



Functional and Stylistic Considerations of Mixed Grog- and Shell-Tempered Late Mississippian Pottery from the Nashville Basin

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ABSTRACT

Mississippian period ceramic assemblages in the Nashville Basin region of Tennessee are traditionally viewed as being overwhelmingly shell tempered. Our petrographic analyses of 30 ceramic sherds from three Middle Cumberland sites have revealed, however, the presence of grog, or crushed potsherds, in shell-tempered pastes in over 40% of our specimens. In our study, serving vessels are often tempered with both shell and grog, with one bowl rim containing solely grog. Cooking vessels tend to be tempered with coarse shell and contain only incidental grog. Grog tempering alongside shell has been only occasionally noted elsewhere in the regional literature, but the lack of its widespread recognition may be due to the difficulty of identification without the assistance of a petrographic microscope. It is not clear whether the addition of small grog particles to a shell-tempered paste offers any immediate functional advantages. Other studies suggest that grog temper could improve the workability of the clay, may reduce thermal shock, and may enhance a vessel's resistance to mechanical stress. The strong correlation of fine grog and shell temper with bowls, however, may constitute a low-visibility horizon marker for an extensive swath of the Late Mississippian culture area.

KEYWORDS

pottery; shell tempering; grog tempering; ceramic technology; thin-section petrography

Mississippian period (ca. AD 1000–1450) ceramic assemblages from the Nashville Basin region of central Tennessee, like those in the Mid-South and lower Midwest in general, are characterized by extremely high percentages of shell tempering. Typically, studies report that pottery tempered solely with shell comprise about 98%–99% of the ceramics of this time period, with Mississippi Plain and Bell Plain types prevalent but also a variety of decorated types, such as Barton Incised, Matthews Incised, Mound Place Incised, and O'Byam Incised, among others (e.g., Barker and Kline 2013; Moore 2005; Smith and Moore 2001; Trubitt 1998; Walling

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2000). Given this well-established pattern, our petrographic analyses of pottery samples from the Averbuch (40DV60), East Nashville (40DV4), and Kellytown (40WM10) sites have revealed the somewhat unanticipated common presence of grog particles, where they occur in over 40% of 29 specimens characterized by macroscopically observable shell-tempered pastes, with another bowl rim containing solely grog.

Ironically, the larger goal of our research on ceramic petrography is not focused on the identification of temper types, at least not as an end goal. Instead, we are analyzing paste composition as a means of tracking the movement of pottery during the late Mississippi period (ca. AD 1250–1450) in the Nashville Basin. We hypothesize this is a proxy for population relocations in the era preceding the abandonment of the region, associated with the so-called Vacant Quarter as defined by Stephen Williams (1990; see also Krus and Cobb 2018). The incidental discovery of grog temper as part of this work may prove to be an important signature for certain paste recipes, and our current study explores possible functional and stylistic relationships between vessel morphology, relative proportions of grog and shell temper, and temper particle size.

Although *grog* is sometimes used to refer to all fired-clay particles in a pottery vessel, our use of the term only applies to intentionally crushed pottery temper. This can be differentiated from natural plastic inclusions (e.g., clay particles) through techniques outlined in our methodology overview. The previous lack of recognition of grog temper in the region is perhaps not altogether surprising since the inclusions are extremely small and not readily discernible without the assistance of a polarizing microscope. Our analyses of sherd cross sections using this technology indicate that grog particles may be difficult to recognize even at high magnification. This case study demonstrates that the optical properties generated under polarized light, such as birefringence, are necessary to consistently identify grog and to differentiate it from other paste constituents.

The introduction of fine particles of grog into shell-dominated pastes has also been documented for late prehistoric ceramic traditions in the Mississippi Valley and Caddoan regions (e.g., Buchanan 2017; Holley 1989; Million 1975; Perttula et al. 2011; Phillips 1970:60). Thus, our discovery may suggest that the Nashville Basin region is linked to this larger pattern. In the ensuing discussion, we describe the methodology of our petrographic analyses followed by a discussion of the technological implications of the ceramic sample fabrics. We then consider possible functional and social variables that may account for the occurrence of shell and grog admixtures for ceramic vessels in the region.

Methodology

The three sites in our study are all middle to late Mississippian sites in the Middle Cumberland drainage of the Nashville Basin (or Central Basin), a physiographic region in north-central Tennessee characterized as a topographic depression encircled

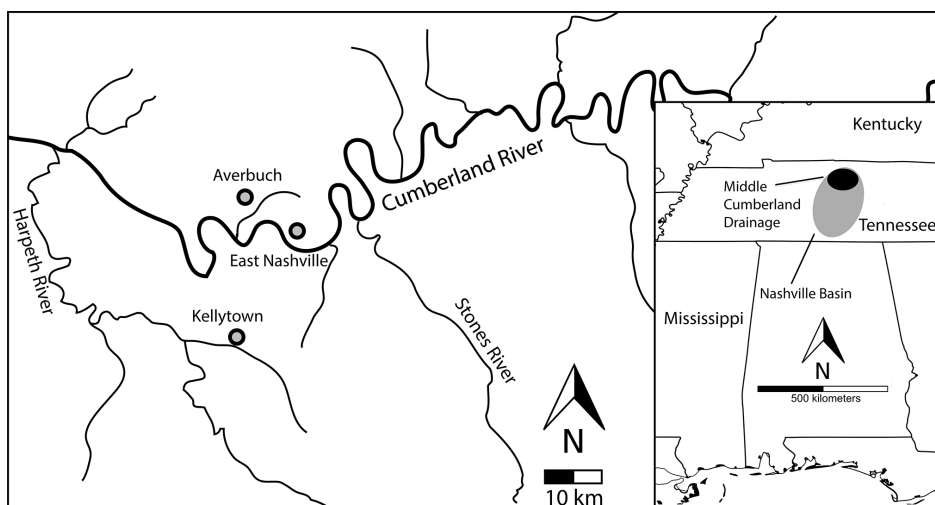


Figure 1. Location of Mississippian sites within the Middle Cumberland region as discussed in the text.

