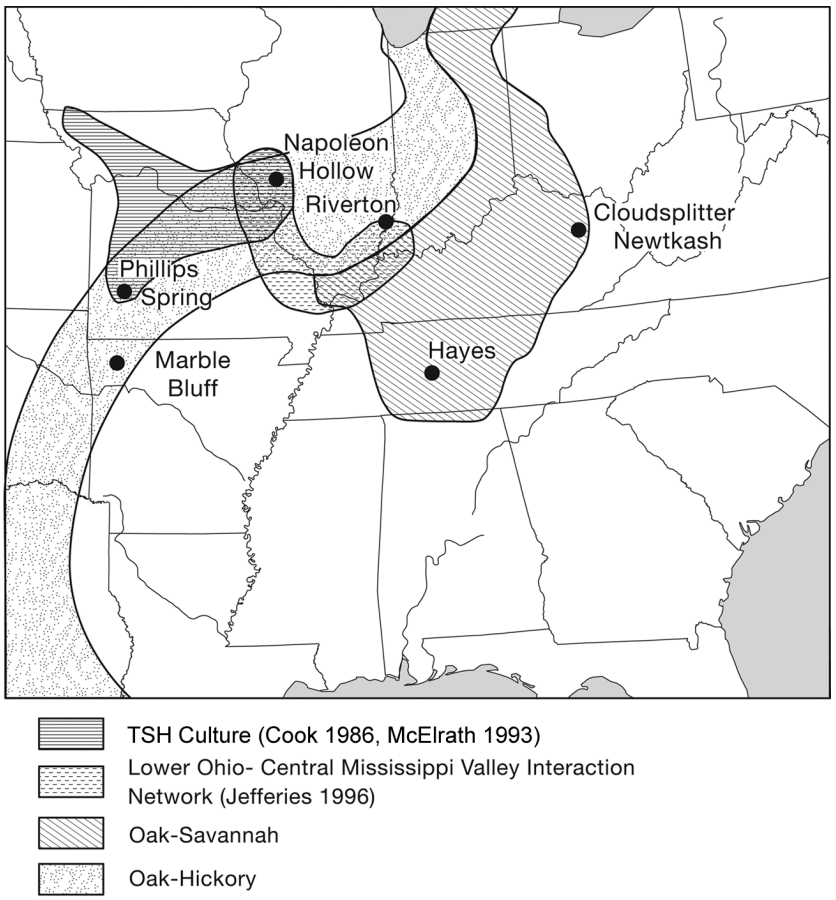

Figure 3. Location of Archaic period interaction zones identified by Cook (1986) and Jefferies (1996).

Although linked by a number of artifact forms (and archaeologists), Phillips Spring, Napoleon Hollow, Riverton, and the Hayes site span a considerable period of time and space, and such linkages are meant not to suggest either direct or contemporaneous interaction between these settlements but rather to indicate that the societies in question were all involved in broadscale networks of simple down-the-line interaction and exchange that existed over long periods of time. People and ideas, as well as seeds and other lightweight commodities, moved along these networks in ways that are as yet not very well understood. But it does seem clear that between 5000 and 3500 BP, the oak-savannah and oak-hickory forest regions were inhabited by a large number of small autonomous societies, some if not all of which were experimenting to various degrees with the cultivation of local seed plants and sharing their success and failure, as well as their seed stores, along well-established networks of interaction.

Summary Discussion

Eastern North America provides a rare opportunity to view the very earliest stages of a transition from hunting and gathering to food production, to look at the societies involved in the initial efforts to domesticate local species and the subsequent emergence of a coherent crop complex (Smith and Yarnell 2009), and to consider the general cultural and environmental contexts of this major shift in human history. As this period of initial experimentation with domestication comes into clearer focus in the other independent centers of agricultural origin worldwide, it will certainly be interesting to compare these as yet less well-documented developmental trajectories with what is known about the societies that domesticated seed plants in eastern North America.

In the oak-savannah and oak-hickory forest regions of the East, the initial domestication and early cultivation of indigenous seed plants (ca. 5000–3400 BP) were carried out by small-scale societies, each consisting of perhaps a half dozen or more related extended-family units. Situated along and tethered to the second- and third-order tributary river valley corridors of the Mississippi River catchment, these societies followed an annual cycle that linked multiple-family-unit

semipermanent to permanent settlements in river valley locations with a range of other short-term multiple-family and single-family river valley and upland occupations.

