CADDO AGRICULTURE ON THE WESTERN FRONTIER OF THE EASTERN WOODLANDS

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Tropical cultigens were adopted and used by the Caddo peoples and their ancestors beginning perhaps 2,000–2,500 years ago on the western frontier of the eastern Woodlands. These cultigens were not adopted as an agricultural package, but came to the Caddo at different times and places, first being squash (ca. 2000–2500 B.P.), then maize (several varieties, ca. 1150 B.P.), and last beans (ca. 650–700 B.P.). Oily and starchy seeds appear to have comprised only a minor aspect of Woodland or Caddo subsistence pursuits in this region. A Caddo diet more dependent on domesticated plants is documented in the archaeological record only after ca. 650 B.P. With intensification, lands were abandoned along the western Caddo reaches while complex Caddo political communities developed in others.

This paper discusses what is known—or what we think we know—about the nature of agriculture among Caddo societies in prehistoric and early historic times. By Caddo, I mean the southern Caddo language-speaking groups, such as the Kadohadacho, Hainai, and Nabedache, that lived from at least as early as ca. 1150 B.P. to as late as the 1830s in eastern Oklahoma, southwestern Arkansas, northwestern Louisiana, and eastern Texas (Rogers and Sabo 2004: Figure 1). Painting with a broad brush, it appears to be the case that tropical cultigens were adopted and used by the Caddo peoples and their ancestors beginning perhaps 2,000–2,500 years ago on the western frontier of the eastern Woodlands (Figure 1), primarily in what is now eastern Texas. This includes the environmentally sensitive Post Oak Savannah and Pineywoods of the Temperate Forest.

These cultigens were not adopted as an agricultural package, or domesticated in the Caddo archaeological area, but came to the Caddo at different times and places, first being squash (possibly as early ca. 2000–2500 B.P.), then maize (several varieties, ca. 1150 B.P.), and last beans (ca. 650–700 B.P.). Oily and starchy seeds apparently comprised only a minor aspect of Woodland and/or Caddo subsistence pursuits in this region, but this was not necessarily the case across the entire Caddo archaeological area, and certainly not in eastern Texas Caddo sites. A Caddo diet more dependent on domesticated plants is documented (primarily by stable isotope data and selected flotation analyses) in the archaeological record only after ca. 650 B.P. With intensification, lands nearer to the Post Oak Savannah and tall grass prairie habitats were eventually abandoned while complex Caddo political communities developed in others. The fullest elaboration of maize agriculture took place in riparian and broad alluvial valleys within the western Gulf Coastal Plain, especially among Caddo groups living in the Red and Ouachita River valleys, where there was an abundance of arable alluvial soils suitable for cultivation.

The Caddo that lived along the western boundaries of the eastern Woodlands were subject to climatic variation and agricultural risk (e.g., Early 2004; Perttula 2005). Short-term and long-term climatic fluctuations (Figure 2) would change the

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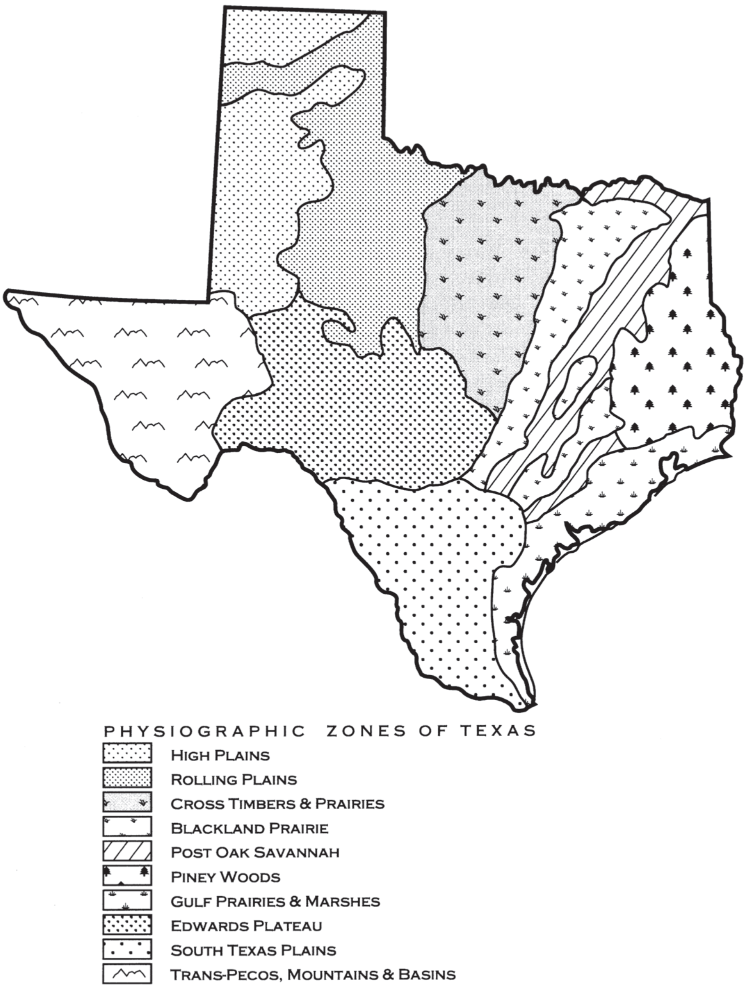

Figure 1. Vegetation zones of Texas.

prairie-woodland border areas are the regions most susceptible to agricultural risk and crop failure.

Agricultural subsistence based on maize has certain characteristics that make it more susceptible to environmental changes: (1) the increasing productivity of maize is frequently accompanied by higher crop variability and yield instability; (2) a decreasing genetic and phenotypic diversity; and (3) any localization or limitation in areas resulting from the establishment of an agroecological niche increases its susceptibility to exogenous factors like short-term differences in rainfall and weather conditions, resulting in variations in levels of productivity. The destabilizing effects of climatic fluctuations probably would be reflected in regional and temporal differences in the establishment and development of an agricultural agroecology. There may also have been changes in agricultural techniques and/or the intensity of controlled environmental modification to maintain these specific niches, as well as the abandonment of less suitable habitats within the local environment (cf. Perttula 2005).

level of risk and range of options of Caddo farmers. Agricultural societies would have faced periodic droughts, especially along the prairie-woodland border.

Short-term climatic variability would have an effect on the range and frequency of anomalous climatic extremes, but would not have had a permanent impact on the feasibility of agricultural production. Long-term climatic variability (i.e., a drought that lasted more than a few years, and increasingly dry conditions) would effect the local environment and the reliable production of crops grown by Caddo peoples in impacted regions. The

Bellwood (2005:247, 250) suggests that the arrival of maize agriculture among the Caddo led to the expansion, and eventual dispersal, of Caddo peoples in the eastern Woodlands and Great Plains. On the basis of historical linguistics and the appearance of maize-terms in Caddo proto-languages, agricultural adoption and dispersal may have taken place about 2,000 years ago, if not earlier (i.e., 3,200–3,500 years ago). Whatever the merits of Bellwood's farming dispersal hypothesis, it does seem probable from the archaeological evidence reviewed herein that ancestral Caddo people along the western part of the eastern Woodlands were beginning to adopt and use domesticated plants about 2,000–2,500 years ago.

Ethnographic accounts of Caddo plant utilization (Griffith 1954; Rogers and Sabo 2004; Swanton 1942) indicate that the Caddo peoples living in east Texas and along the Red River in Louisiana grew two varieties of maize, six varieties of beans, squash, sunflower, and tobacco as well as the European introductions of watermelon, peaches, and pomegranates (Blake 1981; Swanton 1942:127–134). While maize, beans, and squash were apparently the mainstays of historic Caddo subsistence (see Jones 2005), wild plant foods were also collected, including hardwood nuts, seeds, and greens. Like other Southeastern U.S. tribes (see Scarry and Scarry 2005), the Caddo grew crops in small family plots as well as in larger communal fields, storing the harvests in household granaries.

Because floral preservation is generally poor in the acidic soils of the Caddo area, the consideration and interpretation of prehistoric Caddo subsistence until recently rested more on the fortuitous recovery of subsistence remains (primarily maize), the available ethnographic information compiled by Swanton (1942), and analogies to Mississippian subsistence reconstructions (e.g., Milner 2004; Pauketat 2004), than on a systematic study of the Caddo archaeological record itself. Fortunately, recent research on a number of prehistoric and early historic Caddo sites has been directed towards the development of a regional subsistence data base (especially paleobotanical), and to the utilization of techniques such as flotation to maximize the recovery of subsistence remains. Yet, the relative utilization and contribution of domesticates, and models that account for the development of agricultural economies, remain to be assessed and tested within any one region of the Caddo area. As pointed out by Story (1981:152) some years ago:

> The Caddoan area is neither environmentally or culturally homogenous. Different processes could have been in operation simultaneously and it must be established, not assumed, that the sequence of culture change in one locale applies to another.

Only by means of the development of a series of regional research efforts, and a focus on the investigation of the appropriate archaeological resources, will processes of cultural and subsistence change become more evident. Local developmental sequences cannot be generated easily over different parts of the Caddo area, and therefore require supporting data and sufficient temporal control to insure investigation of short and long-term changes in the archaeological record.

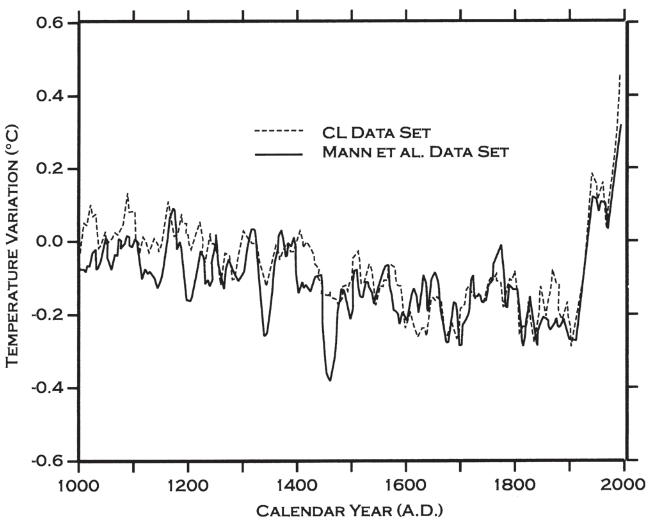

Figure 2. Reconstructed temperature variation, A.D. 1000–2000, after Mann et al. (1998) and Crowley (2000).