by rugged uplands (Figure 1; Miller 1974). This basin extends about 200 km north–south and 100 km east–west, and it is crosscut by several major drainages that include the Cumberland and Harpeth Rivers. The Mississippian period witnessed a particularly rich florescence in this region, distinguished by the relatively abrupt eleventh-century appearance of major mound centers like the Mound Bottom and Pack sites (Moore et al. 2016; O’Brien and Kuttruff 2012; Smith 1992) and an equally abrupt fifteenth-century abandonment as one of the easterly portions of the Vacant Quarter (Williams 1990; see also Krus and Cobb 2018). In our sample, the Averbuch (Klippel and Bass 1984) and Kellytown (Barker and Kline 2013) sites are fortified villages without earthworks that date late in the Thruston phase of AD 1260 to 1450 (as defined by Smith 1992); our ceramic samples from the East Nashville mound center (Walling et al. 2000) were selectively pulled from late contexts. As we elaborate in the concluding discussion, the late date of the sites may have an important bearing on the pottery technology, although the lack of early Mississippian pottery in our sample does make our conclusions provisional in this regard.

Vessel Lotting System and Sampling

Pottery vessels, represented by rim sherds, served as the primary analytical unit for this study. A central reason for focusing on vessels is that past potters likely combined specific forms with certain temper types and size classes to achieve desired effects (e.g., Braun 1983; see also DeBoer and Lathrap 1979). Steponaitis (1983:43–45) argued that Moundville potters may have selectively chosen coarse shell temper for cooking vessels because larger particles enhance thermal shock resistance. He (1983:36–37) further maintained that, unlike jars, bowls and bottles often contained fine temper because low densities of shell temper relative

to matrix increase a vessel's resistance to mechanical stress. This stress stemmed from the frequent hands-on use of these vessels for food consumption and preparation activities, where they would be prone to damage and breakage. Based on these ideas, he reasoned that Mississippian potters intentionally crafted paste recipes based on functional considerations. This supposition is supported by experiments on the effects of temper types and sizes on ceramic strength and thermal shock, indicating that decreasing grain size is inversely related to enhanced impact resistance (Bronitsky and Hamer 1986:97).

Our analysis relied on a lotting system that distinguished individual vessels by evaluating a number of attributes, including orifice diameter, wall thickness, profile shape, and temper. First, rim sherds were selected from appropriate contexts, ideally features (see [Supplemental Table 1](#) for detailed provenience information). We chose sherds from different proveniences whenever possible. Rim sherds are ideal for establishing vessel distinctiveness because they possess clearly identifiable attributes typically absent from undifferentiated body sherds. Next, rim sherds were sorted into major formal categories based on vessel form (e.g., jars, bowls, bottles). Alignment between recorded attributes of rim sherds was then used to establish vessel lots. For instance, two rim sherds from the same or different contexts with identical profiles, orifice diameters, wall thicknesses, and temper size classes most likely came from the same vessel. These sherds would be grouped analytically into the same vessel lot. In contrast, two sherds with similar wall profiles but divergent orifice diameters and temper types (e.g., shell vs. quartz) probably came from different vessels and were thus assigned to separate vessel lots. While this method may slightly downplay the number of vessels from an assemblage or a context, it eliminates redundancy by assuring the distinctiveness of each vessel (see Rice 2015:261–264 for review).

A nonrandom sample of 30 vessel lots was analyzed from the three sites (10 from each site), consisting of 29 shell-tempered plain and 1 Matthews Incised sherd. Identified vessel forms included bottles ($n = 1$), bowls ($n = 8$), effigies ($n = 1$), jars ($n = 16$), pans ($n = 3$), and unidentified restricted ($n = 1$; Figure 2). While shell temper was identified macroscopically in most sherds, grog temper was visible to the naked eye in only a few specimens (see [Supplemental Table 1](#) for detailed temper information). The subsample of sherds per site ($n = 10$) was restricted due to the monetary and time constraints of petrographic analysis. Depending on availability, sherds were also selected to provide a range of samples with different visible inclusions or tempers, types, or forms. In some instances, availability was so limited that sherds with indeterminate forms were sampled.

Functional Classes

We organized vessels into broad functional classes based on Vincas Steponaitis's (1983:33) and David Hally's (1986) seminal research on pottery technology, as well as on Emily Beahm's (2013) descriptions of Middle Cumberland vessels. Vessel

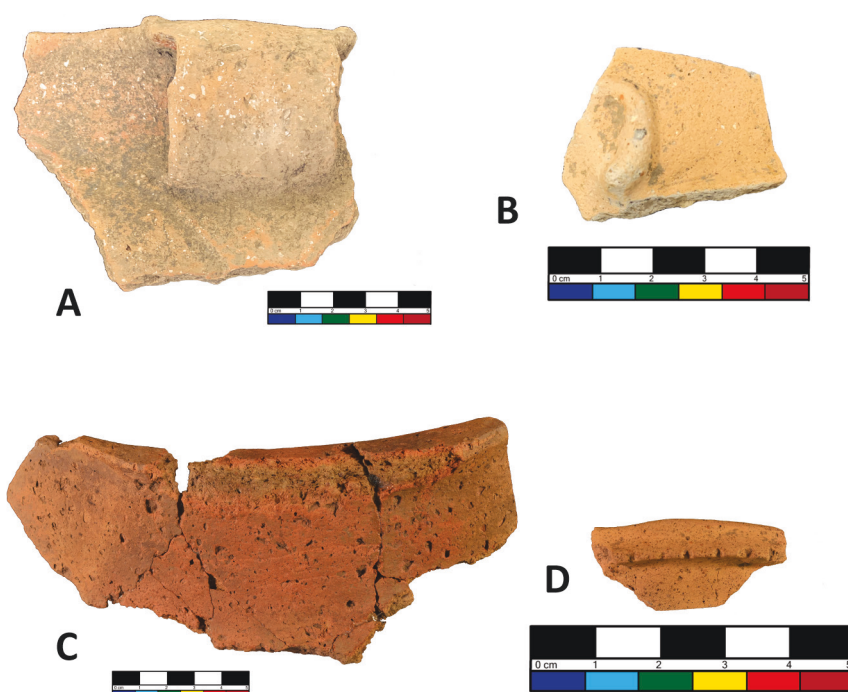


Figure 2. A few of the vessels analyzed in this study: (A) incised jar rim from East Nashville site; (B) effigy body sherd displaying ear from East Nashville site; (C) jar rim from Kellytown site; and (D) bowl rim with notched appliqué from Kellytown site.

