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Hickory nut storage and processing at the Victor Mills site (9CB138) and implications for Late Archaic land use in the middle Savannah River valley

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ABSTRACT
Despite the ubiquity of charred hickory nutshell in archaeological contexts throughout the Eastern Woodlands, evidence for nut processing and storage is elusive and ambiguous. To the extent that hickory nuts factored prominently in Indigenous foodways – particularly as a storable resource – mass processing was possibly specialized at times and sited in places for that express purpose. One such place was Victor Mills (9CB138) in Columbia County, Georgia. Excavations at this site of Early Stallings activity (ca. 4350–4050 cal BP) revealed an assemblage of pits, fire-cracked rock, anvils, hammerstones, fiber-tempered pottery, and soapstone slabs indicative of large-scale nut storage and processing. Given the seasonal ecology of hickory production, visits to Victor Mills for harvesting and storing nuts took place in the fall, but also at other times of the year, when stores were tapped and nuts processed for transport to sites of habitation. Put into larger context, nut storage at Victor Mills fits the conditions for concealment as outlined by DeBoer ([1988] Subterranean Storage and the Organization of Surplus: The View from Eastern North America. *Southeastern Archaeology* 7:1–20), that subterranean stores were established in places subject to raiding when left unattended. Implications follow for the land-use patterns of Early Stallings communities and their relationship to neighbors upriver.

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The common occurrence of hickory nutshell at archaeological sites across the Eastern Woodlands speaks to the importance of this mast resource to Indigenous people since the end of the Ice Age (Caldwell 1958; Hollenbach 2009; Scarry 2003; Walker et al. 2001; Yarnell and Black 1985), particularly during the Late Archaic period in the Southeast (Gremillion 1996). Ethnohistoric accounts corroborate the importance of hickory nuts among Native Americans of the colonial past – along with some of their early European interlopers (Battle 1922:177–178). These same sources provide insight on how hickory nuts were processed and consumed (Bartram 1973; Battle 1922; Gerard 1907). Despite the prevalence of hickory nutshell in archaeological deposits and mentions of hickory in written accounts, little is known about the scale of nut harvesting, storage, and processing (see Sassaman 2010:172–180 for review). Granted, sites where hickory nuts were processed in mass have been documented in the Eastern Woodlands (e.g., Stafford 1991), and plenty of sites have large pits inferred to be used for storage, usually in association with evidence of habitation (e.g., Bentz 1988; Faulkner and McCollough 1982; McCollough and Faulkner 1973; Ritchie 1969:59–60; Sanger 2017). Lacking, however, are cases of both storage and mass processing whose locations apart from places of habitation implicate targeted, even specialized production.

The results of salvage excavations at the Victor Mills site (9CB138) in Columbia County, Georgia, support the inference that this was a dedicated location for the storage and processing of hickory nuts. Located on a ridge nose overlooking the Savannah River, Victor Mills is a single-component site of the Late Archaic Early Stallings phase (ca. 4350–4050 cal BP). Beyond the charred shells of nuts themselves, evidence for storage and mass processing of hickory nuts exists in its assemblage of pits, anvils, hammerstones, fire-cracked rock (FCR), soapstone slabs, and pottery basins suited to the rendering of nuts for consumption using heated water. Although relatively low in frequency, charred nutshell (*Carya* spp.) is ubiquitous in samples processed by fine screening or flotation.[1] A small midden of secondary refuse attests to food provisioning during visits to the site, and abundant lithic debris from the manufacture of dart points attests to deer hunting. Missing from Victor Mills is evidence for long-term habitation compared to other locations in the region with more diverse artifact and feature assemblages, including architecture and human interments.

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Put into broader context, Victor Mills was a special-use location on the geographic margins of an Early Stallings settlement range that extended from the middle Coastal Plain – where hickory and other mast-bearing trees were limited in variety, if not also distribution – to the Lower Piedmont, where species of hickory like the shagbark (*Carya ovata*) first appear. Forays into the Lower Piedmont put Coastal Plain denizens in the habitual spaces of people of Mill Branch affiliation, a coeval Late Archaic tradition with deep ancestry in the Piedmont. Although interactions between persons of these respective communities enabled the interprovincial movement of soapstone, bannerstones, and other media, subterranean storage by persons who spent most of their time away from their stores is arguably a form of concealment, as outlined by DeBoer (1988).

The purpose of this paper is to introduce Victor Mills as a vivid example of the circumstances DeBoer (1988) had in mind by decoupling subterranean storage from sedentism. One of several sites in the middle Savannah River valley excavated in the 1990s, Victor Mills has factored significantly in written narratives of the history of Stallings culture (Sassaman 2006a, 2016), but only recently have technical details of the excavation and analyses been issued (Sassaman et al. 2021). These details support inferences about the types of activities that took place at Victor Mills, when they took place, and how they relate to coeval Early Stallings settlements downriver, in the Coastal Plain. The strength of these inferences turns on the synergy among (1) the clarity of a single-component site; (2) a robust regional record of Late Archaic settlement; and (3) literary insight on uses of hickory in recent centuries. We begin with a review of the findings of salvage excavations at Victor Mills in 1994.

Excavations at Victor Mills (9CB138)

Located on a ridge overlooking the Savannah River floodplain, Victor Mills is one of several Stallings culture mollusk-shell-bearing sites mentioned by William Claflin (1931:41) in his report of excavations at the nearby Stallings Island site (9CB1; Figure 1). The site was registered with the state of Georgia as part of a 1991 reconnaissance survey in advance of a proposed pipeline (Webb 1992). Although the pipeline was later diverted from the site, residential development and looting remained threats. The landowner in 1993, Mr. Victor Mills, permitted some limited excavation to salvage information ahead of development.

In early 1994, a crew of professional archaeologists and volunteers led by the senior author excavated a meter-wide trench through what proved to be a relatively small and shallow shell midden on the northwest side slope of the ridge. Continuing the trench upslope, to the top of the ridge, the crew encountered a series of pits up to one meter wide and nearly as deep. Perpendicular trenches added later exposed more large pits, smaller pits, and a hearth (Figure 2). Distributed throughout midden and pit fill were artifacts of the Early Stallings phase, notably plain fiber-tempered pottery. Seven AMS assays on charcoal and nutshell suggest that the activities resulting in infilled pits and a downslope sheet midden at Victor Mills took place over a 300-year span of ca. 4350–4050 cal BP, or roughly 2400–2100 BC.

As is often the case, shell in the sideslope midden afforded excellent preservation of other organic matter. Fine-screen samples contained the bones of many small fish, along with other vertebrate faunal remains, charcoal, and charred nutshell. Shell midden that was passed through ¼-inch screen – or ½-inch screen in the looters' pits – was dominated by the bones of white-tailed deer. The invertebrate remains that helped to preserve animal bone consist mostly of bivalve (Unionids) shells, along with aquatic gastropod shells (*Campeloma* and *Elimia*).

Excavation upslope from the shell midden exposed the outlines of 31 pit features and one hearth. As shown in Figure 2, most of the features overlap with other features, indicating repeated use of this area for pit digging. While we may never know the full extent of pit features on this landform, we can extrapolate the frequency and density of pits across unexcavated area bounded in all four cardinal directions by known pits, an area 9×18 m in plan (Figure 2). This amounts to 162 m^2, four times the size of the excavation area yielding pits (~40 m^2). Given the density of 0.775 pits/m^2 (31 features/40 m^2) observed in excavation, the extrapolated area is estimated to contain ~126 infilled pits.

