Analysis of Plant Remains from the Macon County Airport Site

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Report Submitted to TCR Garrow Associates, Inc.

Table of Contents

Appendices provided in separate MS Excel files:
Appendix A (Flotation data by feature)
Appendix B (Flotation data by sample/bag number)
Appendix C (Macrobotanical/Handpicked data by sample)
Appendix D (Complete sample inventory)

Introduction

Archaeological plant and animal assemblages represent only a small fraction of what was originally used and deposited by humans in open-air settings. Natural and cultural factors can significantly modify organic remains, resulting in recovered assemblages that differ dramatically from the original deposits. As archaeologists, we examine collections that have undergone a series of processes—from the original selection of plants and animals by humans, to food preparation, cooking, discard, animal and insect scavenging, burial, decay, and weathering, to the recovery of food residues by archaeologists. Using standard methodological procedures for sampling, quantification, and analysis allows us to make sense of our assemblages in spite of the deleterious effects of these processes. Here we report on the identification and analysis of the archaeobotanical assemblage from the Macon County Airport site, North Carolina, a multi-component site spanning the Late Archaic through Woodland periods (Swanannoa phase through the Late Qualla phase). We begin with a consideration of recovery issues, quantitative methods, and laboratory procedures. This is followed by data presentation, analysis, and general temporal interpretations.

Recovery and Preservation Bias

The circumstances under which plants preserve best archaeologically involve extreme conditions (e.g., exceptionally wet, dry, or cold environments) that prohibit decomposition of organic matter (Miksicek 1987). Plants can also preserve through exposure to fire, which can transform plant material from organic matter into carbon (Miksicek 1987). The likelihood that a plant will become carbonized varies according to the type of plant, how it is prepared and used, and whether it has a dense or fragile structure (Scarry 1986). Plants that are eaten whole are less likely to produce discarded portions that may find their way into a fire. Plants that require the removal of inedible portions (e.g., hickory nutshell, maize cobs) are more likely to find their way into a fire, and thus into the archaeological record. Inedible plant parts represent intentional discard that is often burned as fuel. Moreover, because inedible portions tend to be dense and fibrous, they are more likely to survive the process of carbonization than the edible parts (e.g., hickory nutshell vs. nutmeats). Physical characteristics are also important for determining whether or not a plant will survive a fire. Thick, dense nutshells are more likely to survive a fire than smaller, more fragile grass seeds. Food preparation activities also affect potential plant carbonization. The simple process of cooking provides the opportunity for carbonization through cooking accidents. Foods that are conventionally eaten raw, however, are less likely to be deposited in fires than cooked foods. Some plants that find their way into the archaeological record in carbonized form were not eaten at all. Wood fuel is the most obvious example. Other non-food plants that become carbonized are incidental inclusions, such as seeds blown by wind dispersal (Miksicek 1987; Minnis 1981; Scarry 1986). Indeed, most secondary invaders are weedy species with lots of seeds (e.g., cheno/am plants) (Minnis 1981).

While we cannot ever hope to know the absolute quantities or importance of different plants in any past subsistence economy, the preservation and recovery biases discussed above do not prohibit quantitative analyses of archaeobotanical assemblages. The most commonly used plant resources in any subsistence economy are more likely to be subject to activities that result in carbonization (e.g., through fuel use and accidental burning) and ultimately, deposition (Scarry 1986; Yarnell 1982). Thus, we can quantitatively examine the relative importance of commonly used plant resources through time and across space.

Methods of Quantification

Quantitative methods in archaeobotany have developed significantly over the past several decades, and as a result, have been a subject of much critical discussion (Hastorf and Popper 1988). The most common methods for recording and quantifying plant remains are counts and weights. Because of problems with comparability between different types of plant taxa, however, raw (or absolute) counts and weights are not appropriate comparative measures (Scarry 1986). For example, denser taxa yield higher weights than more fragile taxa, and some taxa yield higher seed counts than others (e.g., grasses versus fruits) (Scarry 1986). Thus, using absolute counts or weights to summarize plant data is highly problematic. Most archaeobotanists agree that absolute counts are inadequate for assessing past people-plant interactions in that they do not control for biases related to preservation and sampling error (Kandane 1988; Miller 1988; Popper 1988; Scarry 1986). Absolute counts and weights are simply raw, unstandardized data.

One way to avoid the problems of absolute counts/weights is through the use of ubiquity measures (Godwin 1956; Hubbard 1975, 1976, 1980; Popper 1988, Willcox 1974). This type of analysis is essentially a presence/absence analysis that sidesteps the problems of counts and weights by measuring the frequency of occurrence instead of abundance. In other words, ubiquity analysis measures the number of samples in which a taxon was identified, as opposed to the number of specimens represented by that taxon. The researcher first records the presence of a specific taxon in each sample, and then computes the percentage of all samples in which the taxon is present (Popper 1988). For example, if acorn shell is present in four out of ten samples, then its ubiquity value is 40%. Thus, each taxon is evaluated independently (Hubbard 1980). Because different types of plants are disposed of differently, direct comparisons of ubiquity values between taxa are problematic (Hubbard 1980:53). For example, a 70% ubiquity value for hickory nutshell would not be equivalent to a 70% ubiquity value for beans as these categories have different preservation opportunities—hickory nutshell represents a processing by-product often used as fuel, while beans represent edible portions.

As with any quantitative measure, ubiquity analysis has its disadvantages. A sufficient number of samples is necessary to provide meaningful results as using too few samples creates a high likelihood of sampling error. Hubbard (1976:60) suggests a minimum of 10 samples. Moreover, although ubiquity analysis may mitigate for preservation biases, it is not immune to them (Hubbard 1980:53; Scarry 1986:193). Most importantly, because ubiquity deals with occurrence frequency and not abundance, it can potentially obscure patterns where occurrence frequency does not change but abundance does (Scarry 1986). As Scarry (1986:193) notes: “the frequency with which a resource is used may remain constant, while the quantity used varies.” For example, a family may consistently eat maize on a daily basis, but the quantity they consume may vary from day to day. Despite these weaknesses, ubiquity analysis is a good starting point and can provide meaningful results when used alongside other measures.

While ubiquity measures may sidestep the problems inherent in absolute counts, it does not provide a means for calculating relative abundances of different plant taxa. Using comparative ratios is one way of determining the relative abundances of different plants. Essentially, calculating a ratio is a means of standardizing raw measures. In other words, we can deal with the problems of absolute counts and weights by standardizing them in terms of some constant variable (Miller 1988; Scarry 1986). The density measure standardizes data in terms of soil volume—the absolute count or weight of carbonized plant material (for individual taxa or for larger collapsed categories, e.g., maize kernels or maize) is divided by total soil volume for each sample or context. Density measures calculate the abundance of plants per liter of soil, and it is generally assumed that larger volumes of soil will yield more plant remains. However, differences in the context and manner of deposition between soil samples structure the relationship between soil volume and the size of the plant assemblage. For example, a 10 L soil sample from an intact house floor would probably yield a smaller sample of carbonized plant remains than a 10 L soil sample from a refuse midden, because people tend to keep their houses cleaner than their trash dumps. Thus, density measures are useful in determining feature function. Overall, ratios are useful quantitative tools that overcome some of the problems of absolute counts. It is important to understand, however, that ratios reveal only the relative importance of plants within varied depositional contexts, not the absolute dietary contribution of actual resources used in the past (Scarry 1986). For the purposes of the present analysis, we used both plant weight and soil volume to standardize the data – interestingly, both measures yielded similar patterning in the data. Thus, most of the data are presented as density measures.