function should be considered when contemplating temper selection because some form and temper combinations are better suited to specific tasks than others (Braun 1983; Shepard 1956:25–27, 130–131). While in an archaeological context it can be difficult to know definitively how a vessel was used, archaeologists can infer vessel use by assessing key functional attributes (e.g., Linton 1944). For instance, evaluating aspects of orifice restriction, wall thickness, and wall orientation can help a researcher to identify whether a vessel was most likely used for storage, cooking, transportation, or consumption (Rice 2015:412–415).

Cooking vessels—all of which occur in some variation of the “jar” form—are the dominant functional class represented in these assemblages. Jars ($n = 16$) are adapted to prolonged cooking because the globular body and neck constriction accelerate heating and minimize evaporative heat loss, yet the relatively wide orifice allows easy access to interior contents (Hally 1986; Wallis 2011:158). Hally (1986) and Briggs (2016) demonstrate these vessels were integral to hominy preparation among Mississippian agriculturalists.

The pans in our sample ($n = 3$) represent large shallow basins with very thick walls and large shell-temper inclusions. They may span up to 1 m in diameter and may have rims as thick as 30 mm to 50 mm (Beahm 2013:150; Eubanks and Brown 2015). Traditionally—given their abundance at salt spring sites—pans

have been associated with the processing of salt (Brown 1980; Dumas 2007; Eubanks and Brown 2015; Muller 1984). The received wisdom is that brine collected in these containers would yield salt cakes following a period of evaporation that involved some combination of boiling and exposure to sunlight (Eubanks and Brown 2015). There is some variability in the vessel types used to process brine, with smaller bowls and jars being adopted in the contact period (Brown 1980:87–88). In the Nashville Basin, where there is a significant salt spring near the East Nashville Mounds site, the typical large shallow pan forms prevail (Eubanks et al. 2021).

Bowls ($n = 8$) and bottles ($n = 1$) are well suited to food preparation and consumption. Bowls are particularly ideal for food preparation because their open, wide orifices facilitate manipulation of interior contents. They are less useful than jars for heating foods because the wide surface area near the rim accelerates evaporative heat loss, minimizing effectiveness for prolonged cooking or boiling (Hally 1986:286). It is worth noting that *bowl* is a generic term for a vessel wider than it is tall and, as such, can correspond to many functional categories (e.g., Wallis 2011:171–172; Willey 1949). However, we use the term to refer to relatively shallow vessels with wide, unrestricted or slightly restricted orifices (see Steponaitis 1983:68 for review of common Mississippian bowl forms). A single bottle, defined as a vessel with an elongated vertical neck at least one-third the height of the body, was also included in this sample. Maximum body diameters of bottles far exceed their orifice diameters, making them particularly useful for containment and storage. These same attributes, however, limit their utility for cooking.

Petrographic Analysis

The compositions of all 30 sherds were then analyzed in more detail using petrographic and point count analyses. Thin-section ceramic petrography is a method of ceramic compositional analysis used to study ceramic artifacts under a microscope (Quinn 2013:4). Petrography is useful for identifying the naturally occurring inclusions of parent materials, such as rock fragments or ferric concretions, and intentionally added tempers (e.g., Eramo 2020). The inclusions in ceramic sherds can also reflect provenance via variations in clay deposits and sequences of weathering (e.g., Montana 2020).

In our study, we chose ceramic sherds that were at least 5 cm by 5 cm in size. Each sherd was affixed to a microscope slide and ground to a thickness of approximately 30 μm to create a thin section. Ceramic petrography was conducted using a polarizing light microscope and a 10 $\times$ objective (total magnification = 100 $\times$). Once slides were made, point counting (at an interval of 1 mm) was used to quantify the relative abundance of constituents (i.e., clay matrix, voids, and various aplastics) within each ceramic sherd (Stoltman 1989, 1991, 2001). While totals vary due to differences in sherd size, a minimum of 200 points were taken per sherd (Stoltman 1989:150–151).

All inclusions we recorded while point counting were assigned to Udden-Wentworth silt, sand, and pebble size classes based on the maximum length of each inclusion (Lane 1947; Udden 1898, 1914; Wentworth 1922). A shell size index (SSI) was also used to assess the general size of the intentionally added shell temper in the ceramics. The SSI is a single number that reflects the average size of the shell temper in each thin section. Our index is based on the sand size index employed by Stoltman (2001:314). Our index ranges in value from 0.5 to 6, and shell inclusions are grouped by size based on their corresponding Udden-Wentworth size class. The classes are as follows: (0.5 = very fine) 0.0625–0.124 mm; (1 = fine) 0.125–0.24 mm; (2 = medium) 0.25–0.49 mm; (3 = coarse) 0.50–0.99 mm; (4 = very coarse) 1.00–2.00 mm; (5 = granule/very fine gravel) 2.00–4.00 mm; (6 = pebble/fine gravel) 4.00–8.00 mm. The SSI was then computed for each thin section by multiplying the number of inclusions in each class by the corresponding scale value and, subsequently, dividing the sum of these computations by the total number of shell inclusions recorded in that sample.