It is interesting that Story (1981:148) estimated that the contribution of maize to the Caddo diet in prehistoric times was "conservatively to have accounted for at least 30–40 percent of the diet." This would be in line with the current inference that the Caddo had an agricultural subsistence strategy. However, rarely have quantifiable data been presented to support the estimate, nor is it stated if this estimate pertains to the entire length of the prehistoric Caddo tradition (in east Texas) or to a particular segment of that lengthy Caddo occupation of the region. Archaeological evidence discussed below suggests that it is not until after ca. 550 to 650 B.P. that agricultural subsistence strategies are to be found among the east Texas Caddo.

There is a need to investigate the development of agricultural subsistence strategies within the Caddo area as a whole employing a uniform approach. Were there common prehistoric developmental and adaptive strategies present within the Caddo area? Lacking direct, regionally comprehensive, and systematically acquired dietary evidence (e.g., Rose et al. 1998), what does the paleobotanical evidence from different localities suggest about the timing of agricultural adoption by Caddo peoples, or about the diversity in subsistence strategies across the area?

PLANTS GROWN AND CULTIVATED BY THE CADDO INDIAN PEOPLES

With the ever-increasing flotation of sediments from feature fills and trash midden deposits on prehistoric and early historic Caddo sites (Figure 3), a wide suite of plant foods were grown and cultivated by Caddo peoples (Table 1). This includes the important cultigens maize, common bean, and squash, as well as bottle gourd, oily seeds (namely sumpweed and sunflower), and starchy seeds, including chenopod, knotweed, amaranth, maygrass, little barley, and in a few instances in southwestern Arkansas Caddo sites, panic grass (see Fritz 1993; Powell and Lopinot 2000). The same range of plant foods are documented in prehistoric eastern North American sites dating before as well as after ca. 1050/1150 B.P. (Smith and Cowan 2003:117–122).

Maize is by far the most common cultigen identified on prehistoric and early historic Caddo sites, although its ubiquity varies considerably both spatially and temporally. The types of races of maize grown are a matter of some doubt, principally because few whole cobs tend to be recovered from features on Caddo sites. But paleobotanical researchers have identified Eastern Eight-Row (also known as "Northern Flint") and Midwestern Twelve-Row in collections, and generally speaking the maize has been grouped with Eastern Complex corn (see discussion in Goldborer 2002:84–85).

Beans of several different sizes and kinds have been documented in Caddo sites. At the burned ceremonial structure at the Kuykendall Brake site (see Figure 3), Fritz (1997a) suggests that the more than 600 beans recovered there may have been white navy beans—not the more common kidney beans—and "it is possible that navy beans, given their white color, were chosen to be placed in the ceremonial structure for ritual or spiritual reasons" (Powell and Lopinot 2000:203). Beans are much more commonly recovered in post-fourteenth century Caddo sites on the Red and Ouachita rivers than they are elsewhere in the Caddo area. Nevertheless, we know that maize, beans, and squash were the principal crops among the Caddo peoples living in northeastern Texas in the late seventeenth century (Foster 1998:236, 244). Joutel commented in 1687 that the Nasoni Caddo produced large crops of beans, but that the Caddo did "not make much effort in preparing them; for them it suffices to put them in a large pot, without even removing the strings, then they cover

Figure 3. Caddo sites with well-studied paleobotanical assemblages.

Table 1. Plant Foods and Other Plants Grown and Cultivated by the Caddo Indian Peoples as Seen in Various Post-1050–1150 B.P. Archeological Sites.

Cultigens	
Maize	*Zea mays*
Common bean	*Phaseolus vulgaris*
Squash/pumpkin	*Cucurbita* cf. *Pepo*
Bottle Gourd	*Lagenaria siceraria*
Watermelon	*Citrullus lanatus*
Starchy Seeds	
Chenopod	*Chenopodium berlanderi*
Knotweed	*Polygonum erectum*
Amaranth	*Amaranthus hypochrondriacus*
Maygrass	*Phalaris caroliniana*
Little Barley	*Hordium pusillum*
Panic grass	*Panicum* sp.
Oily Seeds	
Sumpweed	*Iva annua var. macrocarpa*
Sunflower	*Helianthus annuus var. macrocarpus*

the beans with vine leaves until they are almost cooked" (Foster 1998:237).

The squash found on Caddo sites (and Woodland period sites of earlier ages) would have been used as edible flesh (cut into strips) and seeds, and would also have been useful as containers. Other cultivated plants of this kind would include the bottle gourd, pumpkin, and various cucurbits.

The chenopod (harvested in the fall), amaranth, knotweed, sumpweed, and sunflower are clear cultigens that exhibited obvious morphological signs of domestication (i.e., increasing seed size and/or thinner seed coats); these seeds do not occur with regularity on Caddo sites anywhere in the larger Caddo archaeological area. The maygrass, little barley, and panic grass also appear to have been cultivated, based primarily on their occurrence in large numbers at some sites, but they exhibit no such morphological distinctions. Powell and Lopinot (2000:205) suggest that panic grass may be an element of "the native seed complex" in Arkansas Caddo sites, primarily because it commonly occurs in prehistoric sites in the American Bottom in southwestern Illinois (cf. Johannessen 1984).

REGIONAL AND TEMPORAL DIVERSITY IN THE IMPORTANCE OF CULTIVATED PLANT FOODS AMONG THE CADDO

Given the known importance, both prehistorically and in historic times, of the cultigens maize, beans, and squash to the diet of the Caddo peoples, one of the most critical aspects of the plant husbandry system is that these plants were transported and introduced from habitats (probably from the Southwest or even from the eastern United States) where they had been initially incidentally domesticated into an existing Caddo agroecology. Evidence from east Texas and elsewhere suggests that tropical cultigens were introduced independently and sequentially, and that processes of adaptation were gradual.

However, the change to an agricultural subsistence strategy in the Caddo archaeological area, as well as much of eastern North America (see Milner 2004:Figure 62), was not entirely contingent upon the introduction of new or different cultigens. It was not until some 500 to 1,000 years after the initial introduction of maize in the general area, that it became a staple. Furthermore, while native plants such as sumpweed and sunflower were used for a long time before maize was being grown, it was not until after agriculture based on tropical domesticates developed that these native domesticates received their greatest use.

Therefore, it is important in discussing both native and tropical plant species that the period of introduction, and/or morphological changes in plants indicating domestication, be kept separate from the coeval and sequent processes of adoption and dependence upon domesticates in the diet of aboriginal peoples. Discussions of origins and times of initial appearance of plant foods are, of course, important when considering the evolution of the plants that are used in agricultural systems, but of less significance for the purpose of evaluating changes in subsistence strategies. As a result, the fact that the domesticated staples of late prehistoric life were introduced tropical domesticates is of lesser consequences than the ways by which they became the staples. It is necessary to review preceding Late Archaic and Woodland strategies of plant husbandry in the Caddo area (at its broadest extent) to evaluate the continued development of native plant husbandry after ca. 1150 B.P. and the place of Caddo prehistoric plant husbandry in this process.

Pre-2500 B.P.

For this period, evidence of plant husbandry is basically restricted to sites in the Arkansas Ozarks. During the Late Archaic period in this area, a most significant innovation in subsistence strategies may have taken place, that of the introduction and use of domesticated cucurbits and bottle gourds in the Midwest. Both squashes and gourds were used primarily for containers or net floats (Bellwood 2005:175; Fritz 1999:424, 426) but also apparently for food. The squash and gourd zone at Phillips Spring, Missouri, for instance, is dated ca. 4260 B.P., about the same time as the gathering and probable cultivation of native oily and starchy seeds such as sumpweed, chenopod, maygrass, and sunflower (Gremillion 2004; Scarry 2003). Increases in the achene size of sumpweed and sunflower from dry shelter deposits and fecal remains also suggest that some morphological changes in seed size were a manifestation of human - plant interaction and that:

> the prehistories of sunflower and sumpweed involved parallel sequences of continuing change from essentially wild or weed forms to developed cultigens forms which were part of the Mississippian plant husbandry complex (Yarnell 1978:297).

Even with the apparent domestication of sumpweed and sunflower in the Late Archaic period, their representation in paleobotanical assemblages implies a dietary contribution less than the small seeded annuals of the starchy seed species goosefoot, maygrass, and erect knotweed, particularly after 2500 B.P. Nut fragments, however, represent the most common and frequent plant food class in Late Archaic assemblages across east Texas based on carbonized remains from midden contexts or from burned rock features (see Rogers 2000; Story 1985). In paleofecal specimens from Salts Cave, Kentucky, dated between 2240–2765 B.P., sunflower, chenopod, sumpweed, hickory, maygrass, and squash and gourd made up almost 90 percent of the total plant remains found, with sunflower and chenopod estimated to be the most abundant plant foods (Yarnell 1969:Table 7).

It was sumpweed seeds and seeds from other species (e.g., sunflower, chenopods, and ragweed) excavated by Harrington (1924) from northwest Arkansas Ozark bluff shelters that initially suggested certain native North American plants were cultivated and domesticated by aboriginal peoples (Gilmore 1931; Jones 1936). This is not to suggest that these plants were staples of the Late Archaic diet, for it is evident that it was not until after ca. 1500 B.P. that their major utilization began. What is indicated is that by the Late Archaic period certain aboriginal peoples had a plant husbandry system that was probably based on the utilization and domestication of small-seeded annuals (e.g., Fritz 1986a).