Finally, the analysis presented below also uses diversity analysis (the Shannon-Weaver Index) to evaluate the richness and evenness of plant taxa in the assemblages from different temporal contexts. The Shannon-Weaver Index determines diversity based on count data, and diversity values for different assemblages are compared directly. In addition, the Shannon-Weaver diversity index (H', see below) combines both richness and evenness into a single measure. The mathematical formula is as follows (Reitz and Wing 1999:105):

$$H' = -\sum_{i=1}^{s} (p_i)(\mathrm{Log}\ p_i)$$

where:

H' = the diversity index
p_i = the relative abundance of the i^{th} taxon in the sample (for the animal assemblages, this is calculated as NISP and MNI)
Log p_i = the logarithm of p_i (this is calculated to the base 10 for both assemblages)
s = the number of different taxa represented in the sample

When comparing the diversity among different samples, higher numeric values (for H') indicate higher species diversity (Reitz and Wing 1999). Because the Shannon-Weaver index combines both richness and evenness, the diversity of one sample relative to another depends upon how richness and evenness co-vary. For example, if Assemblage A is richer than Assemblage B, but both are similarly even, then Assemblage A will yield a higher diversity value. In addition, if the categories in Assemblage C are more evenly distributed than the categories in Assemblage D, but both are similarly rich, then Assemblage C will yield a higher diversity value (Reitz and Wing 1999:105). While evenness (or equitability) is a component of the diversity index (H'), it can also be considered independently, as follows:

$$V' = H'/\mathrm{Log}\ s$$

where:

V' = equitability
H' = the diversity index (as calculated above)
s = the number of different taxa represented in the sample

Equitability values (V′) can range from 0 to 1, with a value of 1 indicating an even distribution of taxa, and lower values representing less even distributions (Reitz and Wing 1999:106)

Laboratory Procedures

Flotation samples from the Macon County Airport site were collected with variable volumes. Both the light and heavy fractions of the flotation samples were analyzed. Although the materials from the light and heavy fractions were processed and sorted separately, data from the two fractions were combined for analysis. According to standard practice, the light fractions were weighed and then sifted through 2.0 mm, 1.4 mm, and 0.7 mm standard geological sieves. Carbonized plant remains from both fractions were sorted in entirety down to the 2.0 mm sieve size with the aid of a stereoscopic microscope (10–40 X). Residue less than 2.0 mm in size was scanned for seeds, which were removed and counted; in addition, taxa encountered in the 1.4 mm sieve that were not identified from the 2.0 mm sieve were also removed, counted, and weighed. Maize cupules and acorn nutshell were also collected from the 1.4 mm sieve as these tend to fragment into smaller pieces and can be underrepresented in the 2.0 mm sieve.

Botanical materials were identified with reference to the paleoethnobotanical comparative collection at the University of California, Santa Barbara (UCSB) paleoethnobotany lab, various seed identification manuals (Martin and Barkley 1961; Delorit 1970), the USDA pictorial website (http://www.ars-grin.gov/npgs/images/sbml/), and Minnis (2003) which allowed us to identify the range of taxa native to the region. All plant specimens were identified to the lowest possible taxonomic level. Taxonomic identification was not always possible—some plant specimens lacked diagnostic features altogether or were too highly fragmented. As a result, these specimens were classified as “unidentified” or “unidentified seed.” In other cases, probable identifications were made—for example, if a specimen closely resembled a maize cupule, but a clear taxonomic distinction was not possible (e.g., the specimen was highly fragmented), then the specimen was identified as a probable maize cupule and recorded as “maize cupule cf.”.

Once the plant specimens were sorted and identified, we recorded counts, weights (in grams), portion of plant (e.g., maize kernels versus cupules), and provenience information. Wood was weighed but not counted, and no wood identification was conducted. Generally, most of the seeds identified in the samples were too small to weigh, and thus only counts were recorded. Hickory nutshell and maize remains were identified only as fragments, and were both counted and weighed. Other than counts and weights, no other measurements were taken on any specimens. In some cases, taxon counts were estimated by their respective weights. For each light and heavy fraction that yielded more than 200 specimens of a single taxon, the absolute number was extrapolated from the weight of a sub-sample of 200 specimens with respect to the weight of all specimens of that taxonomic category in the light or heavy fraction sample. The equation is expressed as follows:

$$\frac{x}{b} = \frac{200}{a} \quad \rightarrow \quad ax = 200b \quad \rightarrow \quad x = \frac{200b}{a}$$

where *a* is the weight of the sub-sample of 200 maize kernels, and *b* is the weight of the entire sample of maize kernels; *x* is the variable to solve for.

In addition to sampling a portion of the flotation samples that were sent to UCSB, we also sub-sampled selected samples that were extremely large. These samples were weighed and then systematically split using a riffle splitter; some samples were split in half and others in quarters depending on the overall weight of the sample. Counts and weights from the selected subsample were extrapolated using the total sample weight.

Basic Results

This section presents the results of the identification of the carbonized plant remains from the Macon County Airport site, which forms the basis for the quantitative analysis that follows. All tables and figures are presented at the end of the report. Plant data from flotation samples are summarized by site in Tables 1 and 2, organized by temporal period (data summary by feature is listed in Appendix A; data summary by individual sample is listed in Appendix B; a compete inventory of all flotation samples sent to UCSB indicating which ones were sampled and which were not is listed in Appendix D). Table 3 lists all taxonomic names that correspond to the common names provided in Tables 1 and 2 and throughout the report. Raw counts and weights are provided for each taxon; plant weight, wood weight, and soil volume are also provided. Macrobotanical data recovered through hand collection are summarized in Table 4 (these data are detailed by bag number in Appendix C). All appendices are provided as MS Excel files, as they are too large for formatting in MS Word.

A total of 103 flotation samples from 39 features were collected and analyzed, representing a total of 1,358 liters of soil with a total plant weight of 990.4 grams. Combined, these samples yielded 48 plant taxa, including maize, a variety of nuts and fruits, grain, oil, green and miscellaneous seeds (Tables 1 and 2). Maize (*Zea mays*), bean (*Phaseolus* sp.), squash/bottle gourd rind (*Cucurbita* sp.), sumpweed (*Iva annua*) and sunflower (*Helianthus annuus*) were the only definitive field cultigens present in the samples. Additional taxa which were likely field/garden cultigens include chenopod, amaranth, maygrass, and little barley. Maize and beans are often discussed together as they commonly represent partner crops. Whether or not they co-evolved as part and parcel of the same domestication process, maize and beans have a long tradition of inter-cropping and successional cropping in the New World (Lentz 2000). Inter-cropping maize and beans is often beneficial in that maize stalks support the bean vines throughout plant growth (Smartt 1988:149). Moreover, inter-cropping also reduces the risk of pest and disease outbreaks than in pure stands (Smartt 1988:149). Maize and beans are also complementary in terms of nutritional value; maize is deficient in essential amino acids lysine and isoleucine, which beans have in abundance (Bodwell 1987:264; Giller 2001:140). Thus, in addition to the benefits of cropping maize and beans together, there are also benefits to eating maize and beans together. Squash fruit, seeds, oil and leaves are edible and they are easy to grow. The rinds of squashes and gourds can also be hollowed out for storage of water and other substances.

Nutshell recovered from the Macon County flotation samples includes acorn (*Quercus* sp.), hickory (*Carya* sp.), walnut (*Juglans* sp.) and hazelnut (*Corylus* sp.). Hickory was the most abundant nut recovered from the site, followed closely by acorn. While the nutmeats of walnuts can be easily extracted from the shell, hickory nuts and some acorns require extensive processing before they are rendered palatable (Petruso and Wickens 1984). The hickory kernels are so tightly enmeshed in the interior shell that picking the nutshells from the cracked shell casing is a time-consuming task. Instead, hickory nuts were generally pounded into pieces and boiled to extract the oil (Ulmer and Beck 1951). The process of boiling the pounded hickory nuts separates the pieces of shell, which sink to the bottom of the pot, from the oil, which rises to the top as the nutmeats dissolve and can be skimmed off or decanted. This oil or milk would then be used as an added ingredient in soups and stews, as a condiment for vegetables, or as a general sauce or beverage (Scarry 2003; Talalay et al. 1984).