Because our point count total varied from one sample to another as a function of variation in cross section size, comparing the absolute frequency of grog between bowls and jars was problematic. In order to standardize the amount of grog per sherd, we calculated a grog index. The grog index is a single number that reflects the relative frequency of grog inclusions in each thin section. The grog index was computed for each thin section by dividing the number of grog inclusions by the total number of shell inclusions and shell voids recorded in that sample.

Results

As is well documented for Nashville Basin Mississippian ceramic assemblages, shell was far and away the principal constituent introduced by human agency, with other temper types reported only rarely (e.g., Barker and Kline 2013; Moore 2005; Smith and Moore 2001; Trubitt 1998; Walling 2000). Shell temper is represented by shell fragments and platy voids that form from the dissolution of shell (Figure 3A–B). This temper type was observed in all sherds except for one bowl rim that only contained grog temper. Shell inclusions varied by size and frequency, but most were coarse (0.5–1 mm) or very coarse (1–2 mm) in grain size. This tempering agent likely derives from freshwater bivalves. Other researchers in the Southeast have identified freshwater mussels as temper through pottery thin sections (e.g., Steponaitis 1983:20), as well as macroscopically (Feathers 2006:92). The microstructure of the shell fragments in our samples indicates that bivalves were indeed utilized as temper in the shell-tempered ceramics we analyzed. The fragments exhibit the laminae typical of the development of layers of sheet nacre. Nacre, also known as “mother-of-pearl,” can be compared to brick and mortar, with the former composed of inorganic aragonite and the latter of biopolymer (Yao et al. 2013). This microstructure is characteristic of bivalves, although definitively

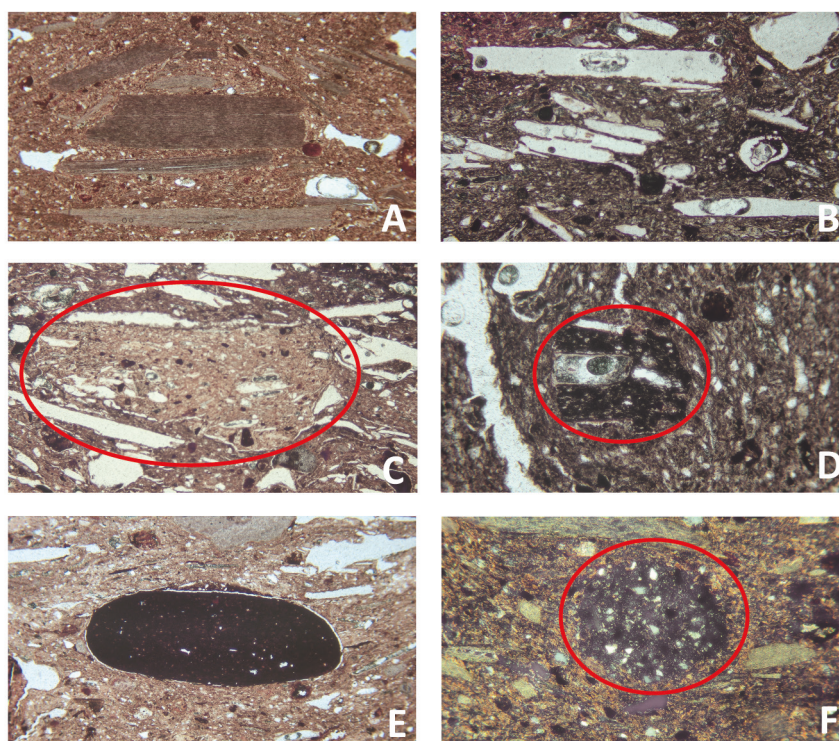


Figure 3. Thin-section photomicrographs of microscopic inclusions: (A) shell-temper inclusions in sample 40DV60-3 (image width ~2 mm); (B) shell-temper inclusion voids in sample 40WM10-2 (image width ~2 mm); (C) shell-tempered grog inclusion (circled) in sample 40WM10-20 (image width ~2 mm); (D) shell-tempered grog inclusion (circled) in sample 40WM10-3, (image width ~0.75 mm); (E) ferric concretion in sample 40WM10-21 (image width ~2 mm); (F) clay pellet (circled) in sample 40DV4-12 (image width ~0.75 mm). Images A–E were taken using plane polarized light, and Image F was taken in cross polars.

identifying these fragments as freshwater mussels is not possible using petrography alone (Yao et al. 2013).

The shell size indices in our assemblage generally conform to these expectations (see [Supplementary Table 1](#); Figure 4). Jars and pans overall have the highest SSI, with an average jar SSI of 2.83 and an average pan SSI of 2.96 (Figure 5). These values are considerably higher than for the bottle and bowls. The single bottle has an SSI of 2.32, and the seven bowls with shell temper have an average SSI of 2.31. A t-test indicates that there is a significant difference between the mean SSI for jars and bowls ($t = 5.13$; $p < 0.01$), lending support to the hypothesis that the difference in shell-temper sizes between the two vessel forms is the result of directed behavior.