While sumpweed and sunflower species domestication appears to be marked by seed size increase, the starchy seed complex is marked more by changes in plant distributions and agroecological niches. However, there does appear to be some evidence for morphological expressions to genetic alteration in indigenous starchy seed species, especially among the chenopods. Morphological changes in chenopods are towards a thinner and lighter seed coat (Fritz 1986a) that is difficult to distinguish from the later Mexican introduction *Chenopodium berlandieri* ssp. *Nuttalliae* (Fritz 1984, 1990).

Summarizing the available evidence from pre-2500 B.P. contexts, oily and starchy seeds were important domesticates, providing an additional set of plant foods contributing either quantities of calories, proteins, and fats, or were high in carbohydrates and calories. The vegetable oil produced by the boiling of hickory nuts is extremely high in calories (Watt and Merrill 1963). The nut resources, importantly, are relatively generalized in nutritive value since they contribute to each type of energy class under consideration. The starchy seeds are less generalized in nutritive value, but probably can be characterized as low-level energy producers prior to 2500 B.P. The large quantities of seeds found on some Midwest sites at this time period may be the product of the plant's dispersal system, but the relative quantification by weight of nuts and seeds from various locations in eastern North America suggests an increasing importance of the native starchy seed crops after 2000 B.P.

2500–1250 B.P.

There are few definite post-2500 B.P. paleobotanical assemblages in the Caddo area, and few Woodland or Fourche Maline sites appear to contain significant floral and faunal assemblages (or at least have been excavated and analyzed, cf. Schambach 2001, 2002). Yarnell's (1981) analysis of the size of sumpweed and sunflower achenes, however, in conjunction with radiocarbon dates from Ozark bluff shelters in Benton, Carroll, Crawford, Madison, and Washington counties, northwest Arkansas, indicate use of these native plants from ca. 1350–1550 B.P. to ca. 570–950 B.P. The seeds increased between 40 to 80 percent in size in this time period. Accompanying the oily seeded cultigens in a Woodland context (predating 1050/1150 B.P.) from these bluff shelters are corn, cucurbits, maygrass seed heads and other starchy seeds (Fritz 1986a).

At 41HP137 on the Sulphur River, cultivated squash rinds (whether of a native or tropical variety has not been established) were recovered in two features. Calibrated radiocarbon dates from those features ranges from 1996–2104 B.P. and 1298–1390 B.P. (see Crane 1996:718; McGregor et al. 1996). These remains represent the earliest known evidence for the use of domesticated plants in the Caddo area. Other plant species recovered at this site include hickory and acorn nutshells, and a small amount of tuber or rhizome fragments, possibly from the prairie turnip or cf. *Pediomelum* (Fields et al. 1997: Table 11). Other Woodland period components are dominated by nutshells, with limited amounts of other kinds of plant remains (Table 2). Chenopod seeds were recovered at the Herman Bellew site in the Sabine River basin, but these were not from a domesticated variety.

In Arkansas, the Edens Bluff (3BE6) Woodland period paleobotanical materials, possibly dating as early as ca. 1158–1292 B.P. or before (Yarnell 1981:58), have characteristics of Woodland assemblages elsewhere in the eastern United States, particularly in the small size of the sunflower and sumpweed achenes. The chenopod seeds from Edens Bluff further have thinner seed coats than the local plants and have truncate margins as well, resembling the later Mexican cultigen chenopod (Fritz 1986a). Their dark color suggests they may be transitional *C. bushianum* seeds from a probable genetically altered indigenous plant crop.

But what about corn? Ford notes (1981:15–16) that "corn was present in the East sometime after 500 B.C (2450 B.P.)...introduced from the Southwest across the southern Plains and into the Midwest riverine area." Yarnell (1986) is more conservative in the interpretation of the paleobotanical record, suggesting that the presence of corn prior to 1650 B.P. anywhere in the East is dubious. Current evidence indicates that maize was broadly distributed across much of the eastern U.S. after 1750 B.P. and was introduced from the northern Southwest (see Clark and Knoll 2005: Figure 13.2). According to Smith and Cowan (2003:117), "it was only after A.D. 800–900 (1050–1150 B.P.) that this introduced crop took center stage and maize-centered farming appeared across much of the East." Furthermore, "the adoption of maize in eastern North America…was not straightforward, rapid, and uniform across the region, but rather a complex, culturally-variable process" (Smith and Cowan 2003:122).

The maize introduced into the eastern United States does seem to reflect considerable genetic diversity, both because of the nature of the sources, and gradual environmental and human selection within the area itself (Cutler and Blake 1977:134–135). Ford (1981:15) suggests, therefore, that:

> With this range of variation present, it is not necessary to postulate successive introductions of new corn types. As corn was introduced into the northern latitudes, natural and cultural selection favored attributes of rapid germination

Table 2. Ubiquity Values of Selected Plant Resources from Caddo Sites in Northeastern Texas and Northwestern Louisiana.

Site	Time Period	N	Hickory	Acorn	Sumpweed	Goosefoot	Maize
Sulphur River Basin							
41HP137	Woodland	3	100.0	100.0	0.0	0.0	0.0
Hurricane Hill	Woodland	42	93	0.0	0.0.	0.0	2.4
Tick	Early Caddo	7	85.7	0.0	0.0	0.0	0.0
Spike	Early Caddo	26	69.2	3.8	0.0	3.8	0.0
Doctors Creek	Early Caddo	26	100	71.4	14.3	9.5	19.1
Thomas	Early Caddo	41	100	76.9	7.7	23.1	7.7
Hurricane Hill	Early Caddo	96	89.6	0.0	0.0	0.0	14.6
Lawson	Early Caddo	9	100	50.0	0.0	0.0	0.0
Spider Knoll	Early-Middle Caddo	26	61.5	0.0	11.5	0.0	7.7
Hurricane Hill	Middle Caddo	125	92.8	0.0	0.0	0.0	9.7
Peerless Bottoms	Late Caddo	31	100	3.2	0.0	0.0	3.2
Earspool	Late Caddo	58	50.0	15.5	0.0	0.0	24.1
Red River Basin							
Ray	Woodland Early Caddo	20	55	20	0.0	0.0	15.0
Roitsch	Middle-Late Caddo	17	76.5	35.3	0.0	23.5	47.0
Sabine River Basin							
Herman Bellew	Woodland	25	40.0	0.0	0.0	4.0	0.0
Spoonbill I	Early Caddo	2	100	100	50[a]	0.0	50.0
Taddlock	Early Caddo	24	100	100	0.0	0.0	100
Hudnall-Pirtle	Early-Middle Caddo	18	61.1	55.6	0.0	0.0	44.4
Spoonbill II	Middle Caddo	4	75	75	0.0	25.0	100
Oak Hill	Middle Caddo	175	77.7	21.1	0.0	2.3	57.7
Nawi haia ina	Middle Caddo	14	85.7	1.7	0.0	0.0	21.4
Burnitt	Late Caddo	108	N/A	N/A	N/A	N/A	30.0
Steck	Late Caddo	30	100	73.0	0.0	0.0	100.0
Big Cypress Creek Basin							
41CP408	Middle Caddo	9	66.6	0.0	0.0	0.0	11.1
Pilgrim's Pride	Late Caddo	72	66.7	8.3	0..0	0.0	41.7
Kitchen Branch	Late Caddo	20	95.0	60.0	0.0	0.0	45.0
41CP316	Late Caddo	6	83.3	0.0	0.0	0.0	33.3
Neches-Angelina River Basin							
41NA285	Early Caddo	31	54.8	0.0	0.0	0.0	0.0
41NA231	Middle Caddo	30	100.0	13.3	0.0	0.0	10.0
41NA242	Middle Caddo	23	100.0	21.7	0.0	0.0	17.4
41NA235	Late Caddo	33	72.7	3.0	0.0	0.0	6.1
41AN38	Late Caddo	45	84.4	4.4	0.0	0.0	42.2
41CE299	Late Caddo	7	42.9	0.0	0.0	0.0	42.9
Trinity River Basin							
41FT425	AD 1200–1400	40	97.5	37.5	0.0	0.0	15.0

Note: N=no. of flotation samples and plant values are percentages. Sources are Crane 1982, 1993, 1996; Dering 2001, 2002a, 2002b, 2003, 2004a, 2004b, 2005, 2007, 2008; Fields et al. 1997; Fritz 2006, 2008; Gadus et al. 2002; Goldborer 2008; Goldborer and Perttula 1999; Kelley 2005; McGregor et al. 1996; Perttula (ed.) 1999, 2005, 2007; Perttula and Bruseth 1983; Perttula and Nelson 2003; Perttula et al. 1982, 2001, 2005; Perttula, Nelson and Walters 2001; Rogers and Perttula 2004; Rogers et al. 2001; Sherman 2002, 2004.
[a]One seed reported to be *Iva annua* var. *macrocarpa*, but the rest are wild type *Iva annua*.

> in cool, moist soil and quicker maturation for a shorter growing season. There is no reason that the Northern Flint…, which came to dominate the Upper Missouri and Northeast… and which later was introduced into the Mississippi valley and the Southeast, could not have evolved in the Upper Midwest as suggested by a reduction in row number frequencies from 12- and 14-row to 8-row.

At the same time, under less stressful climatic conditions (i.e., longer growing season and minimal threat of frost), row numbers need not decrease or cob sizes increase as part of the evolution of maize (Blake and Cutler 1979). In these areas, including that settled by the Caddo, local selective pressures (including their storability) appear to have led to the maintenance of row and cob size variability in both hard flint and pop races (Midwest 12-row and North American Pop) rather than a reduction in rows like the Eastern Eight Row. As Blake and Cutler (1979:55) note:

> Under adverse growing conditions, the row number of corn ears tends to decline... It is certain that environmental stresses contributed to the development and hardiness of Eastern Eight Row by eliminating all strains in its genetic makeup not fitted to stand them... In the lack of stressful conditions, there was little to cause row numbers to decline and no need to import hardy, low row numbered corn from elsewhere.