Pits vary in size and shape, but co-dominant among them are large cylinders ($n = 10$) and hemispheres ($n = 10$). The balance consists of basins ($n = 3$), bell-shaped pits ($n = 2$), and pits of uncertain morphology ($n = 6$). Further consideration of pit morphology and condition below addresses the possibility that pits were involved in the storage (cylinders and bell-shaped pits) and processing (hemispheres and basins) of hickory nuts.

Pit fill does not necessarily relate to the purposes for which pits were dug (e.g., a storage pit whose contents were removed and then backfilled with refuse), but this arguably was the case at Victor Mills. Pit fill sampled for flotation or 1/8-inch waterscreening yielded charcoal and nutshell, but not bone or mollusk shell. Artifacts from pits match the array of materials from the mollusk shell midden inferred to be involved in

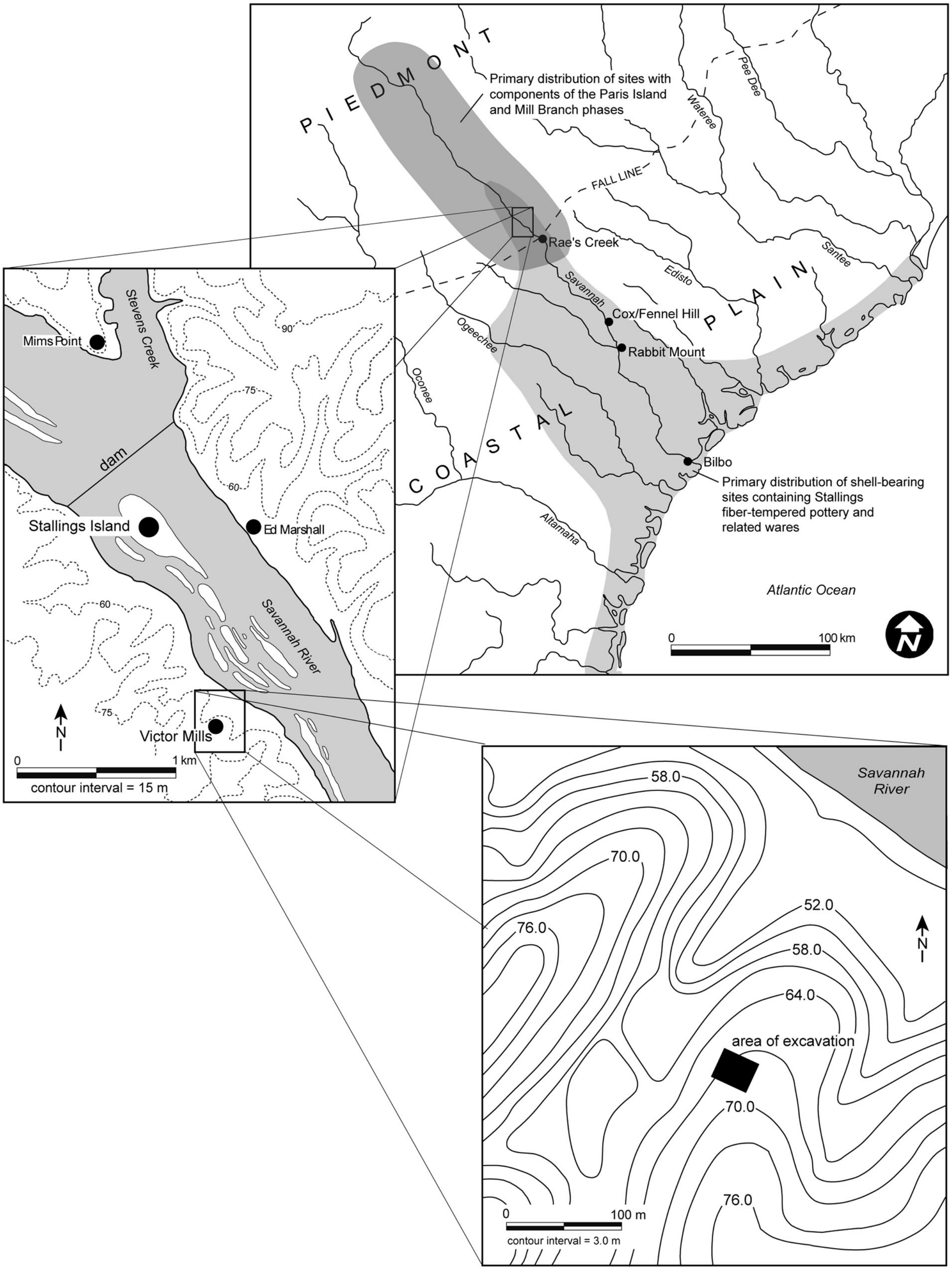

Figure 1. Topographic map of the immediate upland area of Victor Mills (*bottom right*) in the context of Stallings-era sites on and around Stallings Island (*left*) and the regional distribution of shell-bearing sites with pottery of the Stallings tradition, as well as their counterparts in the Piedmont (Paris Island and Mill Branch phases), lacking pottery.

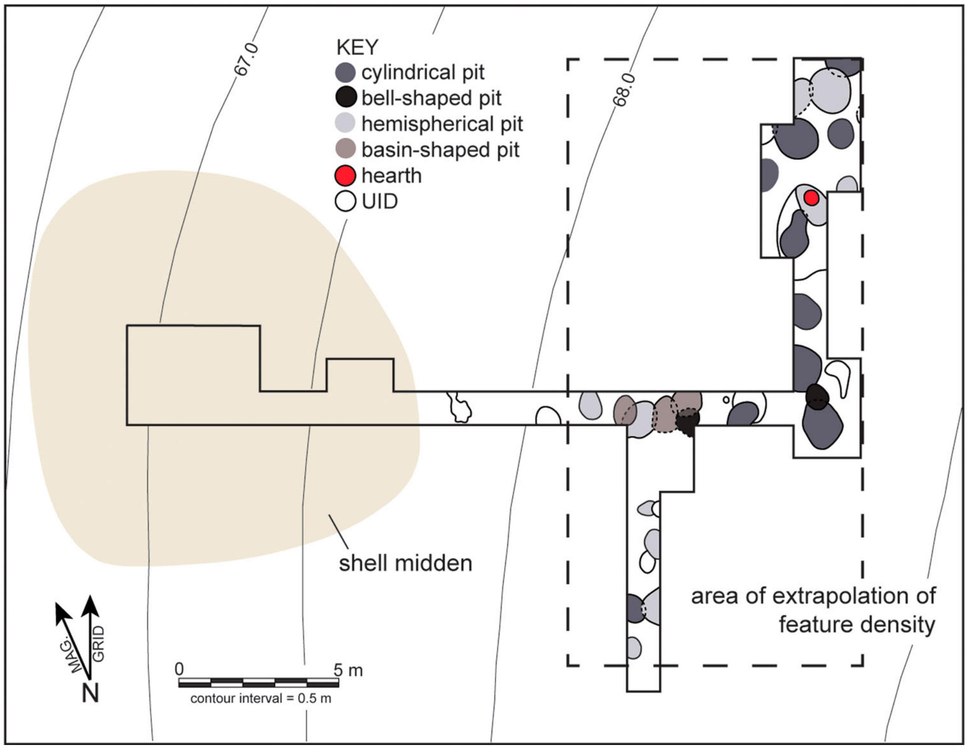

Figure 2. Planview of the excavation of Victor Mills (9CB138), showing features coded by type, and outline of area used to calculate minimum number of features site wide.

nut processing: fiber-tempered pottery, soapstone slabs, FCR, anvils, and hammerstones.