Unexpectedly, grog temper or recycled, crushed potsherds were also found in over 40% of the total sample ($n = 13$) and across all three sites (Figure 6). Most grog inclusions are medium (0.25–0.5 mm), coarse (0.5–1 mm), or very coarse (1–2 mm). It should be emphasized that a variety of ceramic inclusions in addition to

Shell (Temper) Composition Diagram

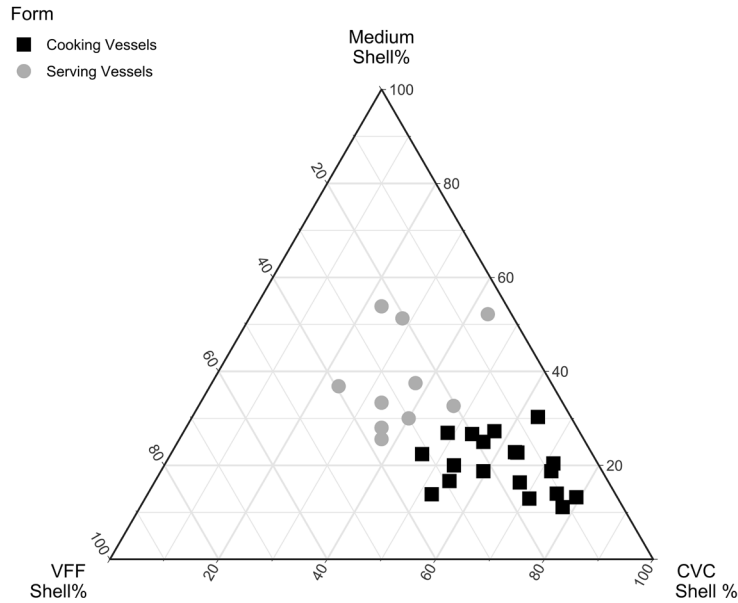


Figure 4. Shell-size ternary diagram (Very fine/Fine shell % $\times$ Medium shell % $\times$ Coarse/Very Coarse shell %). Shell fragments were measured using petrographic analysis, and grain size was determined using the Udden-Wentworth scale. Vessels are labeled by likely function: cooking (jars and pans) or serving (bottle, bowls, and effigy elements [the latter we believe derive from a bottle or bowl instead of a figurine]). The single unidentified vessel is not included in this diagram.

Common Vessel Types by Shell Size Index (SSI)

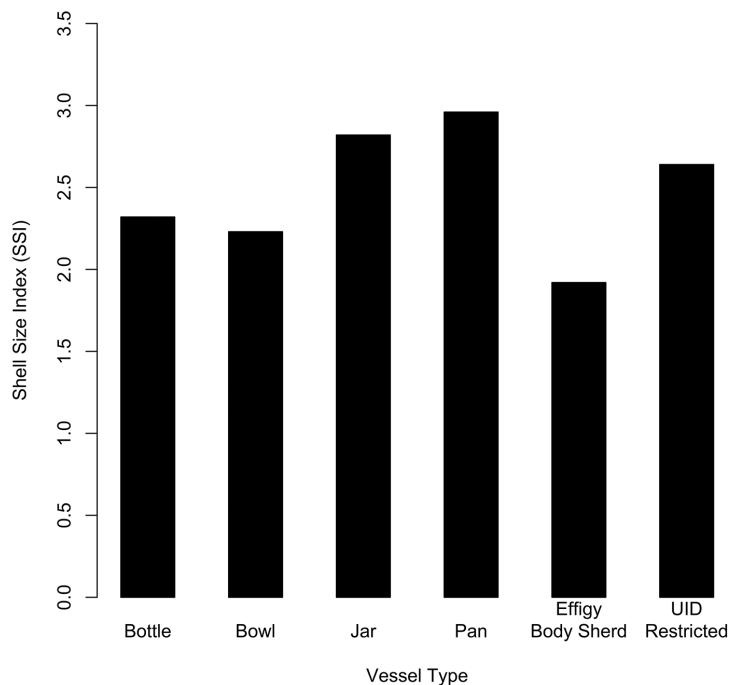


Figure 5. Average shell size index (SSI) for each vessel type category identified from Averbuch (40DV60), Kellytown (40WM10), and East Nashville Mounds (40DV4) sites. Shell size was measured through petrographic analysis.

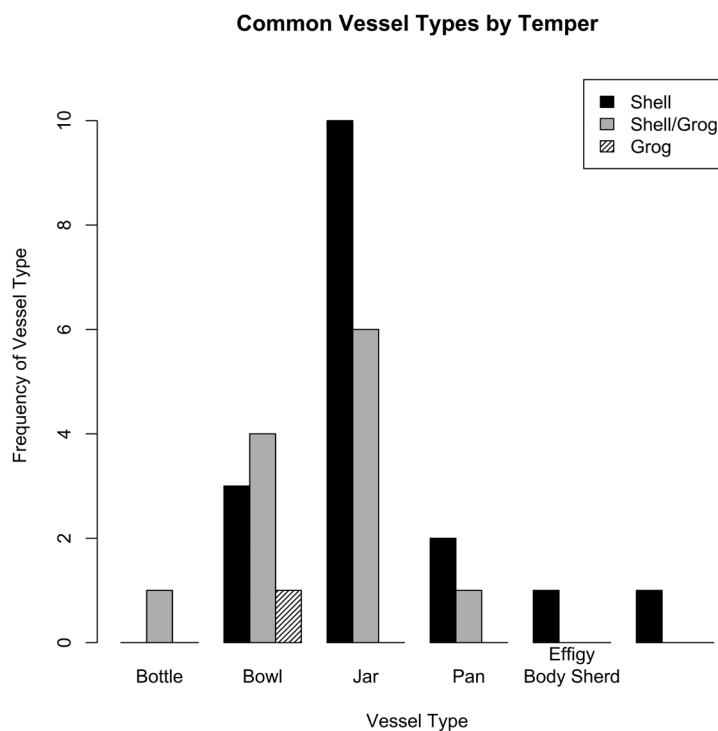


Figure 6. Frequency of tempering agents utilized at Averbuch (40DV60), Kellytown (40WM10), and East Nashville Mounds (40DV4) by vessel type. Temper was identified through petrographic analysis.

shell and grog were identified through petrographic analysis, and some of these may be mistaken for grog (see Figure 3). Many of these are presumed to be naturally occurring in the clay due to their small size and overall low abundance in the sherds. These include very fine (0.0625–0.125 mm) and fine (0.125–0.25 mm) monocrystalline quartz, which was found in most samples.