The hazelnut identified in the assemblage probably represents the American hazelnut (*Corylus americana*). Unlike the other nuts, which come from trees, hazels are shrubs; they prefer open and anthropogenic habitats, and form dense thickets (Scarry 2003). While the nuts begin to ripen in the late summer, they don't fall to the ground until October/November, at which time they are quickly consumed by animals (Scarry 2003). These factors would have resulted in low collection rates for this type of nut (Scarry 2003; Talalay et al. 1984). Hazelnuts are high in fat and were probably processed for the nutmeats themselves, as opposed to the oil they produce (Scarry 2003).

Acorn processing depends upon whether the nuts derive from white or red oak trees. Nuts from the red oak are high in tannin and are extremely bitter as a result. White oaks, however, yield sweeter nuts; the nutmeats from these acorns can be used for cooking immediately after extraction from the shell (Scarry 2003). The tannin present in the bitter acorns, however, requires an additional processing step. Leaching the tannin from acorns can be accomplished either by soaking them in water, or parching and then boiling them with an alkaline substance such as wood ash. Once processed, acorns were generally ground into a fine meal, which could then be used to make gruel, bake bread, or thicken stews. Less often, acorns were boiled and the oil extracted (Swanton 1946:260, 277).

Fruit taxa recovered from the samples are represented by a combination of wild and domestic species. The only definitive domesticated fruit identified was peach (*Prunus persica*). The presence of peach, an Old World species, does not necessarily indicate direct contact with Europeans. Rather, this species was probably incorporated into native food systems through traditional exchange networks (Gremillion 1993)[1]. Fruit taxa recovered from the samples are represented by several wild species, including blackberry/raspberry (*Rubus* sp.), wild grape (*Vitis* sp.), groundcherry (*Physalis* sp.), maypop (*Passiflora incarnata*), nightshade (*Solanum* sp.), one pawpaw seed (*Asimina* sp.), persimmon (*Diospyros virginiana*), and sumac (*Rhus* sp.). Other possible fruit seeds include chokeberry (*Aronia* sp.), elderberry (*Sambucus* sp.), hawthorn (*Crataegus* sp.), and huckleberry (*Gaylussacia* sp.), all of which are edible.

A variety of grains/oil and greens seeds were also identified in the Macon County assemblage. These include amaranth (*Amaranthus* sp.), bearsfoot (*Polymnia uvedalia*), chenopod (*Chenopodium* sp.), little barley (*Hordeum pusillum*), pokeweed (*Phytolacca americana*), purslane (*Portulaca* sp.), sumpweed (*Iva annua*) and sunflower (*Helianthus annuus*). People probably collected and consumed the seeds of amaranth, bearsfoot, chenopod, and sumpweed. Amaranth, chenopod, pokeweed, and purslane may also have been eaten green or as potherbs (Hedrick 1972; Medsger 1966, Ulmer and Beck 1951). Chenopod (*Chenopodium* sp.), a common weed throughout the southeastern U.S., is represented in the assemblage by 159 seeds. These chenopod seeds likely represent a combination of wild and domesticated Chenopodium[2]. Little barley is a grain seed and a good source of carbohydrates; sunflower is an oil seed and contains more fat and protein. Grain seeds were probably parched and could be ground down to a meal and baked into breads or incorporated into stews. Similarly, oil seeds could be mixed into bread meal and/or stews (Scarry 2003).

Other seeds that probably represent incidental inclusions in the assemblage include bedstraw (*Galium* sp.), bulrush (*Scirpus* sp.), carpetweed (*Mollugo* sp.), and tickclover (*Desmodium* sp.). Carpetweed is a weed seed and was probably not consumed. Bedstraw may have been consumed as a tea and the weedy legume may have been used as food (Hedrick 1972; Peterson 1977). Other seeds recovered consist of dogwood (*Maizeus* sp.), holly (Ilex sp.), maygrass (*Phalaris caroliniana*), mustard (*Brassica* sp.), penny cress (*Thlaspi arvense*), sage (*Salvia* sp.), skullcap (*Scutellaria* sp.), smartweed (*Polygonum* sp.), spurge (*Euphorbia* sp.) and violet (*Viola* sp.). Uncertain seed IDs include crowngrass (*Paspalum* sp.), morninglory (*Ipomoea/Convolvulus* sp.), spikerush (*Eleocharis* sp.) and wax myrtle (*Myrica* sp.) Some species of dogwood fruit are sweet and edible. Although the holly could not be

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[1] Peach may have also extended its range naturally throughout the southeastern U.S. (Gremillion 1993).

[2] Domesticated and wild chenopod can be distinguished based on thickness of the inner seed coat; domesticated chenopod has a much thinner seed coat than its wild counterpart (Smith 1985).

identified to species, it is possible that it represents yaupon holly (*Ilex vomitoria*), a ritual plant known as the primary ingredient in the native Black Drink. Four species of the genus *Salvia* are native to region. These sage seeds may represent an incidental inclusion or they might have been used medicinally. Smartweed could have been collected and eaten. Bulrush, crowngrass, maygrass, penny cress, skullcap, spikerush, spurge and verbena are not usually consumed by humans. Violet flowers are edible, and wax myrtle leaves can be dried and used for seasoning. Their berries are edible but bitter (Edible Wild Plants book-online). Mustard seeds can be used as seasonings in stews and other foods. Some species of morninglory produce edible tubers, although the seeds identified in the samples might simply be field weeds (Medsger 1966).

A general assessment of seasonality for these plants indicates the harvesting and collection of resources from April through November. We have broken up the seasonality data by temporal period (Tables 5-13). Regardless of temporary or permanent occupation, most plants do not bloom in the winter months, between December and March, which make plant seasonality data difficult for assessing length of occupation without other complementary datasets. A perusal of the seasonality tables, however, reveals that most plants are ripe and ready for collection between May and October. Clearly, there is a bounty of wild plant foods that can be collected fresh throughout the spring, summer, and fall months. Many of these can be stored for later use in the winter.

Quantitative Results: Temporal Analysis

A consideration of temporal changes in the data reveals a variety of patterns. Here we employ ubiquity analysis, diversity analysis, and density comparisons; the density measures are presented as box plots, which reveal statistical differences through time. Ubiquity analysis is limited to data from the following temporal periods: Swanannoa contexts, Connestee contexts, Connestee/Woodstock contexts, and Late Qualla contexts (Table 14). As discussed above, ubiquity analysis requires a minimum of 10 samples, a requirement that was only met by four chronological periods represented at the site. Tables 15-18 present ubiquity values for these four periods in descending order of importance. Table 19 compares the top five ranked taxa (based on the ubiquity calculations) across these four time periods. Hickory is the most ubiquitous plant during all periods. Acorn ranks second for Swannanoa, Connestee, and Connestee/Woodstock periods; Maize replaces acorn as the second most ubiquitous plant during the Late Qualla period, with acorn ranking third. Chenopod, walnut, and squash/gourd all rank within the top five ubiquitous plants during most periods.

Diversity analysis reveals a kaleidoscope of patterning that is hard to interpret. As people became more invested in maize agriculture, plant diversity appears to decline, followed by a renewed increase in plant food diversity during the Middle Qualla phase. We have elsewhere interpreted this second wave of increased plant food diversity as being related to the risks and uncertainty connected to increasing contact with Europeans (VanDerwarker et al. 2012).