Distributed widely across the excavated portion of Victor Mills are the byproducts of making hafted bifaces from local quartz river cobbles. Lesser numbers of biface fragments and flakes consist of chert from the Coastal Plain downriver and occasional metavolcanic material from sources more proximate to the site. Although flaked stone in the assemblage possibly includes edged tools used in the processing of hickory nuts, the prevalence of white-tailed deer among the larger faunal remains points to a considerable amount of hunting launched from the site, as well as butchering and consuming on site. Although small in number, Coastal Plain chert biface fragments suggest that visitors to Victor Mills traveled from points downriver, where Early Stallings sites abound.

It is worth emphasizing that the area tested at Victor Mills does not appear to be a biased sample of a much larger site. Although the results of reconnaissance survey showed the site to extend 40–50 m north, east, and south of the excavation, positive shovel tests on these margins contained but a few pieces of quartz debitage and cracked rock, and no additional shell. Indeed, shell midden at Victor Mills is restricted to the ~150 m^2 area of side slope that was trenched. The top of the ridge, where pits were dug, completely lacks any midden even as it supported activities other than pit digging. Evidently, most organic refuse from activities upslope was deposited downslope. Although the content of the midden speaks to more than the harvesting, processing, and storing of nuts, nothing about it or the pit assemblage recommends Victor Mills as a place of prolonged habitation.

In sum, salvage excavations at Victor Mills intercepted two very different types of deposits (shell midden and pits) that were spatially segregated but shared a suite of artifacts expected of mast processing. Relevant expectations follow from ethnohistoric sources, but ultimately they must manifest in observable outcomes, that is, the archaeological residues of technology needed to store hickory and process it for consumption. We thus return to the residues of Victor Mills to substantiate this inference after reviewing ethnohistoric sources and modern studies to outline the expectations for harvesting, storing, and processing hickory.

Harvesting, storing, and processing hickory nuts

The ubiquity of charred nutshell in archaeological contexts across the Eastern Woodlands is tacit evidence that hickory nuts were routinely collected, cracked, and consumed, but it does not indicate that nuts were stored, nor does it necessarily reflect the dietary contribution of hickory relative to other mast, notably acorn. Because hickory nuts have an exceptionally thick husk and hull that when charred preserve well compared to acorns, they are likely to be overrepresented in botanical assemblages (Yarnell 1982). Still, even with a compensation factor of 50, hickory nutshell remains outnumber acorn remains in deposits dating to the Middle, Late, and Terminal Archaic periods in the Eastern Woodland (Yarnell and Black 1985:103). For the ubiquity of hickory nutshell to rise to the level of a stored resource, harvests have to attend to several logistical constraints.

Harvesting hickory nuts

The logistics of nut harvesting are complex, but can be anticipated in advance of harvesting with experience (Gardner 1997; Nixon et al. 1980). Like other mast, hickory nuts are available for collecting from the ground from late September through late November, with optimal harvests spanning mid-October through mid-November (Munson 1984:462; Scarry 2003:60). However, annual mast yields are irregular. Although some species of hickory yield nuts every one or two years, other species produce only every three to five years, with sparser crops in intervening years (Abrams and Scheibel 2013; Asch and Asch 1978; Bonner 2008; Sork et al. 1993; Talalay et al. 1984). Also known as "mast years," highly productive seasons provide an exceptional opportunity to collect large quantities of nuts within a short period of time. Mast years also draw in populations of nonhuman nut eaters such as squirrels and are quickly removed from the forest floor (Asch and Asch 1978; Talalay et al. 1984), leaving limited time for humans to harvest nuts after they fall. Insect and microbe infestation further shortens the opportunity for harvesting high-quality nuts.

Because hickory trees are long lived, select trees could be monitored and harvested over several human generations. Time-to-maturity and longevity varies by species, but in general a healthy hickory tree can be expected to produce fruit for at least 150 years. Apart from commercial silviculture, most species of hickory do not grow in stands but are instead individually scattered among other hardwoods and pines. Moreover, aside from mast years, the yields of "natural" production may not account for the level of hickory use inferred from archaeological evidence, implying some form of intervention, if not outright silviculture (Abrams and Nowacki 2008; Munson 1986). Repeatedly targeting a group of scattered trees does not qualify as husbandry, but to the extent mast years among scattered trees were synchronized (e.g., Sork 1983), "natural" harvests could be bountiful.

That Early Stallings people repeatedly targeted a particular set of trees for harvest is hardly remarkable. What is remarkable is that they seem to have targeted trees that were distant from places of habitation, which is to say that they targeted trees of the Lower Piedmont and Fall Zone while spending most of their time downriver, in the Coastal Plain. Travel up and down the river was no doubt motivated by a variety of factors (e.g., deer hunting, acquiring soapstone), but among them arguably was access to varieties of hickory that were not available in the Coastal Plain. Chief among them were shagbark (*C. ovata*) and shellbark (*C. laciniosa*), which produce sweeter fruit than most species of hickory. "Shell bark hiccory" was noted by Bartram (1973:38) as the preferred species of Creek Indians he visited west of Augusta. Modern analysts consider Bartram's *Carya exaltata* to be a synonym for the more common and widespread shagbark hickory, which extends down from the Midcontinent to the Fall Zone of the south Atlantic slope, but not into the Coastal Plain. Other species of hickory – bitternut (*C. cordiformis*), water (*C. aquatica*), mockernut (*C. tomentosa*), pignut (*C. glabra*), and sweet pignut (*C. ovalis*; Radford et al. 1968) – thrive today in the Coastal Plain and along the Atlantic coast; all are edible but other than mockernut can be quite bitter. Unfortunately, the pulverized remains of charred hickory nutshell from archaeological deposits cannot be classified by species. All such remains from Victor Mills and other Stallings sites can be taken only to genus, *Carya* spp. (Auten 2004). Nonetheless, the quality of shagbark and shellbark hickory compared to most Coastal Plain species likely factored into decisions not only to travel some distance to gather the nuts of Piedmont trees (likely in conjunction with other activities, such as deer hunting), but also to stockpile them near harvested trees to bridge years of exceptional production.

Storing hickory nuts

Ethnohistoric insight on storing hickory nuts is limited to what Bartram (1973:38) observed among Creek households in Georgia: "… the fruit is in great estimation with the present generation of Indians, particularly juglans exaltata, commonly called shell-barked hiccory. The Creeks store up the last [latter] in their towns. I have seen above a hundred bushels of these nuts belonging to one family." With nothing to compare, it is impossible to generalize from this brief mention, but it is clear that stores were kept at residential sites (towns) and Bartram's observation on volume of nuts stored is useful for modeling storage capacity.

Historical accounts of subterranean storage of hickory nuts do not exist. Whether stored underground or in an above-ground granary, nuts have to be dried to ensure preservation for months or years. Sitting in the dry, open atmosphere of a Creek house, the water of nuts could have evaporated slowly. Quicker drying is enabled by applying low heat to whole nuts. One modern purveyor of hickory nuts recommends drying in a low-temperature oven (125°F) for an hour or two (Kudasik 2021). Lacking an oven, parching could also be accomplished on beds of rock that have been heated in an open fire. Failing to drive out the moisture of nuts before they are stored in an airtight container makes them vulnerable to rot.

If kept dry, cool, and out of sunlight, hickory nuts can be stored for years. Given this potential, it is worth considering that storing hickory nuts goes beyond the problem of overwintering noted in the literature (e.g., Gardner 1997:171; Moore and Dekle 2010) – a concern that diminishes with decreasing latitude and altitude – to a matter of ensuring access to a preferred resource across the unproductive time between mast years.