Less frequently observed inclusions that could only be detected under magnification in thin section include polycrystalline quartz (quartzite), mica, feldspars, metamorphic rock fragments, bioclasts (likely algae), ferric concretions, and clay pellets. Ferric concretions are rounded, iron-rich inclusions that may contain silt or sand-sized fragments, most often quartz (see Figure 3E; Quinn 2013:61). We identified ferric concretions as opaque inclusions with defined boundaries and often present in hues of red, although, in some instances, the colors may be so dark as to appear dark brown or even black (Quinn 2013:198–200). Clay pellets are rounded, equant, miniscule balls of clay, often containing silt or sand-sized inclusions (see Figure 3F; Whitbread 1986:83–84). We distinguished the clay pellets from the rest of the matrix by differences in their fabrics, which may contrast with that of the surrounding matrix. Clay pellets may

be darker than the surrounding matrix due to the relative quantity of oxides or the density of the pellets themselves. The boundaries of clay pellets may be sharp but may also seem to partially blend or merge into the surrounding matrix (Whitbread 1986:84).

Most of the inclusions are readily distinguishable macroscopically. Clay pellets and ferric concretions are potentially problematic, however. At a macroscopic level, or even at a low magnification, they may be mistaken for grog or each other since they occur in similar sizes and colors (Herbert and Smith 2010). In thin section, we identified ferric concretions and clay pellets based on a few criteria (see Figure 3). First, grog inclusions tend to be angular in shape (Whitbread 1986:82). The angularity of grog derives from the fresh crushing of pottery prior to its use as temper, the recent preparation of which shows no evidence of rounding due to weathering. The aplastic nature of fired clay (grog) also makes the material rigid and less susceptible to rounding (Rice 2015:203; Whitbread 1986:82). Clay pellets and ferric concretions tend to have a more rounded shape owing to the weathering and erosional processes inherent in clay formation (Quinn 2013:61). Additionally, due to the plastic nature of clay pellets, their rounded shape may be enhanced by vessel forming (Whitbread 1986:84). Second, grog elements can have a visible temper. In Mississippian ceramics, grog inclusions are typically tempered with shell (e.g., Green et al. 2020). Third, grog inclusions have defined boundaries. While ferric concretions also have defined boundaries, clay pellets can have merging boundaries, where part of the inclusion blends into the matrix (Whitbread 1986:84). Fourth, and finally, differences in opacity, color, and naturally occurring inclusions may also be used to differentiate these inclusions from grog at the microscopic level. This is especially true for ferric concretions, which are opaque and usually appear in shades of red (Quinn 2013:198–200). In sum, the grog inclusions in our sample were identified by these characteristics that distinguish them from other inclusions.

While grog was associated with most vessel morphology types, these inclusions were identified in the highest percentage in bowls. Most of the bowls (4 of 7) include grog alongside shell temper, with an additional example consisting solely of grog temper, and were typically medium (0.25–0.5 mm) or coarse (0.5–1 mm) in size. Grog inclusions were in about one-third of the jars ($n = 6$), with particles ranging from fine (0.125–0.25 mm) to granule (2–4 mm) in size, but they occurred with very low frequency in the matrix compared to the bowls. The average grog index for the four bowls was 0.4 and for the five jars it was 0.05 (see [Supplementary Table 1](#); Figure 7). In other words, when grog does occur in jars (which seemingly is far less common than for bowls), its abundance is very low. It is possible that the rare grog inclusions in the cooking vessels were introduced as an accidental by-product of preparing clay pastes for bowls (which seem to have purposefully introduced grog inclusions) in the same physical setting used for preparing the paste for the jars and pans.

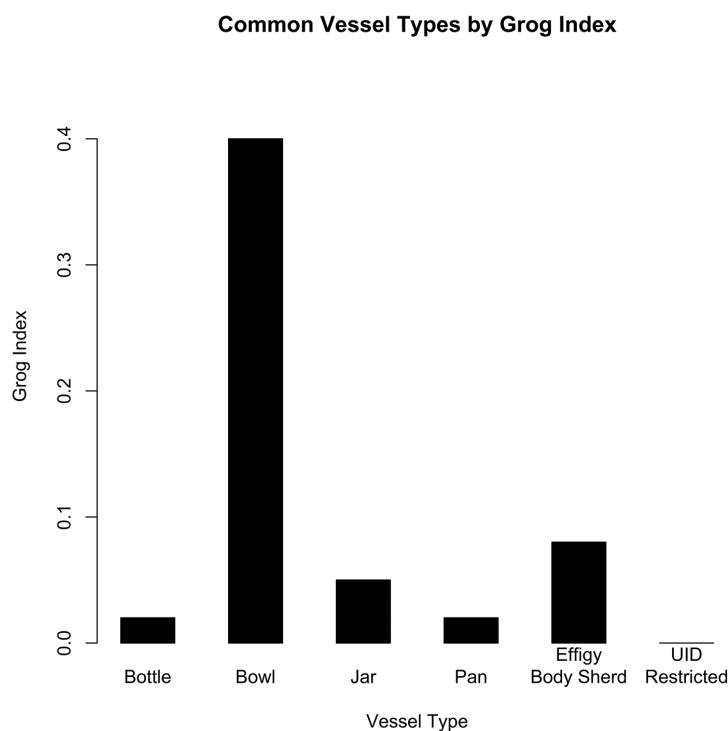


Figure 7. Average grog index for each vessel type category identified from Averbuch (40DV60), Kellytown (40WM10), and East Nashville Mounds (40DV4) sites. Grog size was measured through petrographic analysis.