To evaluate changes through time in terms of plant abundances, we use box plots. Box plots allow us to determine if two distributions of data are statistically different at the 0.05 level (see also Cleveland 1994; McGill et al. 1978; Scarry and Steponaitis 1997; Wilkinson et al. 1992). Box plots summarize distributions of data using several key features. The median value of the distribution is marked by the line at the center of the box. The edges of the box, or hinges, represent the 25th and 75th percentiles of the distribution—the approximate middle 50% of the data fall between the hinges (Cleveland 1994:139). Vertical lines, or whiskers, extend outward from the box and represent the tails of the distribution. Box plots also designate outliers—these are unusually large or small data values that "portray behavior in the extreme tails of the distribution" (Cleveland 1994:140). Outliers are depicted as asterisks and far outliers as open circles. Box plots can also be notched, which converts the box shape to an hourglass shape – the notches in the hourglass shape represent the 95% confidence intervals for the distribution. If any the notched areas on any two plots do not overlap, then the two distributions can be said to differ significantly. The box plots presented here use density data (calculate per sample). A consideration of changing nut densities through time reveal that while hickory may have been the most ubiquitous plant during all periods, its abundance fluctuated dramatically through time, finally dropping statistically during the Qualla period (Figure 1); we see a similar pattern with acorns (Figure 2). Walnuts, on the other hand, increase significantly during the Late Qualla period – it appears that walnut abundance may be inversely related to that of hickory and acorn (Figure 3). Interestingly, the patterns in the maize data parallel the pattern of walnut abundance, with a clear statistical increase during the Late Qualla phase (Figures 4, 5). Thus it appears that as hickory and acorn abundances drop during the Qualla period, maize and walnut abundances increase. At the same time, native cultigens (chenopod, amaranth, maygrass, little barley, sumpweed, and sunflower) decrease during the Qualla period, in a pattern similar to the decrease in hickory and acorn (Figure 6). Fruits, however, appear to have been exploited in consistent amounts throughout the site’s occupation (Figure 7). In summary, we see a trend of decreasing abundance of hickories, acorns, and the cultivation of native grains through time. This trend appears to be inversely related to a pattern of increasing walnut collection and the intensification of maize cultivation, both of which are most pronounced during the Late Qualla phase.

Table 1. Counts and weights of plant taxa by temporal periods, part 1.

	Swanannoa		Pigeon		Connestee		Probable Connestee		Connestee/ Woodstock		Etowah	
N of Samples	13		3		40		3		14		4	
Total Volume (l)	135		26		466		24		136		73	
Plant Weight (g)	28.01		2.65		200.4		301.65		15.85		20.31	
Wood Weight (g)	25.34		1.29		173.11		298.45		13.79		14.92	
COMMON NAME	(n)	(g)	(n)	(g)	(n)	(g)	(n)	(g)	(n)	(g)	(n)	(g)
Cultigens												
Maize cob												
Maize cupule					3	0.04	12	0.08	3	0.01	83	0.41
Maize cupule cf.			1	0.01	1	0.01					4	0.03
Maize kernel					4	0.02			1	0.01	38	0.14
Maize kernel cf.	4	0.04			3	0.04						
Common bean												
Bean cf.												
Squash/Gourd rind	2	0.01	7	0.02	11	0.07			2	0	1	0
Nuts												
Acorn cap					1	0.01						
Acorn meat					7	0.09						
Acorn nutshell	29	0.11	61	0.19	1465	2.72	5	0.54	95	0.3	40	0.11
Acorn nutshell cf.			1	0	1	0					7	0.02
Hazelnut	1	0.01	8	0.07	7	0.06					5	0.04
Hazelnut cf.					7	0.04						
Hickory	205	1.72	89	0.74	1822	19.8	62	0.54	179	1.38	366	4.47
Hickory cf.	9	0.04			6	0.04					1	0.01
Hickory husk			1	0.02								
Hickory husk cf.							3	0.01				
Hickory meat cf.			2	0.01								
Black walnut			3	0.07	33	1.03	33	0.58	4	0.05	1	0.01
Walnut family							2	0.02				
Fleshy Fruits												
Blackberry/Raspberry					7	0						
Chokeberry cf.												
Elderberry cf.					1	0						
Grape			1	0.01	7	0.01	4	0	2	0.01		
Grape cf.			3	0					1	0	1	0
Groundcherry					1	0						
Groundcherry cf.					1	0						
Hawthorn							1	0.01				
Hawthorn cf.												
Huckleberry cf.					3	0						
Maypop			2	0.01	5	0.04			5	0	1	0
Nigthshade					4	0						
Nightshade cf.												

Pawpaw												
Peach												
Persimmon												
Plum/Cherry cf.					1	0.01						
Sumac												
Sumac cf.					1	0						
Grains/Oil Seeds & Greens												
Amaranth			1	0								
Bearsfoot					6	0.04			3	0.01	3	0.01
Chenopod			12	0	134	0			5	0		
Chenopod cf.					1	0	4	0	2	0		
Little barley					16	0.02	2	0				
Little barley cf.					44	0.05						
Pokeweed	1	0			3	0			1	0		
Purslane					16	0			5	0		
Sumpweed					4	0						
Sumpweed cf.					2	0.01						
Sunflower	1	0.01			2	0.01						
Sunflower cf.	1	0.01			2	0						
Wild Legumes												
Tickclover					1	0			1	0	1	0
Other Seeds												
Bedstraw	2	0			20	0.01						
Bedstraw cf.												
Bulrush					2	0						
Bulrush cf.					2	0						
Carpetweed					1	0						
Carpetweed cf.					1	0						
Crowngrass cf.												
Dogwood	2	0.02										
Dogwood cf.	3	0.05										
Grass family			3	0	2	0	1	0				
Grass family cf.					2	0						
Holly					1	0						
Juniper							30	0.13				
Maygrass	1	0	1	0	76	0	1	0	5	0		
Maygrass cf.					1	0						
Morninglory cf.			2	0								
Mustard									1	0		
Nightshade family cf.	7	0										
Penny cress												
Rose family cf.									1	0		
Sage												
Sage cf.					1	0						
Skullcap	1	0										

Skullcap cf.	1	0										
Smartweed					2	0						
Spikerush cf.	2	0			1	0						
Spurge			1	0					2	0	1	0
Violet												
Violet cf.					1	0						
Wax myrtle cf.			1	0	6	0						
Miscellaneous												
Pine cone flap cf.									3	0.01		
Unidentified												
Unidentified												
Unidentified nutmeat cf.	3	0.02			111	0.75						
Unidentifiable	90	0.63	44	0.2	425	2.29	143	1.29	41	0.28	24	0.13
Unidentifiable seed	1	0	6	0.01	32	0.03			3	0	1	0.01
Unidentifiable seed frag					22	0.01	4	0	12	0		

Table 2. Counts and weights of plant taxa by temporal periods, part 2.

	Early Qualla		Middle Qualla		Late Middle/ Late Qualla		Late Qualla	
N of Samples	2		8		1		15	
Total Volume (l)	48		134		23		292	
Plant Weight (g)	24.15		10.71		0.48		386.19	
Wood Weight (g)	9		8.65		0.35		314.35	
COMMON NAME	(n)	(g)	(n)	(g)	(n)	(g)	(n)	(g)
Cultigens								
Maize cob							13	2.42
Maize cupule	61	0.18	71	0.36	4	0.02	5136	40.85
Maize cupule cf.	2	0.01					8	0.04
Maize kernel	27	0.16	25	0.15	1	0.01	96	0.57
Maize kernel cf.							3	0.03
Common bean							40	0.44
Bean cf.							23	0.16
Squash/Gourd rind							22	0.11
Nuts								
Acorn cap	1	0.01						
Acorn meat	3	0.07						
Acorn nutshell	1680	3.07	3	0.01			89	0.23
Acorn nutshell cf.							4	0.02
Hazelnut	26	0.13						
Hazelnut cf.	1	0.01						
Hickory	711	10.3	106	1.25	9	0.06	1123	19.22
Hickory cf.			1	0.01			7	0.03
Hickory husk								
Hickory husk cf.								
Hickory meat cf.								
Black walnut	7	0.45	3	0.12			37	1.34
Walnut family	16	0.05						
Fleshy Fruits								
Blackberry/Raspberry								
Chokeberry cf.							10	0
Elderberry cf.								
Grape							21	0.07
Grape cf.								
Groundcherry			4	0				
Groundcherry cf.								
Hawthorn								
Hawthorn cf.			1	0.02				
Huckleberry cf.							1	0
Maypop			2	0.02	2	0.02	25	0.07
Nigthshade			1	0				
Nightshade cf.					1	0		
Pawpaw	1	0.02						