Clay floors and post mold patterns, along with spatially discrete feature clusters, provide occasional glimpses of the spatial structure and size of these settlements, which lack any indication of ascribed status differentiation or corporate organization above the level of extended-family domestic units. The relative frequency and within-site distribution of a range of different chipped-stone, groundstone, and bone tools allows for the identification of different activity sets, from lithic and bone-tool manufacture and maintenance to food processing.

Although a large range of different species of plants and animals have been identified in the archaeobiological assemblages of these settlements, their subsistence economies were generally comparable over a broad area of the interior riverine midlatitudes in terms of centering on a limited number of plant resources (e.g., hickory, walnut, oaks) and a consistent list of terrestrial animal species and species groups, including the white-tailed deer, several smaller terrestrial species (e.g., turkeys, raccoons, rabbits, squirrels), and aquatic resources (bivalves, snails, and fish). Although seeds of a variety of different species played a small role in the economy of these groups, based on consistently low seed/nut ratios, the initial domestication and early cultivation of local species did take place within their river corridor natural habitat zones rather than in upland settings based on the earliest recovery of all four eastern domesticates from river valley settlements (table 1). Subsistence economies remained stable over long periods of time, reflecting general long-term successful adaptations to the resource-rich river valley corridors of the oak-savannah and oak-hickory forest regions. These societies may have been modifying their environments in a range of different ways, from differential culling of trees to expanding natural stands of floodplain seed plants and establishing "orchards" of fruit- and berry-producing species, and initial domestication of eastern seed plants could well have taken place within a broader behavioral context of human niche construction (Smith 2007, 2009*b*, 2011).

There has been considerable discussion over the past several decades about the extent to which population growth during the Late Archaic period resulted in the filling up or "packing" of eastern North American landscapes. This, it is argued, resulted in a reduction in resource catchment zones and increased territoriality and competition over resources, which in turn resulted in a range of adaptive responses, including, perhaps, the domestication of plants (Brown 1985; Jeffries 1996; Smith 1986). Alternatively, I would argue that even though site density certainly increases in the Late Archaic and corporate cemeteries and deep-midden deposits reflect the establishment of long-term human utilization and "ownership" of sections of river valley corridors and adjacent uplands, the case for landscape packing and resource competition playing a causal role in plant domestication has yet to be made. Claassen (1996) makes a major point in this regard, observing that there are many resource-rich river and stream valley settings in the region that did not witness substantial human occupation during the Late Archaic period. If human population growth led to an increase in human occupation of river valleys and greater competition over resources, why do some valley segments remain empty? Similarly, why do subsistence economies remain stable and generally comparable over long time spans and across geographical areas? In addition, in a number of areas where extensive surveys have documented the size and spacing of Late Archaic river valley settlements having a long history of occupation, resource catchment zones turn out to be quite substantial. The three large river valley settlements identified by Winters in the Wabash Valley that make up the Riverton culture, for example (Riverton, Swan Island, Robeson Hills), are spaced at 10-mi intervals, and he estimates that the resource catchment area on one side of the river for all three settlements was 500 mi^2 (Winters 1969:110).

The debate about the role of population growth, landscape packing, and resource in the initial domestication of plants and animals worldwide will no doubt continue for a substantial period of time. I would argue, however, that eastern North America, arguably the best-documented regional case study currently available, does not provide much support for general models, including those of human behavioral ecology (Smith 2009*a*) that incorporate environmental downturn, external environmental stress, population growth, landscape packing, constricted resource zones, and carrying-capacity imbalance or resource scarcity in explaining the initial domestication process. Based on the archaeological information now available, small societies in eastern North America first domesticated local seed plants and developed initial crop complexes in resource-rich river valley environments within a larger context of stable long-term adaptations and broad-scale niche construction efforts that were carried out in the absence of any carrying-capacity challenges or seriously compressed and compromised resource catchment areas. It is interesting in this regard to reconsider the discussions of the role resource-rich environments and initial domestication made more than 15 years ago by Price and Gebauer (1995).

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