Processing hickory nuts for consumption

Referred to by Asch and others (1972) as a first-line resource, hickory nuts were undoubtedly a high-quality food resource (Gardner 1997; Keene 1981). Following a daily energy intake of 2,200 kcals, Gardner (1997:162) estimates that just 12 ounces (0.34 kg) of hickory nutmeat could feed a person for a day. It goes without saying that no Indigenous economy was predicated on hickory nuts alone, but given its ubiquity at archaeological sites across the Eastern Woodlands, hickory nuts factored significantly in Native diets.

In a survey of the Algonquin language adopted in English terminology, William R. Gerard (1907:91) indicates that *powcohicora*, or *pawcohiccora*, is an Algonquin word meaning the milk-like emulsion Native Americans in Virginia made from hickory nuts, in this case mockernut (*Carya tomentosa*). Although hickory nuts can be eaten straight from the shell, ethnohistoric accounts indicate that they were boiled in water to extract oil and nutmeat, a process that is less labor-intensive than manually removing the nutmeat from the shell but results in less overall edible product. Hudson (1976:301) estimates that 100 lbs. of hickory nuts generates roughly one gallon of oil.

Hickory nuts are enclosed within husks that dry and split open when the nut is ripe. These nuts have thick, strong shells that tightly surround the nutmeat within a convoluted structure of woody tissue. Experimenting with hickory nut processing, Talalay and others (1984) found that nutmeat is easiest to separate from the shell after it is sufficiently dry and then pulverized. They further indicate that hickory nuts would require crushing-and-boiling technology to make them calorically worthwhile (Talalay et al. 1984:356). Bartram (1973:38) observed Creek Indians pounding and boiling hickory nuts to render oil, sometimes called hickory "milk." He noted that this sweet, creamy oil was an ingredient used in "most of their cooking" (Bartram 1973:38). Hickory oil/milk is the most common nut product referred to in the ethnohistoric record and thus has been emphasized in archaeological research (Fritz et al. 2001:23; Gardner 1997; Talalay et al. 1984). While some ethnohistoric records describe hickory nut oil as milk, others make a distinction between the two products. Referring to the Creeks in 1799, Benjamin Hawkins (Hemperley 1971) described a process of crushing and boiling hickory nuts then skimming oil off the top; what remained was the milk. After simmering in water for some time, nutmeat separates from shell. Shell fragments sink to the bottom and the nut oil rises to the surface, where it can be skimmed off and used as a condiment or food additive. The remaining liquid contents render into a milky emulsion that can be strained, stored, and used in a variety of ways.

One variation on the processing and storing of hickory is found among the Cherokee of eastern Oklahoma (Fritz et al. 2001). A recipe involving "nut balls" is known by Cherokee people as *ku-nu-che*. As documented by Fritz and others (2001), hickory nuts are dried for several weeks or months to ensure the nut separates more easily from the shell, then cracked one or two at a time to prevent contamination from a spoiled or infested nut. After cracking the nuts, larger pieces of nutshell are removed before pounding the nutmeat with a large mortar and pestle into an oily meal that can be shaped into a ball. Measuring between 7 and 9 cm in diameter, nut balls can be stored for years if kept in a cool, dry environment. To make the hickory soup, *ku-nu-che*, the ball is added to hot water, where it melts into a milky concoction that is strained and served over hominy or rice. While there is no mention of hickory nut balls in the ethnohistoric record, Fritz and others (2001:23) rightfully argue that this process resulted in a storable product that would have been easier to transport from sites of processing than would containers filled with oil/milk.

Hickory nut oil/milk extraction and the production of *ku-nu-che* balls involve similar processing technologies, notably, some means to pulverize nuts that have been dried. They also both entail some means of containing water that can be heated. Added up, any archaeological residue of processing hickory nuts in mass can be expected to contain ample evidence of pounding tools, if inorganic (e.g., pestles, mortars, anvils, hammerstones); methods for quick-drying nuts, if not air died (e.g., fire-cracked rock, thermal features); containers for holding water (e.g., water-tight pits, pots); and the capacity to heat water in containers (e.g., cooking stones if indirect, thermal features). To this list, we can add evidence for nut storage, if subterranean (i.e., pits), which is the expectation if stores were left unattended (DeBoer 1988). The archaeological traces of Victor Mills meet expectations for mass storage and processing of hickory nuts at a place of transient but specialized use.

Archaeological traces of hickory nut storage and processing

Excavations at Victor Mills did not produce an abundance of hickory nutshell (although it was ubiquitous), let alone storage bins filled with hickory nuts. As DeBoer (1988:4) quipped, archaeologists are not likely to find pits filled with stored products, for that would be a "monument to failed intentions." The intent presumably was to remove stores as needed. Nonetheless, as "empty" pits, these features have good analytical potential: they tell us something about the technology of storage, as well as the capacity for storage, which we can model. Considering their association with technology suited to pulverizing and rendering nuts, the large cylindrical pits of Victor Mills more than likely once held nut stores.

Storage technology

Among the 31 pit features documented at Victor Mills are 10 that average about one meter wide and one meter deep. Classified as "cylinders," these large pits were suited to opportunities for below-ground storage. As summarized by DeBoer (1988), subterranean storage in the earth is most effective when the ratio of aperture to volume is minimized. In common terms, the opening to a below-ground vault ought not to be any bigger than is necessary to moves things in and out. A sphere with an opening at the surface fits the bill, but is impractical or even impossible to construct, or to keep from collapsing. The compromise is a bell-shaped pit, essentially a sphere with a neck that extends to the surface, minimizing the aperature: volume ratio without increasing vulnerability to collapse. Given that the upper portions of all pit features at Victor Mills were truncated at about 20 cm below the surface, cylinders may have been bell shaped. In lieu of bell-shaped pits, deep cylinders serve well the needs of subterranean storage. Large cylindrical pits at Late Archaic sites in the upper Duck River valley are referred to by Faulkner and McCollough (1982:172) as "silos," connoting a storage function.

Pits classified as cylinders were concentrated in the eastern, upslope area excavated at Victor Mills. Three of the 10 cylinders identified were fully profiled and sampled in bulk (Figure 3); the other seven were mapped in plan and augered to determine depth, but not further investigated. All pits in plan expressed organically enriched pit fill that stood in sharp contrast with the red clay of natural substrate. In two of the three cylinders profiled (Features 2 and 3), clay substrate in the lower portions, including the base, appears to be altered by heat. At the very base of Feature 2, a lens of dark reddish brown clay attests to thermal alteration; the relatively high density of charcoal flecks at the base of pit fill supports this inference. At the base of Feature 3 was a thin stratum of charcoal with small clasts of red clay. Continuing along the basal margins of the pit and about halfway up either wall was a hardened red clay, a presumed consequence of thermal alteration. As with Feature 2, matrix outside the pit margins transitions from red clay of the upper mantle to the reddish yellow clay of the deeper substrate. The friability of this deeper clay was likely a consequence of heat.

When first encountered in 1993, the thermal alteration of cylindrical pits was accepted tacitly by the first author as evidence for use as earth ovens. The more likely scenario is that fire was used to harden the base and lower sidewalls of cylinders to improve their use as storage containers. Pits may have also been capped with clay that was fired, although any such caps, if they existed, were destroyed by plowing. Hardened clay would be less vulnerable to infiltration of water and pests from without. As with digging into clay generally, thermal alteration of pits would be an investment in long-term storage, not a matter of convenience. It is hardly inconsequential that the persons who sought to harden clay pit walls with fire were themselves potters. The process and result of applying heat to clay would have been familiar to them.