Therefore, while systematic research into regional and temporal variation in Woodland and Caddo maize has yet to be done, the supposition of Blake and Cutler (1979) indicates that high variations in maize types might be characteristic not only of the earliest introduced maize from the Southwest into the Caddo area, but of the entire period of Caddo maize cultivation. Low average row numbers, however, might not indicate classic Northern Flints or the introduction from Mexico of the fully formed Maiz de Ocho (Galinat 1985), but only the gradual evolution of a lower row corn variety in the area.

Some of the earliest eight row corn in the eastern United States was initially identified by Jones (1949) from the George C. Davis site (41CE19) corn (see Figure 3). Dated originally at A.D. 399 $\pm$162 (1551 B.P.; C-153, corrected, calibrated age range of A.D. 25–434 or 1516–1925 B.P.), it was considered to be significant not only in terms of discussions about the cultivation of maize in the Caddo area, but was integral in the development both of the Caddo tradition and of Mississippian groups in general (Krieger 1948:158; Newell and Krieger 1949:231). Jones (1949) suggested that the George C. Davis maize resembled the Northern Flint type, perhaps originating in Highland Guatemala, rather than in North America. This particular date on maize came from a pit (Feature 31) under Mound A at George C. Davis, but has since been discredited because of (1) the early method of radiocarbon analysis (i.e., solid carbon) that tended to produce older than expected radiocarbon ages, and (2) its archaeological context (Story 1990:254). That being said, there are a few other more recently obtained radiocarbon dates on maize from George C. Davis that suggest some use of the plant before 1150 B.P.: 1163–1352 B.P. (A.D. 598–787, also from Feature 31, along with another calibrated date on maize from this feature of 731–906 B.P. (A.D. 1044–1219), 1384–1699 B.P. (A.D. 251–566 Feature 195-137 in one of the village areas), and 1416–1604 B.P. (A.D. 346–534, Feature 195-149 in the same village area as Feature 195-137)

While the paleobotanical and archaeological evidence appear to go hand in hand, subsequent examination of the Davis site samples and more comprehensive absolute dating (Story and Valastro 1977) indicates that such an affiliation is unlikely. Radiocarbon dates from the George C. Davis site suggest that the Caddo occupation there did not begin prior to 1179 B.P. (Story and Valastro 1977:67), or perhaps not until after ca. 1100 B.P. (Story 2000). While Galinat (1985) argues that 8-row corn spread to the eastern United States from northwest Mexico and the Southwest after ca. 1250 B.P., the appearance of 8-row corn at the George C. Davis site need not imply its dominance even if such an introduction could by demonstrated. Small 10- and 12-row maize was apparently the most common kind of maize at George C. Davis and throughout the Caddo area on sites of this time period where quantitative data on corn is available (Cutler and Blake 1977, 2001).

The virtual absence of maize remains from a Woodland context in the Caddo area, except for the Ozark bluff shelter materials (Fritz 1986a, 1986b), may in part be interpreted as (a) primarily the result of limited data, (b) its still relative unimportance as a crop compared to wild plant and animal resources, and (c) perhaps a lack of suitable storage facilities. The oily and starchy seeds, and the gourds, may have been the dominant domesticated crops, but even their level of utilization had yet to intensify prior to the adoption of maize cultivation. In a pre-Caddo tradition horticultural context, Fritz (1984) suggests that starchy grain crops native to eastern North America were important components of the pre-Mississippian as well as Late Prehistoric diets in the Ozarks as elsewhere. This indigenous husbandry base predated the acquisition of maize, flourished at the time of early, non-intensive maize farming and finally declined in importance as maize became the dominant staple.

The timing of the introduction and adoption of maize as a crop in the Caddo area is not precisely known. Evidence from flotation samples from some sites in east Texas (see Figure 3 and Table 2) suggests it is ubiquitous only after 1000 B.P. (Perttula and Bruseth 1983:16). In the Arkansas basin, maize is absent from sites dating prior to ca. 1050 B.P. (Fritz 1982).

Schambach (2002:105) has suggested that "corn horticulture" and/or the gardening of starchy and oily seeds may have been present in Woodland period Fourche Maline culture groups by ca. 1550 B.P. He bases this not on any analyses of plant remains from Fourche Maline sites along the Red River, but on the appearance of certain types of stone tools that he thinks may be gardening tools, perhaps hoes. Schambach (2002:106) also asserts that corn was present and being used by Fourche Maline groups around 1150 B.P., citing the early dates from the George C. Davis site that I mentioned earlier, and a single calibrated radiocarbon date of A.D. 820/840/860 $\pm$ 90 (1090/1110/1130$\pm$90 B.P.) from Feature 2 at the Ray site (41LR135) in the Red River basin (Bruseth 1998:53). Jeter [2007:176] has made the same mistaken assertion that corn was present in pre-Caddo contexts by relying on this one date. From these dates, Schambach (2002:106) assumed that late Fourche Maline-early Caddo groups "added corn gradually to their (still hypothetical) starchy and oily seed horticultural complex, which they almost certainly would have done." He goes on to suggest that corn was introduced to the Caddo area from Late Woodland peoples in the American Bottom, and that the corn may have been an accompaniment of foreign prestige goods exchanged between the American Bottom and Caddo peoples.

What Schambach has overlooked—at least in the case of the putative early corn at the Ray site—is that the corn at the Ray site has been directly dated from two features at the site, including the feature with the ninth century calibrated date on nutshell, and that it actually dates between 745–950 B.P. (Feature 2) and 730–905 B.P. (Feature 37) (Perttula et al. 2001:207 and Table 11). It is clear that the corn from the Ray site is from a later Caddo occupation, and has little relevance with regard to the early adoption and use of this cultivated plant by the Woodland ancestors of the Caddo peoples.

That the adoption of maize was not rapidly accomplished seems clear from the paleobotanical record in other areas. Its widespread utilization in the East after 1150 B.P. in the archaeological record, however, must be balanced with its low frequency within sites and features of the period, indicating other factors need to be considered in evaluating its importance. Corn may be over-represented relative to other plant remains because of its use as fuel in smudge pits. This points to the higher probability of plant preservation when the food stuff is also used as a fuel. In regions where the paleobotanical record is well known, there is at least a 200–300 year interval between when maize was introduced and when it came to dominate the plant food assemblage. Changing rates in the adoption of maize also appear to have varied according to local conditions.

The introduction of maize into an existing agroecology based on incidental native crops brought about a change in the scale of aboriginal plant husbandry (e.g., Fritz 1986a). Through time, the relative importance of maize as a crop plant increased as opposed to both native cultigens and wild plant and animal resources. Plant selection was primarily directed towards the production of energy and carbohydrate-rich starchy plant foods, of which maize is most appropriate nutritionally, and in terms of the ability to increase its productivity. The cultivation of maize also increased the agroecological niche for the more successful cultivation of other starchy plant foods. That is, while starchy seeds had been harvested and perhaps grown for several thousand years prior to the introduction of maize, it was not until the human environmental modification associated with corn cultivation became established that starchy seeds, and even oily seeds, became domesticates able to take advantage of the agroecological habitat.

The intensified consumption of starchy seeded annuals after ca. 1550 B.P. appears to be confirmed in the paleobotanical record at least in the southwestern Ozarks (Fritz 1986a, 1986b, 1990). Such is not the case in Woodland and prehistoric Caddo sites in northeastern Texas and northwestern Louisiana, where such seeds are absent in Woodland period contexts, and are minimally represented in Early, Middle, and Late Caddo (ca. 270–550 B.P.) period sites in the Sulphur River, Red River, and

Sabine River basins (see Table 2).

Even in the absence of preserved paleobotanical remains, differences in the use of ceramics on Woodland period sites in the Caddo area suggests regional differences existed in food processing (boiling of foods in vessels and a change from stone to wood preparation tools) and dietary habits, namely an increased consumption of carbohydrate-rich foods. Elevated caries rates from some Fourche Maline Woodland peoples are associated with "non-maize consuming stable carbon isotope values" (Rose et al. 1998:117), or low levels of maize consumption.

1250–550 B.P.

The most significant aspect of the paleobotanical record for this time period is the common appearance of corn in all regions of the Caddo archaeological area. Systematically collected paleobotanical assemblages indicate that the introduction and adoption (at least to some extent) of maize by Caddo peoples as a food source was generally accomplished by ca. 1050 B.P. The record of its utilization is sporadic at best prior to 1050 B.P. because only a few paleobotanical assemblages are known in detail before this period of time (e.g., Story 1990).

Paleobotanical samples from east Texas and the Ozark Highland, based on the systematic recovery of plant remains, has produced evidence of the consumption of corn as early as the ninth century A.D. in Caddo archaeological contexts. At the George C. Davis site pre-mound A (Jones 1949) and Early Village samples from features contained maize from small 8- to 10-rowed varieties. Quantification of maize remains from village excavations (Jackson 1981; Ford 1997) suggests that maize was more prevalent, however, only by the Late Village (650–900 B.P.) occupation at the site. Such a trend was also the case at the Oak Hill Village (see Figure 3), where maize ubiquity increased from 31.6 percent in the Early Village (ca. 700–800 B.P.) to 96.9 percent in the Late Village (ca. 500–575/600 B.P.) (Dering 2004a: Table 88). The relative abundance of maize was low compared to hardwood nuts throughout the Caddo utilization of this settlement. The general ratio of hardwood nutshells to maize fragments has been used as a measure of the relative importance of wild plant foods versus crops (cf. Scarry and Scarry 2005:267). There is a general scarcity of seeds from these archaeological deposits.

