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WHY NOT POTTERY? A COMPARATIVE APPROACH TO THE VARIABLES UNDERLYING THE ADOPTION (OR NON-ADOPTION) OF CERAMICS

ABSTRACT: This paper considers from a comparative perspective the spread of ceramics and the widespread but highly variable pattern of a two stage adoption of pottery: an initial sparse "software horizon" followed by a transition to intensified production of more durable pottery. It first illustrates this multi-step pattern not just as an issue in the initial invention of pottery technology but as relevant particularly to later cases of the adoption of ceramic production. Second, it summarizes a set of examples, particularly from the southwestern United States, to demonstrate variation in the software horizon pattern. Finally, it considers models and underlying variables that have been suggested to account for these examples, and points to several potential explanations with possible implications for interpreting Neolithic origins in central Europe and for considering the pattern of adaptation and interaction between pioneer farmers and persistent Mesolithic groups during the early Neolithic period. It argues that the multivariate nature of pottery technology and the low visibility of the software horizon may contain suggestions of variation in early Neolithic adaptations but may also be obscuring hints of interaction between farming and non-farming groups.

KEY WORDS: Pottery – Ceramic technology – Southwestern United States – Central European Neolithic

This paper considers from a comparative perspective the spread of ceramics and the widespread but highly variable pattern of a two stage adoption of pottery. The first stage is what Rice (1999) called the "software horizon", a period characterized by sparse ceramics that are often thick, low fired, with limited surface treatment and either organic inclusions (or temper) or no deliberate addition of non-plastic materials at all (e.g., Brown 1989: 209–210, Garraty 2011, Hayden 2010: 21, Jordan, Zvelebil 2010, Özdoğan 2009: 27–28, Rice 1999).

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Pottery is sporadic: few sites have any and the sites that do typically have very low quantities (e.g., Budja 2010: 510–511, with references, Heidke, Habicht-Mauche 1998, Milisauskas 2011: 163, Perles 2004, Pratt 1999: 83). Abundant, well made pottery vessels often only appear during a subsequent stage of adoption.

The paper makes three major points. First, it illustrates this multi-step pattern of adoption of pottery not just as an issue in the initial invention of the technology but as relevant particularly to later cases of the adoption of ceramic production. Second, it summarizes a set of examples, particularly from the southwestern United States, to demonstrate variation in the software horizon pattern. Finally, it considers some models and underlying variables that have been suggested to account for these various examples, and points to a few explanations that should be examined critically, with possible implications for interpreting Neolithic origins in central Europe and for considering the pattern of adaptation and interaction between pioneer farmers and persistent Mesolithic groups during the early Neolithic period.

Although there are many contrasts between the two cases, the appearance of pottery in the United States Southwest, as in central Europe, occurred in the context of the northward spread of agriculture, as well as of widely shared ceramic traditions, and perhaps, though more controversially of the migration of major language families (Hill 2001, Renfrew 1987). The argument is not that the Southwestern and European cases are closely parallel. Rather, the comparison highlights some similarities, but even more importantly *variations within* both regions, and draws attention to the underlying variables relevant to interpreting this variation. The Southwest comparison may perhaps most directly parallel *non*-Linear Pottery traditions beyond the Linear Pottery (LBK) core of central Europe, but it raises intriguing questions within the LBK area as well. It should be noted this is not the first consideration of such a comparison; Pavlů's (1997) volume on pottery origins emphasized the Southwest and central Europe in a far-ranging examination of underlying variables and patterns. The current paper is focused on a narrower range of issues and also takes advantage of 15 years of recent research in the Southwest.

FIGURE 1. Map of early pottery dates from the Americas. Redrawn after Clark, Gosser (1995: 210).