Besides constructing adequate underground containers, nuts destined for long-term storage had to be dried. Plausibly, a freshly fired cylinder could serve to dry several bushels of nuts if left open until fully cooled. With pit volumes averaging about 24 bushels, this method alone may not have sufficed. Instead, the hemispherical pits at Victor Mills ($n = 10$; averaging 60.2 ± 11.7 cm below the surface) could have afforded batch parching of nuts with indirect heat. The source of heat invariably was fire, but like most Archaic sites in areas rich in rock,

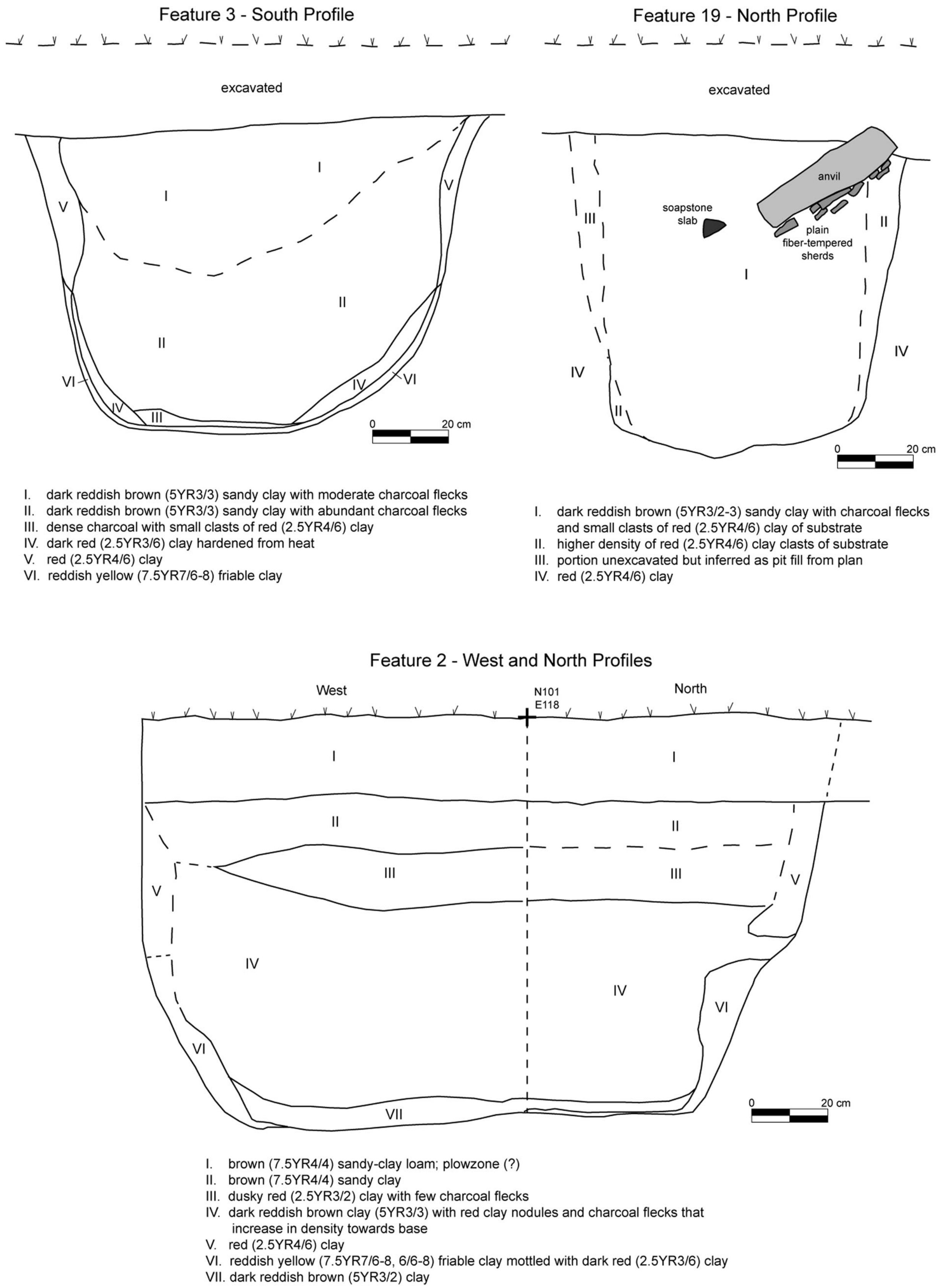

Figure 3. Profiles and stratigraphic descriptions of three large cylindrical pits, Victor Mills (9CB138). The profile of Feature 19 (*upper right*) shows large anvil, sherds of two plain fiber-tempered pottery basins, and a soapstone slab fragment in the pit fill.

the ubiquitous FCR attests to the pervasive application of heat to stone. Emplacing rock in hemispherical pits either over a bed of coals or beneath a fire results in a pavement of heat that dissipates gradually, ideal for parching nuts. Lacking along margins of hemispherical pits is evidence of thermal alteration, which suggests that fires were emplaced on top of rock. Although FCR was not routinely collected from general excavations, about half of the 47.5 kg recovered came from pit features.

Pulverizing technology

By all ethnohistoric accounts, processing hickory nuts for consumption began by pulverizing them. As noted in some of these same accounts, pulverization was accomplished with wooden pestles and mortars. Lacking better organic preservation, we do not know if wooden tools were involved in pulverizing nuts at Victor Mills, but clearly a large number of cobbles were drafted into impact and grinding activities. Rich in water-worn cobbles, the shoals of the Savannah River was a ready source of hammerstones, manos, and anvils.

Among the many cobbles recovered from Victor Mills are 61 that show traces of battering or grinding (Figure 4). Most common are cobbles that are small enough to be wielded in one hand and used as a hammer ($n = 41$), or less frequently, a grinding stone, or mano ($n = 4$). Evidence of use for the former group is expressed as facets of impact along lateral edges; many of these were undoubtedly used in the reduction of quartz cobbles for bifaces. The latter entails battering or grinding on one or both faces of a cobble. An additional 10 items consist of slabs of rock, mostly sandstone, too large to be used as hammers or manos, but with traces of battering on one or both faces. Classified as "anvils," most of these are fragments of sandstone slabs that fractured from use, although one whole example from Feature 19 shows how large (~41 × 41 × 13 cm) and heavy (22.1 kg) anvils can be.

In sum, locally abundant cobbles and slabs were used for activities involving rock-on-rock impact. Smaller hammerstones would have served the needs of quartz cobble reduction for making bifaces and other edged tools, while larger hammerstones were better suited for impacting materials on anvils. A few hand-sized cobbles were used to grind materials on one or more faces (manos), but the vast majority of the cobble and slab tools show impact attrition expected of battering or pounding, not grinding. The assemblage is consistent with expectations for processing hickory nuts by cracking and pulverizing.

Rendering technology

Ethnohistoric accounts of processing hickory consistently mention the use of containers for boiling or simmering pulverized nuts in water to render oil and milk, or, in the case of the Cherokee, to render balls into *ku-nu-che*. Long before pottery was available in the Eastern Woodlands, shallow pits lined with impervious material, such as animal hide, were more than sufficient to render oil/milk from hickory nuts (e.g., Stafford 1991). But heat could be applied only indirectly, using stone. Often referred to as "stone boiling," indirect-heat cooking was the chief means of heating water in any container that could not be placed directly over fire, portable or not. In most places with local access to stone, the pervasive FCR likely involved the byproducts of stone boiling, as well as dry heating, as noted earlier. In fact, repeated cycles of heating and rapid cooling of rocks such as quartz, granite, and sandstone lead to attrition from thermal stress. In the middle Savannah River valley, however, Archaic chefs drafted soapstone into thermal uses. With the ability to absorb and dissipate heat slowly, soapstone has superior thermal shock resistance over other rocks. Soapstone would eventually be used to make direct-heat cooking vessels (Sassaman 2006b), but long before then it was used to make indirect-heat cooking stones (Sassaman 1993). At about 4500 BP, people of Early Stallings culture introduced the first pottery vessels in the region: shallow, flat-bottomed vessels suited for indirect-heat cooking but ill-suited for use over fire. At places like Victor Mills and many other Early Stallings sites in the Savannah River valley, sherds of fiber-tempered vessels are usually associated with soapstone slabs.