The cal. A.D. 779–955 (995–1171 B.P.) occupation at the Osborn site (41WD73) in the Upper Sabine basin contained maize, hickory nuts, and acorn nuts in only a limited number of flotation samples from storage pits. No other domesticates or seeds were recovered from this Formative Caddo (ca. 950–1150 B.P.) occupation (see Bruseth and Perttula 1981). Flotation at seven different Formative and Early Caddo period (ca. 750–950 B.P.) components in the Upper Sabine basin dating between ca. 600 and 1150 B.P. uniformly contain maize, hickory, and acorn plant remains in paleobotanical samples (see Table 2).

Changes in oily seed and starchy achene sizes and morphology, mean row numbers in maize, and direct radiocarbon dating of desiccated botanical remains, have been used to construct a preliminary chronology of agricultural husbandry (Fritz 1986a, 1986b, 1990, 1997b) in the southwestern Ozarks and the Arkansas basin:

Chenopod, thin-testa	ca. 2930–1960 B.P.
Chenopod, no testa (pale)	ca. 1620–785 B.P.
Amaranth	ca. 1620–920 B.P.
Knotweed, thin pericap	ca. 785 B.P.
Knotweed, thick pericap	ca. 2840 B.P.
Maygrass	ca. 2040–970 B.P.
Ragweed	ca. 2840 B.P.
Sumpweed	ca. 2980–360 B.P.
Sunflower	ca. 2840–450 B.P.
Bottle gourd	ca. 2170–785 B.P.
Maize	ca. 1470–320 B.P.

These analyses point to the likelihood that maize was being grown in the western Ozark Highland as early as ca. 1450–1550 B.P. and then through to the time of European contact. In Ozark Highland dry bluff shelters there is evidence for a much wider range of native and tropical plant utilization prior to ca. 1050 B.P. The eighth century date from Edens Bluff, and the paleobotanical remains there, are comparable with characteristic Woodland period plant husbandry remains described elsewhere in the eastern United States. Fritz's (1986a) analyses document not only the utilization of corn, but of cucurbitae, maygrass, sunflower, sumpweed, and a transitional form of chenopod that is probably a native domesticate. The thin-testa chenopod has also been documented at Middle and Late Caddo sites along the Red River (see Gardner 1997; Roberts 2004).

Trends in sumpweed and sunflower achene sizes suggest that domesticated varieties of these plants increased in size much more rapidly during the period from ca. 1050–1350 B.P. than they had during the 1250–2000 B.P. period, but not as rapidly as they did after 1050 B.P. There were generally consistent increases in sizes for both domesticated plants, particularly a three-fold increase in sunflower achene size (from 2.5 mm to 8.3 mm) between 1350–1750 B.P. and 1050–1350 B.P., compared to a doubling of sumpweed achene size changes (from 1.0 to 2.0 mm). This difference in achene size parameters is closely associated in the archaeological record with the increasing utilization of these weedy annuals (cf. Fritz 1986a).

After ca. 1050 B.P. plant exploitation patterns in the Caddo area are better known. Quantified paleobotanical remains recovered from flotation samples (approximately 1,000 samples) are available from a number of sites dating from the Early to Late Caddo periods in northeastern Texas and northwestern Louisiana (see Table 2). Consequently, there is a better basis for discussion of plant exploitation patterns than in earlier periods.

Utilization of Weeds

The most important weedy annuals utilized by Caddo groups are the oily and starchy seed complex plants. Oily seeded annuals include sumpweed and sunflower, while maygrass, chenopods, knotweed, and little barley comprise the starchy seed complex. Evidence from elsewhere in the eastern United States indicates that the starchy seeded plants, rich in carbohydrates, began to dominate oily seeds as seed crops at the same time as the widespread utilization of maize (Fritz 2000a, 2000b; Gremillion 2004; Scarry 2003). Furthermore, the relative emphasis on weeds for their seeds (and greens), whether they were oily or starchy, also took place then.

The Caddo paleobotanical record for the utilization of weeds for their seeds is consistent with these general changes in plant exploitation patterns, although the total evidence is considerably more limited outside of the northern Caddo region (e.g., Fritz 1990). From quantified paleobotanical assemblages, starchy seeds are present in quantity only after ca. 750 B.P., although they were probably utilized throughout the entire Formative and Early Caddo periods. Oily seeds dominate the Spoonbill site assemblage dated between cal A.D. 967–1160 (790–983 B.P.). Sumpweed and sunflower from that component comprise more than 65 percent of the seeds from weedy annuals present in the assemblage. In the cal A.D. 1228–1395 (555–722 B.P.) component from Spoonbill, *Chenopodium* sp. and knotweed are the only weedy annuals identified except for one sunflower achene. Measurements on the oily seeds by Crane (1982) indicate that they were non-domesticated varieties of these plants, although Crane (1996) has recently reported a domesticated variety of *Iva annua* from Spoonbill.

The seed assemblage from the Copple Mound (Spiro site, Oklahoma) flotation samples included maygrass, little barley, chenopods, and knotweed seeds that together accounted for 62 percent of all the seeds found in the 430–750 B.P. component (Fritz 1989). Fritz (1989:80–81) suggests that at this time, there was a considerable diversity in plant foods, but the only tropical cultigen was maize (a small-eared and low row-numbered variety being dominant). The subsistence strategy of the Spiro site occupants was a relatively generalized and diversified one based on the aforementioned native seeds and maize as important dietary components, supplemented by wild plant foods like nuts, fleshy fruits and greens.

At Spoonbill, the presence of seeds of morning glory and passionflower from the earliest Caddo component reflects the initial disturbance of the habitat and the natural vegetation for the cultivation of domesticated plants. These plants usually occur in close association with garden plots, old fields, and maize stalks (Crane 1982:87).

In the later occupation at the Oak Hill Village, maize and squash were the only cultigens identified by Dering (2004a). As previously mentioned, maize ubiquity increased from 31.6 percent to 96.9 percent through time, and the "rise in density suggests that maize farming increased during the late [ca. 500–575/600 B.P.] occupation" (Dering 2004a:332). Seeds of maygrass and cheno-ams were also recovered—although only in the Middle Village (ca. 575/600–700 B.P.) occupation—but they may be from wild plants.

The oily and starchy seed crops (maygrass and the cheno-ams) constituted a considerable portion of the paleobotanical remains from Formative and Early Caddo period contexts. At the sites where they are best represented, their relative abundance and presence in flotation samples outweighs that of maize. In terms of the nutritional quality and productive capabilities, the weedy annuals represent a complementary pattern of exploitation to maize since both types of plants are successful colonizers of disturbed habitat. Changes in weedy annuals are expressed phenotypically in both increasing seed size (oily seeds) and number (starchy seeds), in combination with evidence for loss of natural seed dispersal, compactness of seed heads, and the colonization of areas outside their natural habitat.

Fritz (1986a: 214–215) has pointed out that chenopods, maygrass, and sumpweed domesticates do become scarcer as maize became the most important plant food source, and other domesticates were introduced, including beans and domesticated amaranth. She (Fritz 1986a: 214–215) suggests that "as maize became what would seem to have been the most productive crop, husbandry of the previous staples appears to have become more casual. Introgression from the by then probably highly evolved weedy companions may have been permitted to the point that something akin to a gradual reversal of the domestication process went into effect."

Tropical Cultigens

Tropical cultigens grown by the Caddo peoples in the Early and Middle Caddo (ca. 550–750 B.P.) periods include maize, squash, gourd, and bean. Only the latter is not well represented in paleobotanical assemblages, and probably was not grown to much extent before 650 B.P., if not slightly later based on paleobotanical remains from Caddo sites in southwestern Arkansas (Table 3). Squash and bottle gourd were among the first tropical cultigens used by the aboriginal inhabitants of the eastern United States, and they continued to be cultivated throughout the Mississippi and Historic periods by these peoples (Gremillion 2007:393–394). Like beans, they are poorly represented in paleobotanical assemblages generally, but since they have consistently been recovered from bluff shelters in northwest Arkansas and southwest Missouri (e.g., Fritz 1986b, 1997b; Harvey 1960), their representation is probably due to better preservation conditions. Squash is very commonly recovered in Early Caddo period contexts at Cooper Reservoir sites, with ubiquity ranging from 50–71.4 percent at the Lawson, Thomas, and Doctors Creek sites (Crane 1996: Table G-

Table 3. Corn and Bean Ubiquities on Selected Caddo Sites in Oklahoma, Arkansas, and Louisiana.

Site	Age	Corn Ubiquity	Bean Ubiquity
Spiro	A.D. 890–910	18%	0%
Hanna	A.D. 1000–1300	7%	0%
Spiro	A.D. 1200–1250	100%	0%
Johnson Farm	A.D. 1215–1400	72%	0%
Standridge	A.D. 1360–1420	40%	20%
Winding Stair	A.D. 1400–1500	79%	4%
Roden	A.D. 1300–1700	67%	51%
Hardman	A.D. 1400–1700	65%	2.5%
Helm	A.D. 1500–1700	94%	5%
Joe Clark	A.D. 1650–1710	58%	0%
McLelland	A.D. 1650–1710	73%	7%

Note: Sources are Early 1988, 1993, 2000; Fritz 1982, 1989, 1993; Gardner 1997; Kelley 1997; Lafferty et al. 2000; Penman et al. 2004; Perino 1981; Powell and Lopinot 2000; Roberts 2004; Shea 1980; Stewart 1981; Williams 2000.

1), but is otherwise infrequent in Caddo paleobotanical assemblages from sites along the western boundary of the eastern Woodlands.

Although the relative abundance of the aforementioned tropical domesticates is generally sporadic, due in large measure to conditions of preservation and probable food preparation and disposal techniques, maize is common in paleobotanical assemblages. Analyses of flotation results from Caddo assemblages, however, indicate that while the utilization of maize was widespread, it was not as intensively used then as it was to become after ca. 550–650 B.P. (see Tables 2 and 3). Weights of maize in Early and Middle Caddo contexts range from less than 1 percent to only 12 percent of the total gram weights of all plant foods, and presence of maize from feature and/or flotation samples discussed rather consistently range between 20–60 percent for these Early and Middle Caddo period samples, except in the Sulphur River basin (see Table 2).