THE APPEARANCE OF POTTERY IN U. S. SOUTHWEST

As in Europe, ceramic technology was probably not invented independently in the Southwest. American pottery is earliest in South America and shows a rough south to north chronological cline, with pottery appearing in most of the southwestern United States relatively late (*Figure 1*) (Clark, Gosser 1995, Heidke 1999). The earliest Southwestern pottery is found in river basins in southern Arizona, adjacent to Mexico. Also as in central Europe, a patchwork of ceramic traditions is evident in the areas surrounding the village farming core region of the Southwest. Some of these represent expansion out of the core area; other cases are more ambiguous and suggest influences from other regions, or substantial reconfiguration of Southwestern inspired ceramic technology. Apparently unlike the LBK expansion in Europe, the core village agricultural region of the Southwest acquired its suite of ceramics and other Neolithic characteristics gradually and piecemeal – though as discussed below, precisely this point deserves to be examined critically.

Regional trends in the archaeological discovery of early pottery

Although the appearance of pottery in the Southwest is now recognized as having been preceded by a software horizon period, for most of the history of Southwestern archaeology this horizon was not recognized. Syntheses of Southwestern archaeology through the mid 1980s suggested that the earliest pottery dated to around A.D. 200, perhaps starting in the Mogollon culture area in the mountainous part of the states of New Mexico and eastern Arizona or possibly at the same time in the poorly dated Hohokam area of southern Arizona, and finally spreading north around A.D. 500 or 600 into the Anasazi or what is now more commonly called the "Ancestral Pueblo" area of northwestern New Mexico, northeastern Arizona, Southeastern Utah and southwestern Colorado (*Figure 2*). Thus, the appearance of pottery appeared fairly abrupt shortly after the start of the first millennium

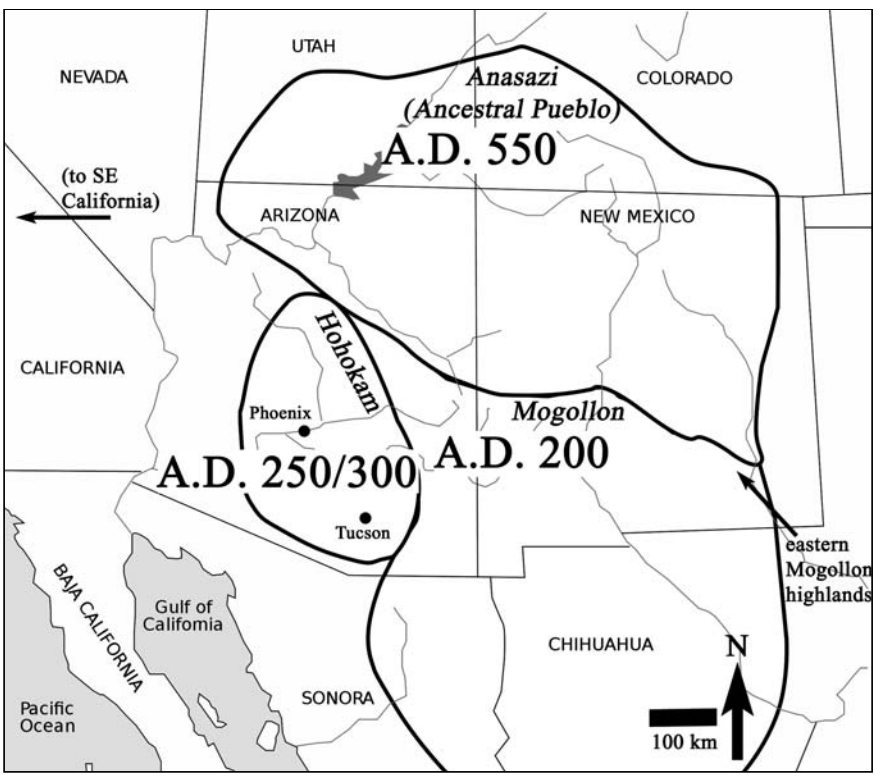

FIGURE 2. Evidence of pottery in the U. S. Southwest as of 1984. The earliest pottery in the Mogollon area was dated ca. A.D. 200, in the Anasazi/Ancestral Pueblo area ca. A.D. 550, and in the Hohokam area ca. A.D. 250 or 300; after Cordell (1984). Map modified from base map http://en.wikipedia.org/wiki/File: Anasazi-en.svg.