Peach							8	0.6
Persimmon			3	0.03				
Plum/Cherry cf.								
Sumac							1	0.01
Sumac cf.								
Grains/Oil Seeds & Greens								
Amaranth							2	0
Bearsfoot			1	0	2	0.02	30	0.14
Chenopod			2	0			6	0
Chenopod cf.								
Little barley								
Little barley cf.	1	0						
Pokeweed					1	0		
Purslane			1	0			3	0
Sumpweed								
Sumpweed cf.								
Sunflower								
Sunflower cf.								
Wild Legumes								
Tickclover								
Other Seeds								
Bedstraw							2	0
Bedstraw cf.					1	0		
Bulrush								
Bulrush cf.								
Carpetweed			1	0				
Carpetweed cf.	5	0						
Crowngrass cf.							2	0
Dogwood								
Dogwood cf.	2	0.01						
Grass family								
Grass family cf.	3	0						
Holly								
Juniper								
Maygrass								
Maygrass cf.			2	0				
Morninglory cf.								
Mustard								
Nightshade family cf.								
Penny cress	2	0						
Rose family cf.								
Sage							1	0
Sage cf.			1	0				
Skullcap								
Skullcap cf.							1	0

Smartweed								
Spikerush cf.								
Spurge			1	0				
Violet							1	0
Violet cf.								
Wax myrtle cf.								
Miscellaneous								
Pine cone flap cf.								
Unidentified								
Unidentified							56	1.57
Unidentified nutmeat cf.	44	0.34						
Unidentifiable	93	0.3	29	0.09			781	3.9
Unidentifiable seed			1	0			4	0
Unidentifiable seed frag							1	0

Table 3. Correspondence of common and taxonomic names.

COMMON NAME	TAXONOMIC NAME
Cultigens	
Maize cob	*Zea mays*
Maize cupule	*Zea mays*
Maize cupule cf.	*Zea mays* cf.
Maize kernel	*Zea mays*
Maize kernel cf.	*Zea mays* cf.
Common bean	*Phaseolus vulgaris*
Bean cf.	*Phaseolus* sp. cf.
Squash/Gourd rind	*Cucurbita* sp.
Nuts	
Acorn cap	*Quercus* sp.
Acorn meat	*Quercus* sp.
Acorn nutshell	*Quercus* sp.
Acorn nutshell cf.	*Quercus* sp. cf.
Hazelnut	*Corylus* sp.
Hazelnut cf.	*Corylus* sp. cf.
Hickory	*Carya* sp.
Hickory cf.	*Carya* sp. cf.
Hickory husk	*Carya* sp.
Hickory meat cf.	*Carya* sp.
Black walnut	*Juglans nigra*
Walnut family	Juglandaceae
Fleshy Fruits	
Blackberry/Raspberry	*Rubus* sp.
Chokeberry cf.	*Aronia* sp.
Elderberry cf.	*Sumbucus* sp. cf.
Grape	*Vitis* sp.
Grape cf.	*Vitis* sp. cf.
Groundcherry	*Physalis* sp.
Groundcherry cf.	*Physalis* sp. cf.
Hawthorn cf.	*Crataegus* sp. cf.
Huckleberry cf.	*Gaylussacia* sp. cf.
Maypop	*Passiflora incarnata*
Nigthshade	*Solanum* sp.
Nightshade cf.	*Solanum* sp. cf.
Pawpaw	*Asimina* sp.
Peach	*Prunus persica*
Persimmon	*Diospyros virginiana*
Plum/Cherry cf.	*Prunus* sp. cf.
Sumac	*Rhus* sp.
Sumac cf.	*Rhus* sp. cf.
Grains/Oil Seeds & Greens	
Amaranth	*Amaranthus* sp.

Bearsfoot	*Polymnia uvedalia*
Chenopod	*Chenopodium* sp.
Chenopod cf.	*Chenopodium* sp. cf.
Little barley	*Hordeum pusillum*
Little barley cf.	*Hordeum pusillum* cf.
Pokeweed	*Phytolacca americana*
Purslane	*Portulaca* sp.
Sumpweed	*Iva annua*
Sumpweed cf.	*Iva annua* cf.
Sunflower	*Helianthus annuus*
Sunflower cf.	*Helianthus annuus* cf.
Other Seeds	
Bedstraw	*Galium* sp.
Bedstraw cf.	*Galium* sp. cf.
Bulrush	*Scirpus* sp.
Bulrush cf.	*Scirpus* sp. cf.
Carpetweed	*Mollugo* sp.
Carpetweed cf.	*Mollugo* sp. cf.
Crowngrass cf.	*Paspalum* sp. cf.
Dogwood	*Maizeus* sp.
Dogwood cf.	*Maizeus* sp. cf.
Grass family	Poaceae
Grass family cf.	Poaceae cf.
Holly	*Ilex* sp.
Juniper	*Juniperus* sp.
Maygrass	*Phalaris caroliniana*
Maygrass cf.	*Phalaris caroliniana* cf.
Morninglory cf.	*Ipomoea/Convolvulus* cf.
Mustard	*Brassica* sp.
Nightshade family cf.	Solanaceae cf.
Penny cress	*Thlaspi arvense*
Rose family cf.	Rosaceae cf.
Sage	*Salvia* sp.
Sage cf.	*Salvia* sp. cf.
Skullcap	*Scutellaria* sp.
Skullcap cf.	*Scutellaria* sp. cf.
Smartweed	*Polygonum* sp.
Spikerush cf.	*Eleocharis* sp. cf.
Spurge	*Euphorbia* sp.
Tickclover	*Desmodium* sp.
Violet	*Viola* sp.
Violet cf.	*Viola* sp. cf.
Wax myrtle cf.	*Myrica* sp. cf.
Miscellaneous	
Pine cone flap cf.	*Pinus* sp.

Table 4. Summary of macrobotanical data from hand-picked samples.

N of Samples	32		
Wood Weight (g)	21.77		
COMMON NAME	TAXONOMIC NAME	(n)	(g)
Acorn cap	*Quercus* sp.	3	0.06
Acorn meat	*Quercus* sp.	142	3.76
Acorn nutshell	*Quercus* sp.	100	1.36
Bearsfoot	*Polymnia uvedalia*	1	0.02
Black walnut	*Juglans nigra*	22	2.42
Maize cob	*Zea mays*	11	3.89
Maize cupule	*Zea mays*	81	3.5
Maize kernel	*Zea mays*	7	0.39
Hickory	*Carya* sp.	464	39.73
Maypop	*Passiflora incarnata*	5	0.06
Peach	*Prunus persica*	3	0.53
Persimmon	*Diospyros virginiana*	14	0.46
UID		9	0.94

Table 5. Seasonality of taxa from Swanannoa Phase contexts in order of bloom.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Dogwood				X	X	X						
Maygrass					X	X	X					
Bedstraw					X	X	X	X				
Pokeweed					X	X	X	X				
Squash/gourd					X	X	X	X	X			
Skullcap						X	X	X				
Spikerush cf.						X	X	X	X			
Maize							X	X	X			
Hazelnut							X	X	X			
Sunflower							X	X	X	X		
Acorn									X	X	X	
Hickory										X		