Fiber-tempered sherds >1/2-inch recovered from Victor Mills are mostly plain ($n = 340$, 98.0%) and from the body or base of vessels ($n = 304$; 87.6%). Plain fiber-tempered sherds came from a minimum of 13 vessels, seven of which are represented by only rim sherds; only a few vessel lots involved reconstructed portions of bodies sufficiently large to estimate size and shape (Figure 5). Two vessel portions from the upper fill of one of the cylindrical pits (Feature 19), beneath the large anvil, came from shallow, open vessels with orifices of about 30 cm in diameter. Another vessel lot has a large enough rim portion to estimate orifice diameter (~32 cm), but its rim sherds provide only a shallow profile.

Despite the limited number of large vessel portions, the assemblage of plain fiber-tempered pottery is relatively consistent in terms of vessel size and shape. We suspect that most of these were open-mouthed, shallow vessels, roughly 30 cm in orifice diameter, and roughly

Figure 4. Select cobble tools and anvils suited to the pulverizing of hickory nuts: hand-sized hammers and manos (*three rows, upper left*); fragments of anvils (*right column*); and 22.1 kg sandstone anvil from Feature 19 (*bottom left*), *in situ* in photo at bottom right.

15–20 cm tall. They are what the senior author refers to as "basins" (Sassaman 1993:144–145), and he infers them to be containers from indirect-heat cooking. Occasional basal sherds in the Victor Mills assemblage attest to mostly flat bottoms, the sort of design that was conducive to indirect-heat cooking but unlikely to have provided effective direct-heat cooking, at least not prolonged cooking over fire. At least one basal sherd shows an advanced level of oxidation, presumably from use over fire, but it is especially thick (~17 mm) and thus not terribly conducive to thermal conductivity. None of the sherds from Victor Mills bears traces of soot.

Fragments of perforated soapstone slabs, amorphous nodules, and miscellaneous fragments of soapstone abound at Victor Mills (Figure 5). A total of 1,716 pieces weighing 11,481.1 g were distributed widely across excavation units and features. The most formalized items were shaped into slabs and then perforated off center with either a hollow reed (cylindrical hole) or tapered drill (biconical and conical holes). Slabs typically broke along planes intercepting holes. At least 42 perforated soapstone slabs are represented at Victor Mills by fragments retaining at least a portion of the margin created by drilling.

Figure 5. Remnants of the technology of indirect-heat cooking: fragments of perforated soapstone slabs (*top two rows*), and vessel portions and rim profiles of fiber-tempered pottery basins.

Misidentified as "net sinkers" in the 1931 report on Stallings Island (Claflin 1931:32), and by C. C. Jones (1873:337) nearly a half-century earlier, perforated soapstone slabs are now understood as a local innovation for indirect-heat cooking, with or without pottery (Sassaman 1993:116–119). Claflin (1931:32) reported over 2,500 flat, perforated slabs from Stallings Island and noted that they averaged about one-half inch (12.7 mm) thick. The Victor Mills assemblage includes similar examples, but also thicker perforated slabs, pitted slabs, and amorphous lumps. Arguably, an evolutionary sequence starting with slightly modified lumps to pitted and then perforated lumps culminated in the flat perforated variety so numerous at Stallings Island and other Classic Stallings sites in the region (Sassaman 2006a:44–45). Irrespective of form, many of the fragments and nodules from Victor Mills show evidence of heat exposure, notably rubification.

Missing from the Victor Mills assemblage are tangible traces of two items mentioned in ethnohistoric sources that factored into the final steps of rendering. The first is some sort of sieve for separating edible product from inedible shell fragments. Fabric or basketry would have served this purpose, but like the uncharred nutshell captured by these materials, they rarely survive in archaeological context. The second is a container for the edible product, which is expected to be liquid. Again, organic media are implicated, but the lack of evidence has perhaps less to do with preservation than it does transportation, in this case away from the site.

Discussion

Establishing that hickory nuts were stored and processed at a nonresidential location invites discussion of the broader land-use practices of Early Stallings communities. Taking this further to suggest that nuts were stored below the ground to conceal them begs consideration of the relationship of those storing nuts to others on the landscape. Since the time of mitigative work ahead of the Richard B. Russell Reservoir in the 1980s (Anderson and Joseph 1988; Wood et al. 1986), we have known about communities of the Piedmont that never adopted pottery but shared with Early Stallings people the use of soapstone for cooking, winged bannerstones, and large stemmed hafted bifaces. Communities of Mill Branch cultural affiliation (ca. 4700–4100 cal BP) left a large archaeological footprint in the middle Savannah River valley, but their use of sites in the floodplain or along the ridge noses overlooking the river ceased after about 4400 cal BP, not long before activity at Victor Mills picked up. Over the ensuing two to three centuries (while Victor Mills was active ca. 4350–4050 cal BP), people of Mill Branch affiliation occupied sites in the nearby uplands of the valley (e.g., Elliott and Sassaman 1995; Ledbetter 1995; Sassaman and Anderson 1995), within a one- or two-day walk from Victor Mills. The coincidental abandonment of riverine sites – including Stallings Island – by people of Mill Branch identity and the onset of Early Stallings activity at Victor Mills lends credence to the idea that stores were being concealed from "others."

Irrespective of concealment, by decoupling subterranean storage from sedentism, DeBoer (1988) points to the need to investigate relationships among sites in a network of movement. In the cases he cites, DeBoer describes the familiar seasonal round of mobile hunter-gatherers in which stores are left behind at places of habitation. There is little to suggest that Victor Mills was ever a place of habitation in this sense; rather, it has all the hallmarks of a place of intermittent use. From where then did Early Stallings people deploy to Victor Mills?

Lacking perfect knowledge of site distributions in the region, we temper our answer to this question by acknowledging the usual sample biases. Early Stallings sites known to us by excavations, collections, and radiometric dating include several possible coeval home bases from which forays to Victor Mills were launched. The most geographically proximate candidate is the Ed Marshall site (Sassaman 2006a:73–76), located a little more than one kilometer north of Victor Mills, across the Savannah River. Several kilometers downriver is Rae's Creek (Crook 1990), followed in the Coastal Plain by Cox/Fennel Hill (Cook 2015) some 75 km distant and Rabbit Mount (Stoltman 1974), another 20 km farther. At ~180 km from Victor Mills, the Bilbo site (Crook 2009; Waring 1968) near the coast is the most distant.

Judging only from inventories of coeval material culture, persons who dwelt at any of these five sites could have regularly traveled to Victor Mills. It is reasonable to expect that sites close to one another were more likely connected than sites farther apart. If so, Ed Marshall and Rae's Creek were more likely home bases than any in the Coastal Plain. However, the presence of abundant soapstone at middle Coastal Plain sites far away from geological sources (Sassaman 1993:123) hints at possible long-distance forays into the Piedmont.

An additional line of evidence for intersite connections is the granular data of ceramic petrography (Sassaman and Gilmore 2021). What these data show is that the pottery from Victor Mills has greater technical affinity (e.g., percent fiber and sand grain size) to pottery from Cox/Fennell Hill and Rabbit Mount than it does to either of the more proximate sites. Neutron activation analysis enables us to infer that a few vessels at each site were made on nonlocal clays (Gilmore et al. 2018), suggesting that groups moving along the river traveled at least occasionally with some vessels in tow.