However, all measures of relative abundance commonly employed in paleobotanical research (e.g., Hastorf and Popper 1989) support the general conclusion that maize utilization was not as frequent in an overall sense as was the procurement of a wide range of wild plant foods gathered in a generalized foraging and horticultural economy. The reliance on these types of abundance measures, while not as reliable as other more direct means of dietary inference such as stable isotopes, does not dispel the fact that in comparably collected, quantified, and analyzed paleobotanical assemblages of the Early and Middle Caddo periods, maize constitutes only one of a wide range of plant resources utilized by Caddo peoples.

It does appear to be the case that the use of maize was more intensive in the eastern part of the Caddo area, namely in the Ouachita and Red River basins (see Figure 3), as well as the Arkansas River basin (Figure 4), than was the case among Caddo groups living along the western edge of the eastern Woodlands (see Table 3). This is based on ubiquity measures. In Caddo sites of different ages in northeastern Texas, maize ubiquity—with a few exceptions in the Sabine River basin—ranged from only 0–19 percent in the Sulphur River basin (with the highest percentage in ca. 750–950 B.P. contexts), to 15–47 percent in the Red River basin (with the highest percentages in post-650 B.P. contexts), to 21–58 percent in the Sabine River basin (with the highest percentages after ca. 575–600 B.P.), and to 6–45 percent in the Big Cypress and Neches-Angelina River basins (the highest percentages are in post-520 B.P. sites, with the exception of several sites in the Attoyac Bayou basin [see Perttula 2007]). By contrast, Caddo sites in the Red and Ouachita River basins in Arkansas and northwestern Louisiana dating after ca. 750 B.P. have maize ubiquity measures that range from 40–94 percent (see Table 3). After ca. 550 B.P., those measures actually range from 58–94 percent, all considerably higher than northeastern Texas Caddo sites.

As a further example of this regional diversity at this time, at Caddo sites investigated at Lake Naconiche in the Attoyac Bayou basin in deep east Texas (northeast of the Deshazo site, see Figure 3), maize was recovered in less than 10 percent of the more than 150 flotation samples from prehis-

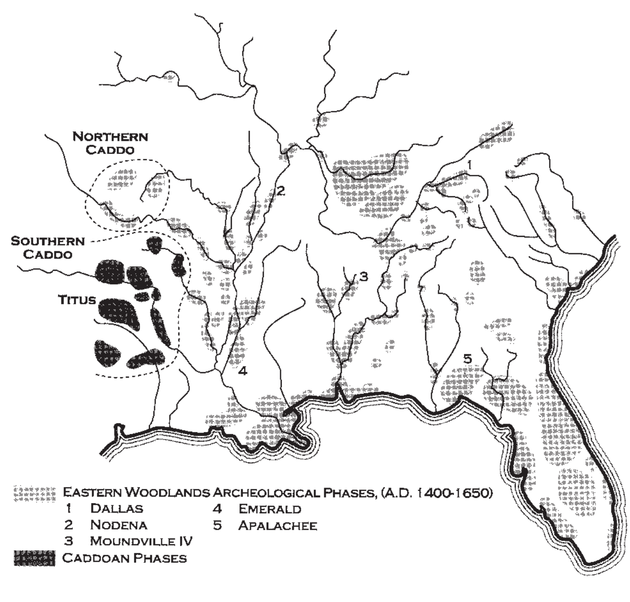

Figure 4. Caddo phases in the Caddo archeological area, divided into southern and northern Caddo groups.

toric Caddo contexts, and squash and bean were found in even lower frequencies (see Dering 2002c, 2002d; Perttula 2002, 2007). Ten miles away at Washington Square Mound and the Deshazo sites, maize was very common in features (see Corbin and Hart 1998; Ford 1982; Story 1982). At Lake Naconiche, maize, beans, and squash were found in low densities at the Foggy Fork site (41NA235) in deposits dated to cal 470–530 B.P. (range of intercepts from five calibrated dates). Only maize was found at the Beech Ridge site (41NA242), which dates from 510–660 B.P. (range of calibrated intercepts for 10 dates), and then also at the Tallow Grove site (41NA231). Calibrated radiocarbon dates for the Caddo deposits there range from 510–740 B.P. Earlier Caddo deposits at the Boyette site (41NA285; with calibrated intercepts of 670, 910, 1050, and 1280 B.P.) contained no maize or other cultivated plants in feature flotation samples (Perttula 2007).

Corn remains from Caddo sites are variable in terms of cob size and row numbers, and this is also reflected in median cupule widths between different assemblages. Cupule width of maize may be a good proxy for large kernels, and larger corn yields. That is, "corn varieties with larger cupules will tend to support larger kernels, thus resulting in greater yields" (Diehl 2005:364). In the Ozark Highlands, the earliest directly dated and measured corn (ca. 1200 B.P.) has the smallest cupule widths (4.6 mm), while the latest corn (dated after ca. 650 B.P.) have cupule widths that are as large as 8.8–11.5 mm (Fritz 1986a). This supports a trend for larger cupules and kernels over a ca. 600–700 year period. However, it is difficult to discern any temporal trends in cupule width in the Red River (see Blake 1994), Ouachita River (Cutler and Blake 2001), or east Texas Caddo sites. In the Ouachita River basin, cupule widths range from 4.3–6.2 mm, with widths peaking at ca. 550–625 B.P. Cupule widths range from 3.2–12.0 mm on Red River Caddo sites, but the largest cupules are reported for the eighteenth century Caddo maize from Roseborough Lake (Fritz 1986c). In east Texas, the largest cupule widths are also reported from a historic Caddo site, in this case the early nineteenth century Timber Hill site (Goldborer 2002; Parsons et al. 2002), while the smallest (3.2 mm) are in Middle Caddo archaeological deposits at the Oak Hill Village (Elson et al. 2004).

The very smallest corn (and hence the least productive) documented is from the non-Caddo or Prairie Caddo (cf. Shafer 2005) McGuire's Garden site in the Post Oak Savanna. Here, in contexts dated from ca. 540–660 B.P., cupule widths are 2.05–4.65 mm on cobs and 2.45–3.76 mm on loose cupules (Dering 2002a). Kibler (2005:198, 200) argues that the cultivation of maize was "a short-lived experiment" in this area, and "never played a major role in the overall subsistence."

The primary determining factor in the source of variation may be time, however, not regional or local environmental differences affecting the success of different corn varieties that may have evolved. Change in maize grown in the Caddo area is expressed primarily as a trend towards increasing the corn row size from 8-rowed to 14- and 16-rowed corn grown during Late Caddo and historic Caddo (ca. 120–270 B.P.) times (Figure 5). This may be an adaptation to the general environmental conditions of the Caddo area, particularly the long growing season, where slower maturation is possible, thereby favoring the evolution of larger-rowed maize (Blake and Cutler 1979). Another

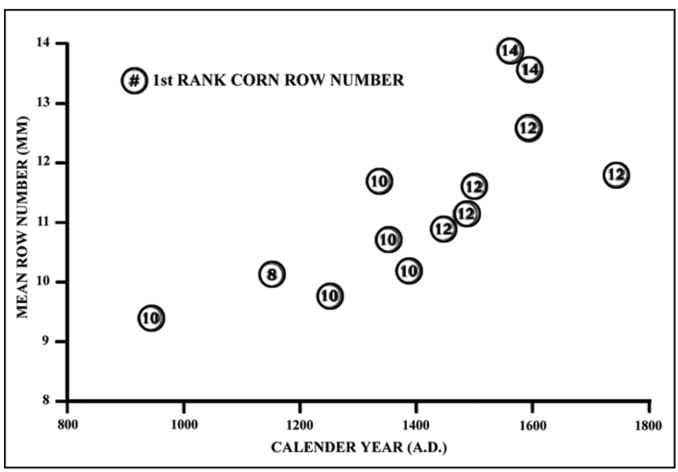

Figure 5. Trends in corn row number rank and mean row number in dated Caddo archeological assemblages (from Perttula 1990).

product of slower maturation was multiple ears of corn on single plants, and the possibility of bringing more than one crop to a successful harvest in a longer growing season. All these behavioral characteristics of maize are evidence of increasing crop productivity.

Most Caddo corn is from 10-, 12- and 14-rowed ears resembling North American Pop and Midwest Twelve Row races. These are corn varieties with small cobs and cupules, and longer than wide kernels (Blake and Cutler 1979:53).

Archaeological samples of maize dating before 550 B.P. are dominated by 8- and 10-rowed varieties. The earliest maize remains in well-studied Caddo plant assemblages with preserved cobs have the highest percentages of 8-rowed corn, amounting to between 29–44 percent of the total samples. These assemblages, of course, have the lowest mean row number values. After 750 B.P. the 10-rowed varieties are most abundant, and remain so until approximately 550 B.P. The corn grown at that time is commonly ascribed to Midwest Twelve Row, an intermediate form between North American Pop and the Eastern Eight Row races described by Cutler and Blake (2001). The 12-rowed varieties, including some examples of quite small corn (King 1984) from the Cedar Grove site, are the most common rowed varieties in Caddo assemblages dating after 550 B.P. (see also Fritz 1986c; Goldborer 2002).

These trends in the evolution of maize present clear evidence for the development of more-rowed varieties through time in the Caddo area. This information points out the basic similarity in maize variation across the Caddo area. Samples were derived from different environmental settings such as the Ouachita Mountains, the Red River and Ouachita River basins, and Arkansas basin sites, but the patterns of variation are significant only at the areal scale. These comparisons suggest that the maize varieties grown by the Caddo peoples of different regions were quite similar to one another in character, just as they are to the maize grown in the lower Mississippi Valley (Blake and Cutler 1979).