Table 6. Seasonality of taxa from Pigeon Phase contexts in order of bloom.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Wax myrtle cf.				X	X	X	X	X	X	X		
Maygrass					X	X	X					
Squash/gourd					X	X	X	X	X			
Amaranth							X	X	X			
Maize							X	X	X			
Hazelnut							X	X	X			
Maypop							X	X	X	X		
Spurge							X	X	X	X		
Chenopod							X	X	X	X	X	
Morninglory cf.							X	X	X	X	X	
Grape								X	X	X		
Acorn									X	X	X	
Hickory										X		
Walnut										X		

Table 7. Seasonality of taxa from Connestee Phase contexts in order of bloom.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Holly				X	X							
Wax myrtle cf.				X	X	X	X	X	X	X		
Blackberry/ Raspberry					X	X						
Little barley					X	X	X					
Maygrass					X	X	X					
Bedstraw					X	X	X	X				
Pokeweed					X	X	X	X				
Violet					X	X	X	X				
Purslane					X	X	X	X	X			
Squash/gourd					X	X	X	X	X			
Carpetweed						X	X	X				
Huckleberry cf.						X	X	X				
Plum/Cherry cf.						X	X	X	X			
Spikerush cf.						X	X	X	X			
Elderberry cf.						X	X	X	X	X		
Sumac						X	X	X	X	X		
Groundcherry						X	X	X	X	X	X	
Nigthshade						X	X	X	X	X	X	
Bearsfoot							X	X	X			
Bulrush							X	X	X			
Maize							X	X	X			
Hazelnut							X	X	X			
Maypop							X	X	X	X		
Sunflower							X	X	X	X		
Chenopod							X	X	X	X	X	
Smartweed							X	X	X	X	X	
Sage								X	X			
Grape								X	X	X		
Tickclover								X	X	X		

Acorn									X	X	X	
Sumpweed									X	X	X	
Hickory										X		
Walnut										X		

Table 8. Seasonality of taxa from Connestee/Woodstock Phase contexts in order of bloom.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Maygrass					X	X	X					
Pokeweed					X	X	X	X				
Purslane					X	X	X	X	X			
Squash/gourd					X	X	X	X	X			
Bearsfoot							X	X	X			
Maize							X	X	X			
Mustard							X	X	X			
Maypop							X	X	X	X		
Spurge							X	X	X	X		
Chenopod							X	X	X	X	X	
Grape								X	X	X		
Tickclover								X	X	X		
Acorn									X	X	X	
Hickory										X		
Walnut										X		

Table 9. Seasonality of taxa from Etowah Phase contexts in order of bloom.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Squash/gourd					X	X	X	X	X			
Bearsfoot							X	X	X			
Maize							X	X	X			
Hazelnut							X	X	X			
Maypop							X	X	X	X		
Spurge							X	X	X	X		
Grape								X	X	X		
Tickclover								X	X	X		
Acorn									X	X	X	
Hickory										X		
Walnut										X		

Table 10. Seasonality of taxa from Early Qualla Phase contexts in order of bloom.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pawpaw			X	X	X							
Dogwood				X	X	X						
Little barley					X	X	X					
Penny cress					X	X	X	X				
Carpetweed						X	X	X				
Maize							X	X	X			
Hazelnut							X	X	X			
Acorn									X	X	X	
Hickory										X		
Walnut										X		

Table 11. Seasonality of taxa from Middle Qualla Phase contexts in order of bloom.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Maygrass					X	X	X					
Purslane					X	X	X	X	X			
Carpetweed						X	X	X				
Groundcherry						X	X	X	X	X	X	
Nigthshade						X	X	X	X	X	X	
Bearsfoot							X	X	X			
Maize							X	X	X			
Maypop							X	X	X	X		
Spurge							X	X	X	X		
Chenopod							X	X	X	X	X	
Sage								X	X			
Hawthorn cf.									X	X		
Persimmon									X	X		
Acorn									X	X	X	
Hickory										X		
Walnut										X		

Table 12. Seasonality of Late Middle/Late Qualla Phase contexts in order of bloom.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Bedstraw					X	X	X	X				
Pokeweed					X	X	X	X				
Bearsfoot							X	X	X			
Maize							X	X	X			
Maypop							X	X	X	X		
Hickory										X		

Table 13. Seasonality of Late Qualla Phase contexts in order of bloom.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Chokeberry cf.				X	X	X						
Bedstraw					X	X	X	X				
Violet					X	X	X	X				
Purslane					X	X	X	X	X			
Squash/gourd					X	X	X	X	X			
Peach						X	X					
Huckleberry cf.						X	X	X				
Skullcap						X	X	X				
Crowngrass cf.						X	X	X	X	X		
Sumac						X	X	X	X	X		
Amaranth							X	X	X			
Bearsfoot							X	X	X			
Maize							X	X	X			
Common bean							X	X	X	X		
Maypop							X	X	X	X		
Chenopod							X	X	X	X	X	
Sage								X	X			
Grape								X	X	X		
Acorn									X	X	X	
Hickory										X		
Walnut										X		

Table 14. Correspondence between period and ubiquity analysis.

Phase/Period	Total Samples Analyzed	Ubiquity Calculated*
Swananoa	13	Yes
Pigeon	3	No
Connestee	40	Yes
Connestee/Woodstock	14	Yes
Etowah	4	No
Early Qualla	2	No
Middle Qualla	8	No
Late Middle Qualla	1	No
Late Qualla	15	Yes

* A minimum of 10 samples is required to calculate ubiquity (Hubbard 1976).

Table 15. Ubiquity values for Swanannoa contexts in descending order.

COMMON NAME	Samples Present	Total Samples	Ubiquity
Hickory	12	13	92.31
Acorn	7	13	53.85
Bedstraw	2	13	15.38
Dogwood	1	13	7.69
Hazelnut	1	13	7.69
Maygrass	1	13	7.69
Nightshade family cf.	1	13	7.69
Pokeweed	1	13	7.69
Skullcap	1	13	7.69
Spikerush cf.	1	13	7.69
Squash/Gourd	1	13	7.69
Sunflower	1	13	7.69

Table 16. Ubiquity values for Connestee contexts in descending order.

COMMON NAME	Samples Present	Total Samples	Ubiquity
Hickory	40	40	100
Acorn	33	40	82.5
Chenopod	17	40	42.5
Black walnut	14	40	35
Maygrass	14	40	35
Blackberry/Raspberry	5	40	12.5
Maize cf.	5	40	12.5
Squash/Gourd	5	40	12.5
Bearsfoot	4	40	10
Bedstraw	4	40	10
Grape	4	40	10
Hazelnut	4	40	10
Maypop	4	40	10
Nightshade	3	40	7.5
Pokeweed	3	40	7.5
Bulrush	2	40	5
Smartweed	2	40	5
Sumpweed	2	40	5
Sunflower	2	40	5
Carpetweed	1	40	2.5
Elderberry cf.	1	40	2.5
Grass family	1	40	2.5
Groundcherry	1	40	2.5
Holly	1	40	2.5
Huckleberry cf.	1	40	2.5
Little barley	1	40	2.5
Plum/Cherry cf.	1	40	2.5
Purslane	1	40	2.5
Sage cf.	1	40	2.5
Spikerush cf.	1	40	2.5
Sumac cf.	1	40	2.5
Tickclover	1	40	2.5
Violet cf.	1	40	2.5
Wax myrtle cf.	1	40	2.5

Table 17. Ubiquity values for Connestee/Woodstock contexts in descending order.

COMMON NAME	Samples Present	Total Samples	Ubiquity
Hickory	14	14	100.00
Acorn	10	14	71.43
Black walnut	3	14	21.43
Chenopod	3	14	21.43
Maize	3	14	21.43
Purslane	3	14	21.43
Bearsfoot	2	14	14.29
Maygrass	2	14	14.29
Maypop	2	14	14.29
Squash/Gourd	2	14	14.29
Grape	1	14	7.14
Mustard	1	14	7.14
Pine cone flap cf.	1	14	7.14
Pokeweed	1	14	7.14
Rose family cf.	1	14	7.14
Spurge	1	14	7.14
Tickclover	1	14	7.14

Table 18. Ubiquity values for Late Qualla contexts in descending order.