If indeed groups who spent most of their time in the middle Coastal Plain at sites like Cox/Fennell Hill and Rabbit Mount were traveling routinely to places like

Victor Mills to store and process nuts, ecological limits of mast production proximate to residential bases provide one possible reason for traveling upriver, as discussed earlier. Shagbark and possibly shellbark hickory trees of the Piedmont and Fall Zone were likely targets.

Allowing that people traveled to Victor Mills to harvest and store select nuts in large cylindrical pits, we can model storage capacity from known pits and then extrapolate to the larger population of pits. Table 1 lists the dimensions of six cylindrical pits for which we have reasonably good plans and profiles (Features 2, 3, 19), or at least good plans with depths estimated by augering (Features 20C, 23, 25). With these figures, we can estimate pit volume, shown in Table 1 as cubic meters, US bushels, and liters. These pits, 0.86 m^3 on average, could have held nearly 24 bushels or ~862 liters of nuts each.

Pit volume can be translated into counts and weights for nuts with reference to modern samples. Dried and unshelled shellbark and shagbark nuts obtained by the second author were counted and weighed for a standard volume of one liter.[2] Shellbark nuts are larger and heavier than shagbark nuts but weight per unit volume is similar, 716.5 and 700.2 g/liter, respectively (Table 1). With an average pit volume of 862.5 liters, pits could have held on average nearly 52,000 shellbark nuts or over 81,000 shagbark nuts, amounting to ~618 and ~604 kg per pit, respectively. Although each pit clearly could hold abundant nuts, it would take four pits filled to capacity to match the 100 bushels stored by a Creek household visited by Bartram (1973:38).

We do not know how many cylindrical pits held nut stores at the same time, although the overlapping outlines of infilled pits precludes simultaneous use in some cases. Extrapolating beyond the area excavated, as discussed earlier, an estimated 40.5 cylindrical pits were excavated and used at Victor Mills over the span of two to three centuries. Hypothetically, if only four were active at once, the extrapolated assemblage of 40.5 would account for 10 sets. Given the investment of time to dig large pits into clayey soil and to hardening the walls with heat, it stands to reason that pits were used repeatedly before being abandoned. If our hypothetical four cylindrical pits lasted as a set for 10 years, then the total span of using all extrapolated pits in sets of four would be a century. Cutting sets in half (i.e., two) or doubling pit longevity gets us to two centuries. It is worth noting that given the periodicity of mast years, stores were not likely filled every year.

In translating stores to edible product, we must consider that only about 35% of raw, unshelled nuts is edible, and that fraction goes way down (to ~7.5%) if only nut oil is extracted. Considering Hudson's (1976:301) estimate that roughly one gallon (3.8 l) of oil can be rendered from 100 lbs. (45.4 kg) of hickory nuts, the single-use store of an average pit would have yielded ~13.5 gallons (51.1 l) of nut oil.

This disparity between stored mass and edible product raises the question of labor costs involved in utilizing hickory nuts. Clearly, the cost of processing nuts is nontrivial, but the cost of harvesting nuts relative to edible product is perhaps much higher. With pits holding between 604 and 618 kg of dry nuts on average, each storage pit would take about 30.5 loads weighing 20 kg (44 pounds) to fill. This burden increases when we factor in the water weight of raw nuts. Given the seemingly high costs of harvesting raw hickory nuts, we can assume that nuts destined for storage were not transported far from trees of harvest. It is worth considering, however, that the relative costs of transporting nuts over greater distances could have been ameliorated by embedding harvests in other mobile tasks, like deer hunting.

As noted at the outset of this paper, recovered from Victor Mills was a sizable assemblage of flaked stone tools ($n = 143$) and the byproducts of their manufacture ($n = 4{,}093$). The vast majority of debitage, bifaces, other edged tools, and biface preforms was made on quartz river cobbles not unlike those used as hammerstones and manos but considerably more vitreous.

The morphology and pattern of breakage of most of the stemmed hafted bifaces from Victor Mills point to primarily projectile functions (Figure 6). The same applies to quartz river cobbles that were reduced first into blanks, then preforms, and finally dart tips. Exhausted or broken hafted bifaces made from Coastal Plain chert ($n = 6$) likewise include forms conducive to projectile uses and they point to the direction (i.e., downriver) from which persons visiting Victor Mills arrived. That these tool users would endeavor to produce so many bifaces from local toolstone implies that they intended to remain in the area long enough to use them before returning to the Coastal Plain and its more isotropic toolstone.

Deer hunting forays launched from Victor Mills would have been completely compatible with nut harvesting, at least schedule-wise. The rutting season (i.e., the time of mating when deer are more active during the day and easier to hunt) for white-tailed deer in the study area begins as early as late September, coincident with the early fall of hickory nuts. The rut can last well into winter but usually peaks in early November, about the same time hickory trees have released all of their seed.

If deer hunting and nut harvesting occurred simultaneously, both men and women traveled to the site in the fall for stays lasting at least a few days. A division

Table 1. Volume estimates of select cylindrical pits and projected storage capacities for nuts from two species of hickory.

Feat.	Len. (m)	Wid. (m)	Depth (m)	Volume			Shellbark		Shagbark	
				m^3	Bushel	Liter	ct	wt (kg)	ct	wt (kg)
2	1.00	1.00	1.09	0.86	24.3	856.0	51,360.1	613.3	80,464.1	599.4
3	1.40	1.20	1.05	1.39	39.6	1,394.1	83,640.1	998.9	131,036.1	976.1
19	1.00	0.84	1.10	0.73	20.7	731.0	43,860.0	523.8	68,714.1	511.8
20C	1.30	1.26	0.80	1.03	29.2	1,029.0	61,740.1	737.3	96,726.1	720.5
23	0.90	0.80	0.90	0.51	14.5	510.7	30,642.0	365.9	48,005.9	357.6
25	1.30	0.76	0.80	0.65	18.6	654.0	39,240.0	468.6	61,476.1	457.9
Total				5.17	146.8	5,174.7	310,482.3	3,707.7	486,422.3	3,623.3
Mean	1.15	0.98	0.96	0.86	24.5	862.5	51,747.1	617.9	81,070.4	603.9

Note: shellbark: 60 nuts/liter, 716.5 g/liter; shagbark: 94 nuts/liter, 700.2 g/liter.

of labor is not unexpected, but it is worth considering that these two activities were complementary and integrated, not cleanly divided. Despite the argument that proximity to harvestable trees makes economic sense for storing mast, hunters encountering freshly fallen nuts at greater distance from Victor Mills may have opted to transport their find back, especially if they failed to take any deer on any given trip. A skin bag holding a bushel of hickory nuts would weigh about 23 kg (~50 lbs). Add a tumpline and a load of this size could be transported with only modest effort while freeing the hands for carrying weaponry or other items.

That Victor Mills was visited in the fall is certain. We are equally certain it was visited at other times of the year to retrieve and process hickory nuts. Evidence in support of visits in the late winter or spring comes from a handful of mature shad and sturgeon bone in the midden. Both are anadromous fish that historically entered the Savannah River in the late winter or early spring, depending on temperature, and made their way up to the Fall Zone, where the shoals impeded further travel while making them vulnerable to capture. The bony remains of suckers (*Moxostoma* sp.) bolster the evidence for spring visits to Victor Mills. While some of the sucker remains from Victor Mills are from young-of-the-year that were easy to net in the first fall of their life, others are from adults whose capture likely coincided with spawning season, in the spring.