Discussion

Although the admixture of shell and grog has not been reported (or at least noted with any frequency) in Thruston phase shell-tempered pottery of the Nashville Basin, it is not necessarily an unusual discovery. An early hint of a ceramic type with a co-occurrence of shell and fine-grog tempers occurs in Phillips's (1970) lower Yazoo Basin pottery compendium. There he described the well-known Bell Plain type as a burnished/polished form made particularly distinctive by pulverized shell temper (Phillips 1970:59–60). He further noted that the type is particularly common in the Memphis (the northern variant) and in the lower Mississippi Valley (the southern variant) regions. Phillips referred to the southern manifestation as the Holly Bluff variety in the type-variety system and indicated that there might be deliberate additions to the shell temper.

The *Holly Bluff* variety is normally tempered with finely pulverized shell, but other inclusions (?) may also be present. Often the included particles look like shell but fail to react to acid. . . . But there are still other cases in which you can see neither shell nor cells left by its leaching; the general character of the paste then becomes very similar to that of *Addis* variety of Baytown Plain [characterized by very fine clay/grog temper particles]. Obviously we are close here to the borderline between “clay” and shell tempering [Phillips 1970:60; question mark in the original].

This assessment seemingly has been fairly well accepted through the years. In their monograph on the Lake George site in Mississippi, Williams and Brain (1983:108) characterized the Holly Bluff variety tempering as a “[f]inely pulverized shell among its rather heterogeneous assortment of inclusions.” More recently, Kowalski (2019:223–225) described Holly Bluff specifically as a mixed grog-and-shell paste at the Arcola Mounds site in the lower Yazoo Basin. The notion that the “heterogeneous assortment” of this paste seemed to be primarily a shell and grog admixture may have been first detected by Million (1975) in his study of Nodena pottery from northeast Arkansas. It is uncertain whether he was familiar with the Holly Bluff variety described for the lower Mississippi Valley since he claimed that the finely ground grog he found in Nodena ceramics had been overlooked in previous descriptions of Bell Plain (Million 1975:202–203). Nevertheless, his identification of the inclusion of grog specifically alongside shell temper—as opposed to an unidentified addition—seems to have been prescient.

As with our findings for the Nashville Basin pottery, in the lower Yazoo Basin the Holly Bluff variety is strongly associated with bowls in relatively late Mississippian contexts (Glass 2018:31; Kowalski 2019:225). Likewise, at Lake George, the ceramic type is more commonly expressed as various kinds of bowls, although it was occasionally associated with bottles and plates (Williams and Brain 1983:108). This type was associated primarily with bowls, bottles, and effigy vessels in the Nodena phase (Million 1975:203). Million (1975:202–203) proposed that when finely ground grog complemented fine-shell temper it made for a more supple paste, lending itself to pottery shapes such as bottles and effigies that perhaps were more difficult to achieve with coarse shell temper.

Systematic petrographic analyses in addition to our own suggest that grog and shell admixtures are more prevalent in the late prehistoric Southeast than heretofore recognized, crosscutting fine wares and coarse wares in addition to vessel morphology. For example, in his landmark petrographic studies of American Bottom ceramics, Porter (1962, 1963a, 1963b, 1963c, 1964a, 1964b) found that grog was often added to the paste, but it could only be identified microscopically. Although most of his samples were pre-Mississippian, they did highlight the elusive macroscopic identification of grog. Later studies of American Bottom Mississippian-period ceramics have since demonstrated that so-called fine grog wares often exhibit a mix of miniscule-sized grog and shell temper particles where even the shell may not be visible macroscopically (e.g., Holley 1989:403–404). These wares seem to occur as early as the eleventh century AD, where they are largely restricted to political centers, becoming more widely distributed after AD 1100 (Wilson 1999).

Livingood’s (2007) petrographic study of ceramic samples from two Plaquemine sites in the Pearl River valley of Mississippi found a spectrum of temper combinations in the pastes, ranging from heavy shell/light grog to moderate grog/little shell. Further, he found that none of the various combinations on this spectrum conformed to standard pottery types. Although he believed his sample size was too

small ($n = 49$) to draw any definitive conclusions regarding pottery technology, he was able to draw the sobering conclusion that

Part of the problem is that the type-variety system developed by Ford, Phillips, Williams, and Brain for the LMV is based on macroscopically observed criteria, whereas potters often ground the tempering agents into very small sizes and sometimes mixed tempering agents together in ways that make macroscopic classification challenging and subjective [Livingood 2007:108].

Similar observations about the potential prevalence of mixed grog- and shell-tempered vessels—in addition to the difficulty in identifying this admixture—have been made for other regions as well. Buchanan's (2015:224–226) investigations in southeast Missouri and the American Bottom discovered that, although mixed grog/shell was always a minor constituent of the larger assemblage, it did appear to be ubiquitous. Like Livingood, she believed that this temper mix was likely “under identified” at most Mississippian sites (Buchanan 2015:224). Early Caddoan pottery is distinguished by “fine-textured” wares with small grog inclusions (Girard et al. 2014:55; Lambert 2017:158); however, in their survey of Caddoan shell-tempered ceramic traditions, Perttula and colleagues (2011) identified numerous instances of grog- and shell-tempered fine ware vessels, which they believe were underreported: “We suspect that petrographic analyses will also demonstrate that temper mixtures are also common in Caddo ceramics, especially in the fine wares, and that grog-and-shell-tempered paste recipes may be more common than vessels with only shell tempering” (Perttula et al. 2011:260).

Galaty's (2008) extensive overview of pre-Mississippian ceramic fabrics in the lower Mississippi Valley, in addition to his own petrographic study of Woodland-period pottery of Mississippi, underscored two key points evident in the preceding studies. First, there is considerable confusion and ambiguity in the macroscopic identification of temper inclusions. Second, temper and paste constellations do not neatly conform to the type-variety system. They crosscut types in ways that may be informative about aspects of pottery traditions not evident in notions of style. These findings led him to advocate a ceramic-ecology approach (*sensu* Matson 1965) to provide a more comprehensive understanding of ceramic manufacture and classification based on surface geology (i.e., localized clays and potential temper resources). This idea draws support from research we have conducted on late Mississippian pottery assemblages in northeastern Mississippi. There, for example, we have identified sherds that nominally would fall into lower Mississippi Valley type varieties characterized by a preponderance of shell temper (e.g., Fortune Noded, Parkin Punctate) but that contain fossil-shell temper typical of late Mississippian and historic Chickasaw traditions in the Mississippi Black Prairie (Boudreaux et al. 2020:46), a physiographic region underlain by a stratum of Upper Cretaceous marine deposits and abundant fossilized shellfish.