COMMON NAME	Samples Present	Total Samples	Ubiquity
Hickory	15	15	100.00
Maize	11	15	73.33
Acorn	10	15	66.67
Maypop	7	15	46.67
Common bean	5	15	33.33
Squash/Gourd	5	15	33.33
Chenopod	4	15	26.67
Bearsfoot	3	15	20.00
Grape	3	15	20.00
Black walnut	2	15	13.33
Purslane	2	15	13.33
Amaranth	1	15	6.67
Bedstraw	1	15	6.67
Chokeberry cf.	1	15	6.67
Crowngrass cf.	1	15	6.67
Huckleberry cf.	1	15	6.67
Peach	1	15	6.67
Sage	1	15	6.67
Skullcap cf.	1	15	6.67
Sumac	1	15	6.67
Violet	1	15	6.67

Table 19. Comparison of top 5 ubiquity values by period, ranked in descending order.

Rank	Swanannoa	Connestee	Connestee/Woodstock	Late Qualla
1	Hickory	Hickory	Hickory	Hickory
2	Acorn	Acorn	Acorn	Maize
3	Bedstraw	Chenopod	Black walnut Chenopod Maize Purslane	Acorn
4	ALL OTHER TAXA	Black walnut Maygrass	Bearsfoot Maygrass Maypop Squash/Gourd	Maypop
5		Blackberry/Raspberry Squash/Gourd	ALL OTHER TAXA	Common bean Squash/Gourd

Table 20. Shannon-Weaver diversity and equitability values by period.

	N	H'	V'
Swananoa	261	0.90	0.34
Pigeon	194	1.53	0.56
Connestee	3678	1.19	0.34
Connestee/Woodstock	315	1.27	0.46
Etowah	541	0.93	0.39
Early Qualla	2530	0.85	0.35
Middle Qualla	228	1.25	0.45
Late Middle/Late Qualla	21	1.59	0.82
Late Qualla	6670	0.73	0.24

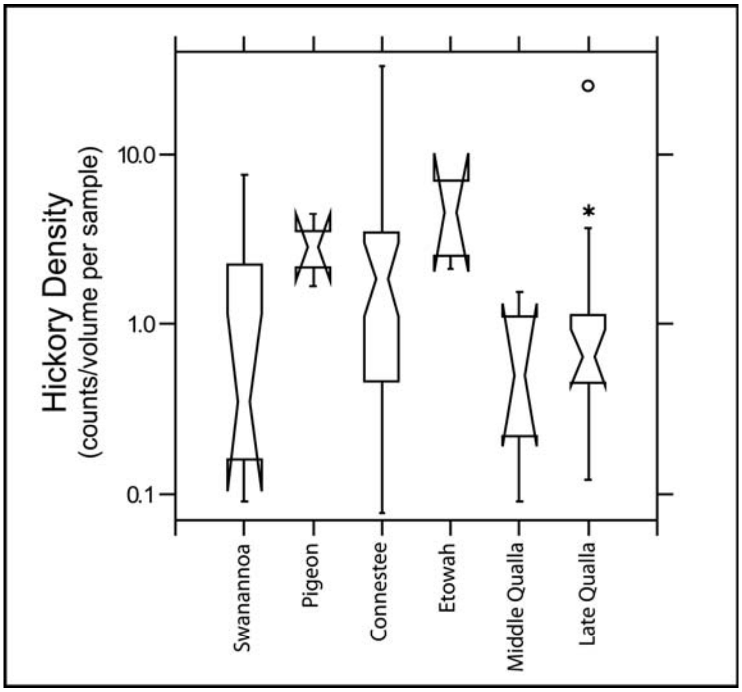

Figure 1. Box plot of hickory densities by phase.

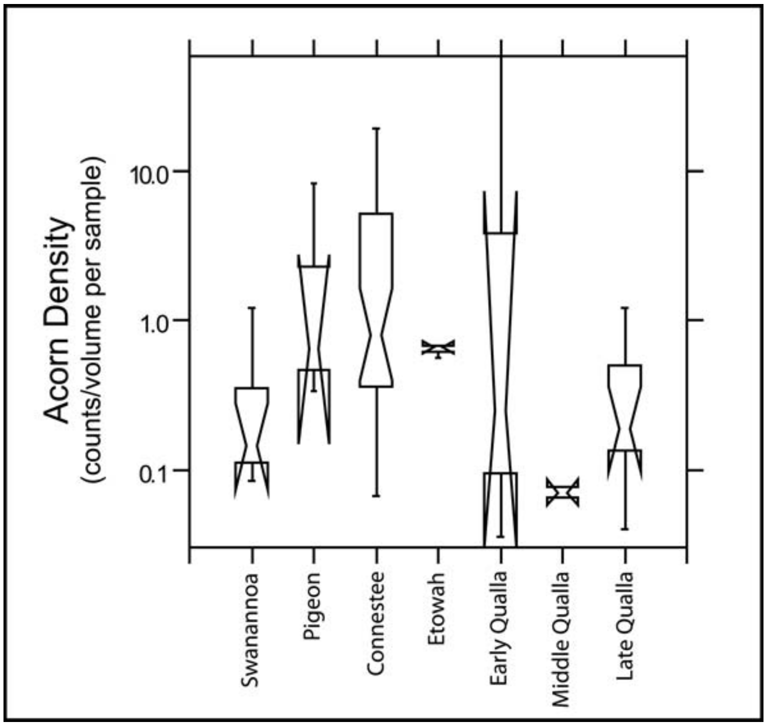

Figure 2. Box plot of acorn densities by phase.

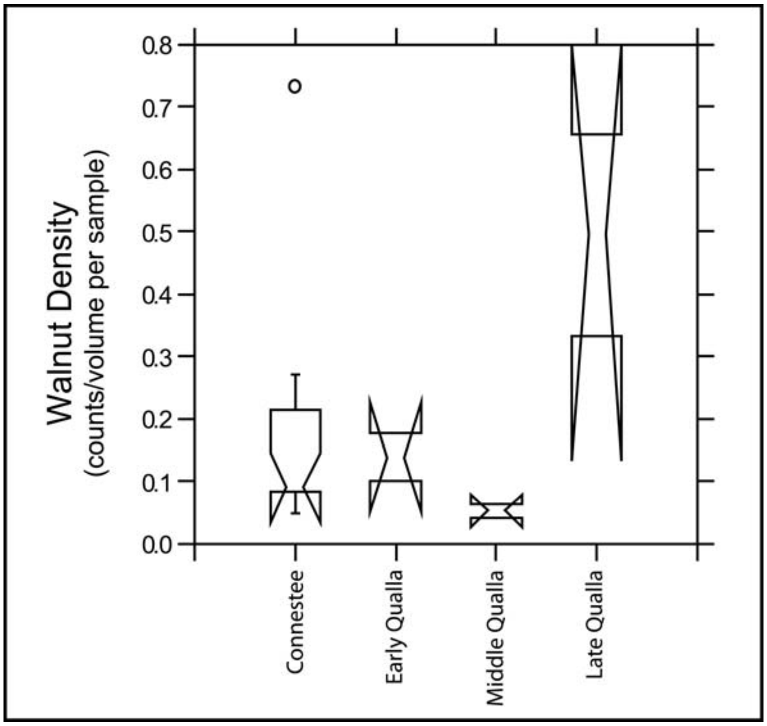

Figure 3. Box plot of walnut densities by phase.