Adding up all its affordances, the locality of Victor Mills offered good potential for sustained living: (1) direct access to mast and the game it attracts; (2) deep clay substrate conducive to subterranean storage; (3) proximity to the Savannah River floodplain and its beds of river cobbles; (4) abundant aquatic resources from the shoals and backwaters of the river; and (5) outcrops of soapstone no farther than 14 km upriver (Elliott 2017:40). These same affordances attracted river settlement of Mill Branch communities for centuries, at places like Stallings Island and Ed Marshall. But they abandoned these and other riverine sites in the decades before Victor Mills became a place of Early Stallings activity, and Mill Branch people never dug cylindrical pits for storage or other purposes, despite their pervasive use of hickory nuts.

Just as the onset of Early Stallings activity at Victor Mills coincided with a major shift in the settlement of Mill Branch people, the end of this activity (ca. 4050 BP) coincides with the occupation of Stallings Island and surrounding riverine sites by people known archaeologically as Classic Stallings (ca. 4050–3800 cal BP). Long regarded by the senior author to be the ethnogenetic consequence of interactions between Early Stallings and Mill Branch communities, Classic Stallings culture entailed greater settlement permanence and formality than ever before (Sassaman 2006a, 2016). In this context, large cylindrical pits found new purpose. Stallings Island and Mims Point, for instance, each have several large cylinders distributed across spaces that would suggest they were associated with particular households (Sassaman et al. 2006), not an entire community and certainly not a transient community. This change possibly signals a shift from public to private storage, although apropos DeBoer's (1988) argument, this change coincides with increased settlement permanence, so perhaps something other than storage is implicated. Indeed, large cylinders at Stallings Island and Mims Point are not only positioned at the presumed front of houses facing a common center (i.e., plaza), they are filled with diverse assemblages of artifacts, shell, vertebrate fauna, and plant remains, what most archaeologists would call "refuse." Whereas this may simply reflect the pragmatics of long-term living, some pits at Stallings Island used for burials and/or structured deposition lend credence to the hypothesis that pit digging and filling was at times ritualized (Blessing 2015).

Conclusion

The last few decades of archaeological research in the Savannah River valley has shown it to be a multicultural landscape during the Late Archaic period. Increasingly refined chronology enables at least century-scale control

Figure 6. A large assemblage of bifacial flaked-stone artifacts from Victor Mills (9CB138) is dominated by forms conducive to projectile functions. A subassemblage of bifacial blanks and preforms made from local quartz cobbles (*bottom three rows*) is complemented by finished and fragmented hafted bifaces of diverse raw materials, including Coastal Plain chert (*upper left row*).

over the sequence and contemporaneity of material residues of constituent groups. Recent geochemical and petrographic data provide insight on the movement of people and pottery. Benefiting from these advances in knowledge, we can imagine how the distribution and movement of persons who expressed themselves materially in different ways created the conditions under which stored resources would have been concealed (DeBoer 1988). Those traveling to Victor Mills from downriver invested considerable effort in digging big pits into tough clay. Although great efforts at storage could be interpreted as a risk minimization strategy (e.g., Halstead and O'Shea 1989; Ingold 1983; Kent 1999; O'Shea 1981), it was more likely a matter of ensuring access to a highly valued resource. No matter the reason for storage, if practiced at all, the material residues of Victor Mills are consistent with the technology of nut processing described in ethnohistoric accounts. Such activity could have taken place only outside the time of harvest if nuts were stored. Subterranean storage was not necessary, certainly not in the context of domestic living, as Bartram observed among the Creek. Lacking evidence of inhabitation and situated on the edge of overlapping settlement ranges of distinct communities, Victor Mills was the sort of place DeBoer (1988) had in mind for concealing stores out of sight.

How unique is Victor Mills as an archaeological site? Were it not for the small shell midden noted by Claflin in 1931 and late-twentieth century looting that exposed shell at the surface, Victor Mills may have gone undetected. Many more sites of nut storage and processing but lacking shell may exist along the ridge noses overlooking the river, where clay substrate is thick and access to the river direct. Even without shell and organic preservation, the usual reconnaissance surveys of CRM would encounter abundant FCR, cobble tools, flaked stone, soapstone, and sherds, like at Victor Mills, provided shovel tests are dug at an interval no greater than about 25 m. We have little reason to believe that sites like this are common in the middle Savannah River valley.

Salvage excavations at Victor Mills produced a material assemblage of artifacts and ecofacts with additional analytical potential. Underway at the time of this writing is a pilot study by the second author to detect biomarkers in sherds to evaluate the inference that fiber-tempered basins at Victor Mills were in fact used to process plant matter. Although lipids extracted from pottery are not expected to be specific to hickory nuts or any other plant matter, relative values of biomarkers for plants, terrestrial animals, and aquatic animals have potential for documenting variation in the functional specificity of pottery across sites and through time. The macroscopic aspects of Victor Mills make a strong case for a specialized site of hickory nut storage and processing, but the case will be much stronger if we could infer these activities from the microscopic residues of actual use.

Notes

1. Analyses of macrobotanical remains from Victor Mills and other Stallings sites in the middle Savannah River valley were conducted by Anna Elizabeth Auten with assistance from Dr. Lee Newsom. These results are reported in Auten's (2004) MA thesis, and those specific to Victor Mills are summarized in a recent technical report (Sassaman et al. 2021). In short, 1,166 pieces (30.0 g) of charred nutshell identified as *Carya* spp. occurred in all contexts of Victor Mills, both pits and midden, albeit at relatively low density. Of the 51 liters of fill processed by flotation, charred nutshell ($n = 263$) averaged 0.12 g/liter. Wood charcoal was higher in density at 0.19 g/liter. Charred acorn parts ($n = 14$; 0.1 g) occurred in only trace amounts. The only other plant remains of note were seven hackberry (*Celtis sp.*) seeds and one pawpaw (*Asimina sp.*) seed.
2. Shagbark and shellbark hickory nuts used to calculate nut count and weight per liter were purchased by the second author from an online vendor in Aiken, South Carolina. The extrapolated count of shagbark nuts/bushel (3,312.5) is appreciably less than the 6,200 nuts/bushel published by the USDA-Forest Service in their 2008 *Woody Plant Seed Manual* (Bonner 2008:335). The discrepancy goes to show how much regional variation exists in the size and weight of shagbark nuts. It also suggests that our estimates for nuts per unit volume are extremely conservative.

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We dedicate this paper to the memory of Warren R. DeBoer, whose 1988 paper in the pages of this journal, like so much of his work, stimulates the archaeological imagination like few others. Were it not for the vigilance of the late George S. Lewis, the opportunity to conduct salvage excavations at Victor Mills would have been lost. We are grateful to the landowner, Mr. Victor Mills, for indulging our interest. We are likewise grateful to Steve Webb, then of Law Environmental, Inc., for the foresight to find significance in a small, unassuming site. The Savannah River Archaeological Research Program of the South Carolina Institute of Archaeology and Anthropology (SCIAA) supported this effort with field and lab staff, funding, and collegiality. We are grateful to one anonymous reviewer whose astute comments helped us to avoid unsupported inferences.

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Data availability statement

All recovered materials, photographs, and paper records of the 1994 salvage excavations of Victor Mills by the first author, as well as the materials and records of reconnaissance survey by Webb (1992), are currently curated at the Laboratory of Southeastern Archaeology (LSA), Department of Anthropology, University of Florida. A complete technical report of the Victor Mills excavation and lab analyses is available on the LSA website (https://lsa.anthro.ufl.edu/).

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