Based on this brief survey of the literature, the occurrence of grog/shell admixtures in late Mississippian-period vessels in the Nashville Basin is not necessarily

an oddity. Yet, numerous questions remain. If we are correct that the grog inclusions in cooking vessels are likely incidental based on their low frequency, then, like the Holly Bluff variety described above, purposeful grog inclusions seem to be mainly affiliated with fine-ware bowls and bottles. In his Nodena study, Million (1975:203) argued that technological variables were an important consideration for including grog in the manufacture of finely crafted bowls that might be prone to breakage in the firing process: "The fine grog particles, usually smaller than 1 mm, will considerably improve the working of the clay body by giving it a firm, granular texture; and because the grog is already fired, it will reduce the thermal shock that occurs when the vessel is fired."

Our research is an outgrowth of a project investigating pottery composition and sources post AD 1300, so early Mississippian ceramics were not a target of our study. Such samples would obviously be important as a test control. It is noteworthy, though, that of the various regions examined in our survey, only the American Bottom seems to display a distinct pattern of early (pre-AD 1300) shell- and grog-tempered fine wares. Holley (1989:303–304) pointed out that, at one time, it was believed that fine grog-tempered pottery (which he concluded may also be grog and shell) in the American Bottom and regions to the north (lower Illinois River valley and northwestern Iowa) was likely an import from the Caddoan region. With the discovery that mixed shell- and grog-tempered fine-ware recipes occur early in the American Bottom sequence associated with endemic pottery types, Holley (1989:65) suggested that "[i]t is possible that the Cahokia area was the ultimate source of this pottery." If the deliberate mixture of shell and fine-grog inclusions in primarily bowl and bottle forms is indeed a later phenomenon in the Middle Cumberland region and elsewhere in the South, it is conceivable that this technological crafting tradition diffused from the American Bottom.

Finally, it should be pointed out that Buchanan (2015, 2017) has raised the provocative idea in her study of the Common Field site in southeast Missouri that the adoption of mixed grog and shell pastes and the rise of warfare may be interrelated. She suggests that potters may have found access to freshwater shell resources restricted because of fear of traveling outside the protection of fortified villages. In this scenario, easily obtainable grog would have partially replaced shell temper. An analogous argument has been made for late twelfth- to thirteenth-century settlements in north-central New Mexico (Fowles et al. 2007). Neutron activation and petrographic analyses of ceramic assemblages from sites in the Taos region indicate a decrease in the diversity of clays alongside an increasing reliance on local clays—potential technological proxies for a landscape of conflict.

Because Buchanan's study relied on the macroscopic determination of tempers, we presume the grog inclusions in her sample were fairly sizable in comparison to the Holly Bluff variety or our specimens from the Nashville Basin. So, while her hypothesis may hold for southeast Missouri, it does not seemingly account for the fine-grog and shell tradition for bowls and bottles that seems to reflect a heavier investment in the preparation of a high-quality paste. Moreover, if we are correct

in our hypothesis that the grog in cooking vessels is incidental, it further lowers the likelihood that Nashville Basin potters were facing a scarcity of freshwater shell. In light of Livingood's finding for his study area that there was no consistent relationship between the relative amount of shell and grog on the one hand and vessel type or morphology on the other, it may be that grog-particle size rather than frequency may be a distinguishing feature of late Mississippian pottery. In other words, there seems to be a widespread and well-defined tradition of late Mississippian bowls, and perhaps bottles and effigy vessels, characterized by the consistent inclusion of small grog particles alongside shell temper. And this may be functionally and/or stylistically distinct from a tradition of a broad spectrum of pottery characterized by a considerable variety in grog size or frequency, as identified by Buchanan and Livingood for the Mississippi River and Pearl River drainages, respectively.

Conclusion

Based on our present state of knowledge, it is not evident whether the mixture of small grog and shell inclusions confers any immediate utilitarian advantages. The idea that this combination may enhance the workability of the clay, while intriguing, is somewhat subjective. On the other hand, the recurrent association of tiny grog inclusions with vessel forms, notably bowls, that also have a lower SSI may suggest that a small particle size—even if the tempers are mixed—may have combined advantages in terms of the shaping of a vessel as well as enhancing its resistance to mechanical stress. Additionally, the inclusion of small grog particles may enhance thermal shock resistance.

But it seems that other factors must have come into play as well. The strong correlation of small-sized grog and shell temper with bowls and bottles seems to be a low-visibility horizon marker for a swath of the late Mississippian culture area spanning at least the Caddoan region to central Tennessee. In other words, the tempering mix is not readily apparent to the naked eye, yet it was widely adopted. This would seem to imply that this ceramic technology practice was disseminated through the movement of potters or the traditions themselves or some combination of the two. One implication of this hypothesis is that it should prompt archaeologists to place as much weight on technological practices as on stylistic and typological ones in the development of models of connections and exchange. The mixed shell-and-grog tempered bowl traditions of the Nashville Basin and elsewhere in the Southeast underscore how extensive these shared technological traditions may be.

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reviewers and Thomas E. Emerson, editor of the *Midcontinental Journal of Archaeology*. All scientific preparations analyzed in this study are stored at the Florida Museum of Natural History and can be accessed for comparative purposes with prior arrangement.

Supplementary Material

Supplementary Table 1, detailing the 30 vessel lots that provided data for this article, can be found at <https://www.midwestarchaeology.org/mcja/supplemental-materials>.

Notes on Contributors

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