550–200 B.P.

The emphasis on weedy annuals, nuts, and a wide variety of domesticated plants in the larger Early and Middle Caddo period paleobotanical assemblages is not totally duplicated in the Late Caddo archaeological record. Instead the paleobotanical record indicates: (a) a reduction in wild plant food utilization, especially with the weedy annuals, (b) a de-emphasis on nuts, and (c) a higher relative abundance of beans, squash, and gourd accompanied by more frequent use of maize. Caddo subsistence remained geographically variable. Our best measure of the importance of maize in the diet of Caddo peoples comes from stable isotope analyses from sites throughout the Caddo area (see Perttula 1996; Rogers 1997; Rogers et al. 2003; Rose et al. 1998).

The stable carbon isotope information from sites in the southern Caddo area indicates that around 750–850 B.P. there was a significant increase in the consumption of maize, as marked by C4-enriched samples at that time. It is important to note that stable carbon isotope data are incapable of detecting consumption of maize or C4 plants until it is a major source of protein (Hart 1999:169). Later Caddo samples leveled out and reached a stasis after ca. 650–700 B.P. (Figure 6). In the

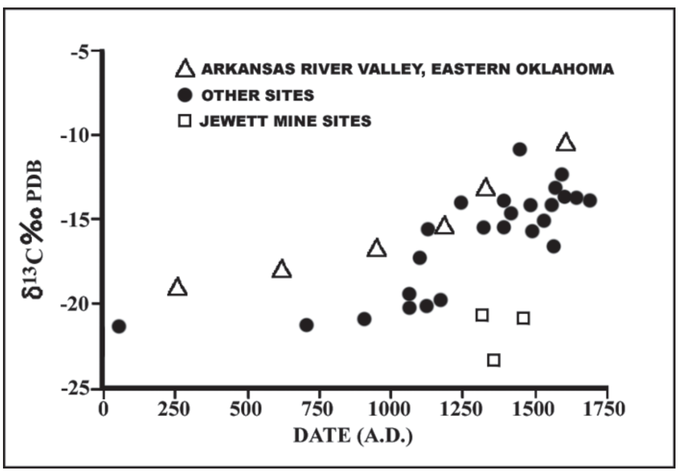

Figure 6. Stable carbon isotope analyses from various Caddo sites (other sites) in the southern Caddo area, the Arkansas River valley in eastern Oklahoma, and contemporaneous non-Caddo sites at Jewett Mine in the Post Oak Savanna of east central Texas.

Arkansas River valley of eastern Oklahoma, there was a more gradual increase in the consumption of maize through time (as well as the consumption of bison meat), with the most enriched samples dating after ca. 500–700 B.P. (Rogers 1997) and peaking during the Late Caddo Fort Coffee phase. By way of comparison to these Caddo samples, stable carbon isotope analyses of non-Caddo individuals from three contemporaneous sites (dating ca. 510–790 B.P.) at Jewett Mine (even one with maize in several features; see Gadus et al. 2002; Fields and Klement 1995; Dering 2002a) in the Post Oak Savannah have isotope values much like those of pre-950 B.P. Caddo peoples.

At the Pilgrim's Pride site in the Big Cypress Creek basin (Dering 2005; Perttula 2005), and at other Late Caddo Titus phase sites in the basin (Perttula et al. 2004; Dering 2004c, 2004d; see Figures 3–4), maize and beans recovered in feature contexts provide the best evidence for Caddo agricultural production. Nevertheless, the abundance of charred nutshells, and a high nut-to-wood ratio (Dering 2005:345), indicate that nut mast collection and processing was also an important part of the subsistence strategy. Dering (2005:345) concluded that these Caddo "clearly relied on maize-based food production as a major source of subsistence, but were not as heavily invested in plant food production as were some of the much larger regional settlements to the north and east in this part of the Caddoan archaeological area." Notably absent from these Titus phase sites is evidence for the use of oily and starchy seeds of the Eastern Agricultural Complex (Fritz 2000a; Scarry 2003).

In the Ouachita River basin, at sites occupied by the Caddo after ca. 550 B.P., such as Helm (Powell and Lopinot 2000), Hardman (Fritz 1993), Winding Stair (Williams 2000), and Standridge (Early 1988), a wide variety of wild plant and tropical cultigens have been recovered. This includes a heterogeneous mix of maize with from 8-14 rows, starchy seeds, oily seeds (including cultivated sumpweed from Kuykendall Brake), squash/gourds, and beans. Mean maize row numbers increase through time, from 10.2 rows at ca. 750–850 B.P. to 11.2 rows from ca. 415–500 B.P. This trend is consistent with the result of environmental and human selection towards many-rowed crops.

The seventeenth century Joe Clark and McLelland sites along the Red River in northwestern Louisiana (see Figure 3) had high-rowed maize, beans, squash, cultivated sunflower and sumpweed (Gardner 1997:116), as well as maygrass, and chenopod. None of the seeds of the Eastern Agricultural Complex are abundant (a total of 109 seeds were found at both sites). Gardner (1997:116) suggests that the thin-testa domesticated chenopod from the two sites represents a cultivated small grain described among the Natchez in the early eighteenth century. At the Belcher site (see Figure 3), deposits of charred corn cobs (12 row and 16 row) were found on the floor of seventeenth century Belcher phase houses, along with persimmon seeds, beans, black walnut, and hickory nuts (Webb 1959:179–180).

Beans are abundant in this same set of Late Caddo sites (see Table 3), and the size of the beans are consistent with selection for increasing seed size and plant productivity. Length to width ratios of bean seeds from these sites range from 1.60 for ca. 750–950 B.P. components, to 1.73–1.77 on Caddo sites dating from ca. 350–550 B.P. Beans from historic Indian sites dating after 350 B.P. are even larger, with ratios of 1.84–1.90 (Blake and Cutler 1982: Table 3). Measurable cotyledons of beans from elsewhere in the Caddo area are limited, but the length/width ratios are consistent with the trends noted in the Ouachita River basin. Beans from the Washington Square Mound site in Nacogdoches County, Texas, dated at ca. 600/700 B.P. (Corbin and Hart 1998), have length/width ratios of 1.60 (Gennett 1983). Those from an Early to Middle Caddo period context at Beaver Pond Bluffs have length/width ratios of 1.55 (Fritz 1986b: Table 14).

In general, these changes regionally may be marked by a reduction in the number of domesticated plants used as staples, with an increasing reliance on one or a few species of plants in a specialized subsistence strategy. This focus on one or a few plant species may have resulted in the displacement and/or differing use of other wild and cultivated plants that had previously been important parts of the diet. The selective effects of increasing productivity in these few species resulted in the relative proportional use of these resources at the expense of the displaced resources.

The relative percentage of nutshell remains in Late Caddo period paleobotanical samples ranges between 57–60 percent of the total plant weights, compared to estimates of 87–100 percent in previously mentioned Early and Middle Caddo assemblages. The same types of plant species were harvested by Caddo populations, but the importance of the harvesting was changing through time. Any major increase in maize productivity relative to the potential productivity of wild plant foods—as well as to weedy annuals with a less inherent capacity for productivity increases compared to maize—would mean a reorientation of plant husbandry and associated wild plant foraging activities. Thus, this characteristic of maize would have a positive influence on its fitness. Changes in preparation techniques, storage methods (i.e., a shift to above-ground granaries to save seed for the following year's crop and for maintenance of the food supply for 1–2 years) or harvesting strategies, may also have been critical in Caddo efforts at maize intensification. Archaeological evidence from sites in the Red, Sabine, and Big Cypress basins point to a change from below-ground storage pits to above-ground granaries after ca. 575/600 B.P. (Perino 1981; Perttula 2005; Rogers and Perttula 2004; Trubowitz 1984). These granaries are also documented in the ethnohistorical records as the primary means of food storage used by the Caddo peoples.

The utilization of the weedy annuals of the oily and starchy seed complex was also adversely affected by changes in the role of maize in Caddo subsistence. In the Ozark Highland bluff shelters where the evidence of their use is best preserved, the archaeological record indicates a very minimal use after ca. 600 B.P. (Fritz 1986a).

The ethnographic and ethnohistorical data on the Caddo utilization of wild and cultivated plant foods is a record of the primary use of maize, beans, and squash (Swanton 1942), including up to six varieties of beans and squash as well as sunflower and tobacco. There is no archaeological or paleobotanical evidence of the use of tobacco, which is difficult to recover because of the small size of the seeds. At least two varieties of maize were described by Europeans as grown by the Caddo, but paleobotanical evidence from Late Caddo and Historic period occupations (see Ford 1982; Goldborer 2002; King 1984) suggest that the varieties mentioned by the Europeans actually referred to differences in harvesting strategies rather than to physical differences in the maize itself. Eight- 10-, 12-, 14- and 16-rowed varieties of North American Pop, Midwest 12 Row, and Eastern 8 Row races were present and being cultivated during those periods of time.

SPECIAL STUDIES OF MAIZE ON EAST TEXAS CADDO SITES

As part of a study of the age of maize on Caddo sites in east Texas, I have been investigating the spatial and temporal trends in the stable carbon isotope values of maize (Table 4). These trends likely reflect differences in the kinds of maize being grown by the Caddo over time and across the region. Another contributing factor may be the result of environmental differences (particularly precipitation changes from east to west across the region) or larger-scale environmental changes through time, especially after ca. 500 B.P. (see Perttula 2005: Figure 2-4; see also Figure 2, this paper) when the region experienced drier conditions. For instance, Blake and Cutler (2001) have noted that under adverse growing conditions, the row number and size of corn ears tend to decline, which would influence the character of the maize being grown and harvested. Dering (2004a:332) has suggested that the variability in the corn being grown at the Oak Hill Village site not only reflects the variability in the kinds of corn being utilized, but that "maintaining separate types of corn may have been a risk-reduction strategy, because planting several different cultivars would require placing them in separate fields in order to prevent cross-pollination. Such a strategy would improve the chances of getting a good crop yield in years when some fields were flooded or rainfall was spotty."