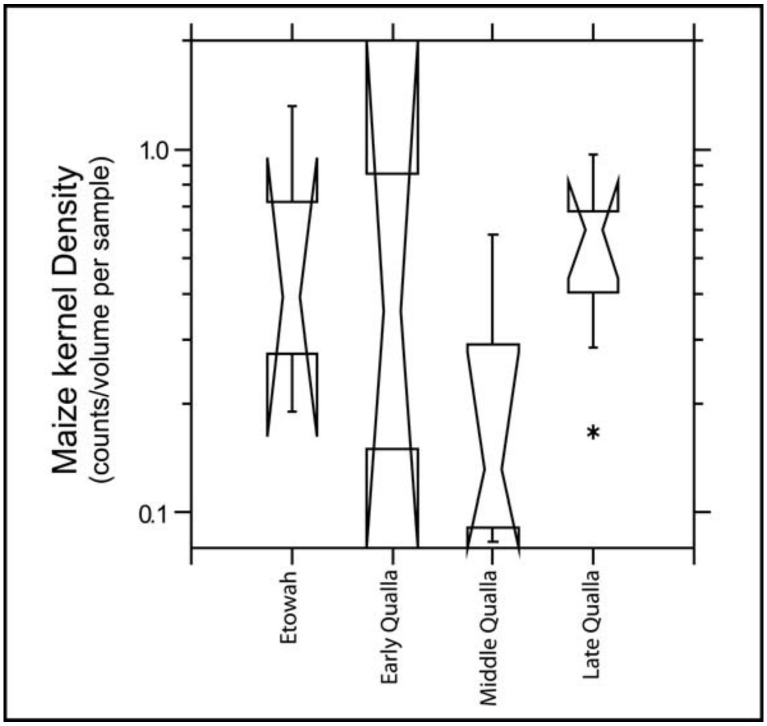

Figure 4. Box plot of maize kernel densities by phase.

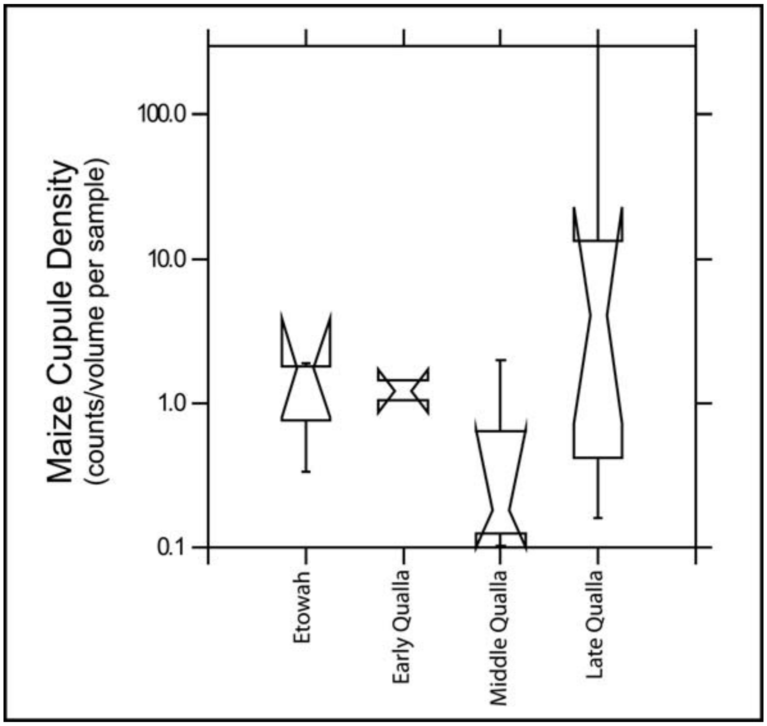

Figure 5. Box plot of maize cupule densities by phase.

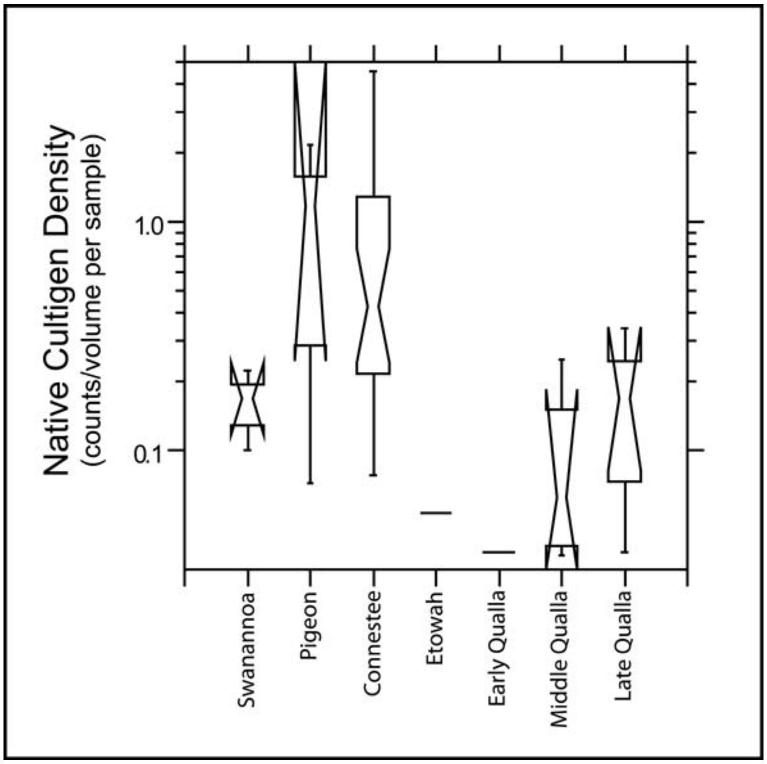

Figure 6. Box plot of native cultigens by phase.

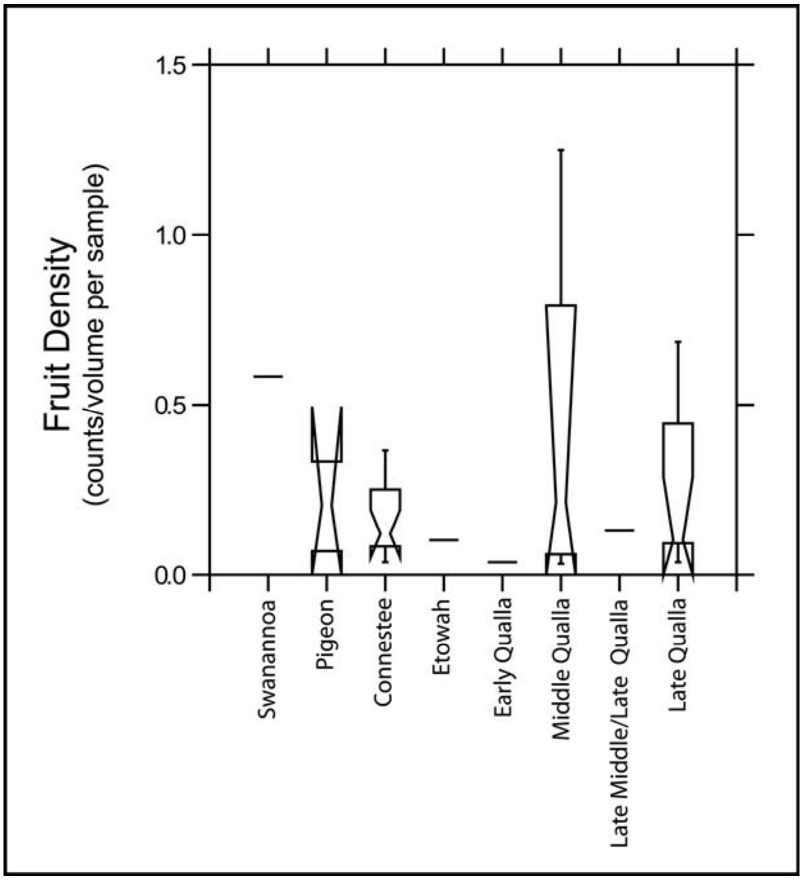

Figure 7. Box plot of fruit densities by phase (horizontal line indicative of a single sample).

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