At the Oak Hill Village, the different rowed maize varieties (8, 10, 12, and 14 rows from the same feature) have different isotope values (ranging from –10.0 o/oo to –11.9 o/oo), and the higher-rowed varieties are C4 enriched compared to the 8- and 10- rowed corn (Elson et al. 2004:Table 94). This suggests that the 12- and 14-rowed maize was harvested by the Caddo at the end of the growing season, taking advantage of the full growing season to produce a mature plant with multiple ears, while the 8- and 10-rowed maize

Table 4. Caddo Sites in East Texas with Directly-dated Maize Samples.

Site No.	2 sigma calibrated age range	C13/C12 value	Biotic Zone
41CE19	A.D. 783–1021	-10.26 o/oo	Pineywoods
41CE19	A.D. 891–1030	-10.06 o/oo	Pineywoods
41CE19	A.D. 971–1160	-11.98 o/oo	Pineywoods
41CE19	A.D. 1027–1194	-10.42 o/oo	Pineywoods
41CE19	A.D. 1048–1278	-11.77 o/oo	Pineywoods
41CE19	A.D. 1175–1288	-11.81 o/oo	Pineywoods
41CE19	A.D. 1182–1291	-10.10 o/oo	Pineywoods
41CE299	A.D. 1476–1652	-14.5 o/oo	Pineywoods
41CP220	A.D. 1410–1470	-11.2 o/oo	Pineywoods
41CP304	A.D. 1025–1290	-12.8 o/oo	Pineywoods
41CP304	A.D. 1395–1635	-10.5 o/oo	Pineywoods
41CP304	A.D. 1401–1652	-10.1 o/oo	Pineywoods
41CP304	A.D. 1420–1655	-9.3 o/oo	Pineywoods
41CP304	A.D. 1436–1640	-9.5 o/oo	Pineywoods
41CP304	A.D. 1449–1674	-10.9 o/oo	Pineywoods
41CP304	A.D. 1451–1678	-9.2 o/oo	Pineywoods
41HE139	A.D. 1320–1480	-11.6 o/oo	Pineywoods
41HE343	A.D. 1440–1640	-11.93 o/oo	Pineywoods
41NA242	A.D. 1300–1430	-10.0 0/oo	Pineywoods
41PN149	A.D. 1435–1660	-12.9 o/oo	Pineywoods
41RK4	A.D. 1010–1175	-9.4 o/oo	Pineywoods
41RK4	A.D. 1040–1220	-10.1 o/oo	Pineywoods
41RK170	A.D. 1260–1430	-9.6 o/oo	Pineywoods
41RK214	A.D. 1030–1290	-10.1 o/oo	Pineywoods
41RK214	A.D. 1040–1400	-10.0 o/oo	Pineywoods
41RK214	A.D. 1057–1294	-12.8 o/oo	Pineywoods
41RK214	A.D. 1280–1405	-11.2 o/oo	Pineywoods
41RK214	A.D. 1280–1405	-11.9 o/oo	Pineywoods
41RK214	A.D. 1301–1392	-13.2 o/oo	Pineywoods
41RK214	A.D. 1305–1393	-9.9 o/oo	Pineywoods
41RK214	A.D. 1305–1403	-12.3 o/oo	Pineywoods
41RK214	A.D. 1315–1421	-9.5 o/oo	Pineywoods
41RK214	A.D. 1315–1421	-9.7 o/oo	Pineywoods
41RK214	A.D. 1315–1421	-10.3 o/oo	Pineywoods
41RK243	A.D. 1263–1409	-9.3 o/oo	Pineywoods
41FT425	A.D. 1290–1410	-8.6 o/oo	Post Oak Savannah
41HP106	A.D. 1249–1285	-10.7 o/oo	Post Oak Savannah
41LR135	A.D. 990–1056	-11.8 o/oo	Post Oak Savannah
41LR135	A.D. 1044–1184	-12.1 o/oo	Post Oak Savannah
41LR135	A.D. 1049–1220	-11.6 o/oo	Post Oak Savannah
41SM273	A.D. 1290–1410	-9.6 o/oo	Post Oak Savannah
41TT653	A.D. 1545–1635	-11.4 o/oo	Post Oak Savannah

Note: Sources are Bruseth and Perttula 2006; Cliff et al. 2004; Dering 2002a, 2002b, 2004e, 2004f; Gadus et al. 2002; Goldborer and Perttula 1999; Haskins and Walters 2001; Perttula 1999, 2005, 2007; Perttula and Nelson 2003, 2004; Perttula, Nelson, and Walters 2001; Perttula et al. 2001, 2005; Rogers and Perttula 2004; Sherman 2001, 2002; Story 1990.

may have been harvested as the "little" crop earlier in the year, probably before the summer. One previously dated maize cob from the Oak Hill Village had a C13/C12 isotope value of –12.3 o/oo, and may have come from a 10-rowed cob (see Table 4).

At the present time, 17 different sites in east Texas—including one site (41FT425) that does not appear to have been inhabited by prehistoric Caddo people (Gadus et al. 2002), unless they were Prairie Caddo (see Shafer 2005)—have radiocarbon dates directly on maize where delta C13/C12 isotope values have been obtained. These sites occur in the Red, Sulphur, Big Cypress, Sabine, Neches, Trinity, and Angelina stream basins, and in the Post Oak Savannah and Pineywoods. These samples range in age from as early as 929–1167 B.P. (2 sigma) at the George C. Davis site (41CE19) to as late as 272–499 B.P. (2 sigma) at the Pilgrim's Pride site (41CP304). Most of the dated maize samples fall after 750 B.P. (Table 4).

The stable carbon isotope values range from a very C4 enriched –8.6 o/oo at the McGuire's Garden site (41FT425), well in the Post Oak Savannah in the Trinity River basin, to -14.5 o/oo at the Late Caddo period occupation at 41CE299 near Jacksonville, Texas. Most of the sites have C13/C12 values on maize samples that range between –10.0 o/oo and –12.0 o/oo (see Table 4).

Using sites with more than one date on maize, the most enriched samples occur at Hudnall-Pirtle (41RK4) between 730–940 B.P., at the Pilgrim's Pride site (41CP304) between 272–555 B.P., and in Late Village contexts (between 529–645 B.P.) at the Oak Hill Village. All three sites are situated in the Pineywoods and have mean C13/C12 values between –9.74 o/oo and –9.9 o/oo.

The one Post Oak Savannah Caddo site with multiple maize samples—Ray (41LR135), dating from 730–960 B.P.—has less C4-enriched maize than the previously mentioned Pineywoods sites, with a mean value of –11.83 o/oo . Another Pineywoods site, namely George C. Davis, has mean values of –10.68 o/oo for mean calibrated dates ranging from 849–1022 B.P. and –11.23 o/oo for mean calibrated dates ranging from 664–815 B.P. on maize samples.

The considerable spatial and temporal variation in the stable carbon isotope values of maize samples from Caddo and non-Caddo sites in east Texas—in combination with the different isotope values obtained on the 8-, 10-, 12-, and 14-rowed row maize from a single feature at the Oak Hill Village site (see Elson et al. 2004: Table 94)—is intriguing. Does this mean that different varieties of maize were grown by different Caddo populations living in east Texas, some favoring 8 and 10 rows, and other groups favoring the 12- and 14-rowed maize, as part of a risk-minimizing effort? At this time, and given the limited number of maize dates from only a few east Texas archaeological sites, we simply do not know. Perhaps these stable isotope values on maize from sites in the Pineywoods and Post Oak Savannah are also reflective of subtle environmental differences across the region, resulting in depleted or enriched stable isotope values in a C4 pathway plant at different times and places depending upon the amount of moisture, sunlight, and drought (water stress) conditions in local environments. Detailed paleoenvironmental data from the east Texas region may hold one key to interpreting the variability in maize stable isotopes on Caddo sites (cf. Perttula 2005), as will continued archaeological research on prehistoric and historic Caddo sites that have preserved maize samples.

CONCLUDING COMMENTS

In my view, tremendous variability existed among Caddo populations through time and across space in their agricultural practices, their food production success, as well as their absolute dependence upon cultivated foods in the diet. A wide array of cultigens were grown—including the tropical cultigens corn (*kish-sih* in Caddo), beans (*bah-hey*), and pumpkin (*coo-nooh-cah-ke-cus-neh*)—as well as various oily and starchy seeds, among them chenopods/lambsquarter (*bah-ha-tse*), sunflower (*bah-hun*), sumpweed, and maygrass. The Caddo also talk of the *e-ha-si-nai*, a wild tuber that was found in northwestern Louisiana and east Texas (Newkumet and Meredith 1988:33). The Caddo believe all these plants are gifts from the earth that "they were to hold and use for their benefit. The two gifts most closely associated with the earth were corn and pumpkin" (Newkumet and Meredith 1988:30).

The available archaeological and paleobotanical evidence recovered from Woodland and prehistoric/historic Caddo sites suggest that these plants were most intensively used beginning after around 1050/1150 B.P. A number of them had been grown and used for at least a millennium before that. By 1050/1150 B.P., the Caddo lived in complex sedentary communities. Intensive food production strategies, however, became most important across almost all of the landscape occupied by the Caddo after about ca. 650/750 B.P. As tropical cultigens became the dominant crops, the other plant foods were much diminished in use and eventually were no longer grown.

The Caddo agricultural strategies and economies (based on domesticated plants and various wild plant foods) were resilient and flexible, and developed surely to suit the changing environments and seasons along the western frontier of the eastern Woodlands, and as part of their critical understanding of the rhythms of growth. The Caddo believe they came into the world carrying the seeds of corn and pumpkin. To paraphrase Mooney (1896:1094): they held fast to their things and have never thrown them away.

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