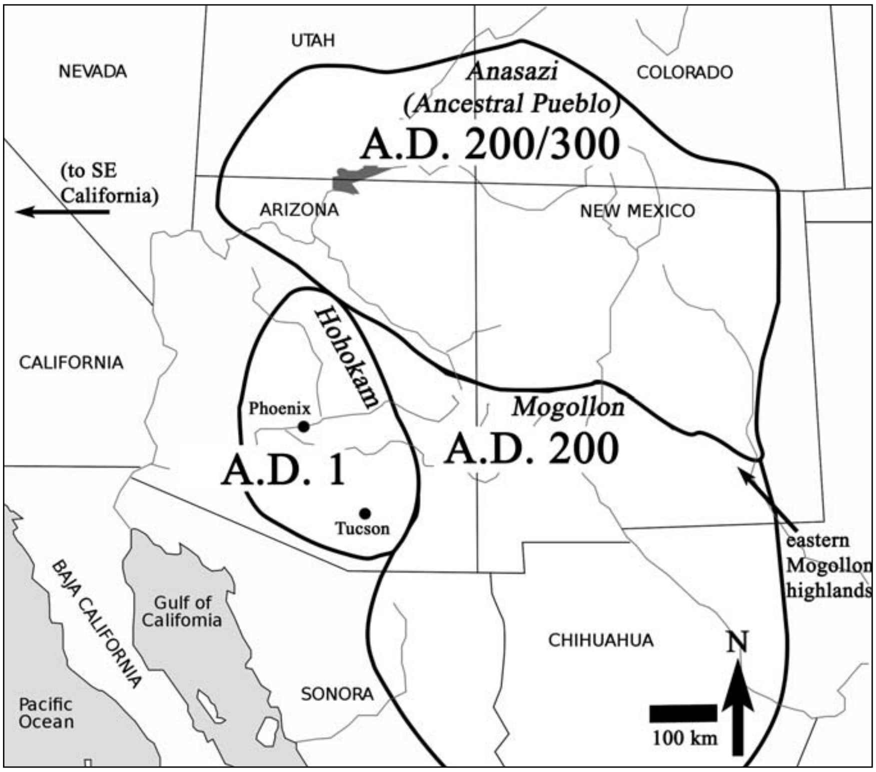

FIGURE 3. Evidence of pottery in the U. S. Southwest as of 1995. The earliest pottery in the Mogollon area was dated ca. A.D. 200, in the Anasazi/Ancestral Pueblo area ca. A.D. 200 or 300, and in the Hohokam area ca. A.D. 1; after Wilson, Blinman (1994) and Crown, Wills (1995). Map modified from base map http://en.wikipedia.org/wiki/File:Anasazi-en.svg.

A.D., followed by a spread through the Southwest over a few hundred years.

But by the mid 1990s, pottery was found at least 250 years earlier in the Anasazi north as researchers realized that the occasional undecorated untempered early brown ware pottery sherds found at sites in the area were neither anomalous nor imported. Furthermore, the Hohokam region in the south was recognized as having even earlier pottery vessels, by A.D. 1 (and figurines 800 years earlier still) (*Figure 3*).

Tucson Basin

This trend of discovering increasingly older pottery has dramatically continued in the southern portion of the Southwest, where in the last few years, both pottery vessels *and* possible figurines have been dated to around 2100 B.C. in the Tucson Basin of the Hohokam culture area of southern Arizona (*Figure 4*).

This gradual archaeological discovery of increasingly earlier pottery only partially reflects improvements in dating or general archaeological wisdom; largely it is simply a function of sample size. That is, early pottery was long missed because it was so very rare. In the case of the Tucson Basin, the entire sequence from 2100 B.C. to A.D. 50 is currently represented by 219 sherds from less than a dozen sites representing a minimum of 174 vessels. The record for the first 900 years of that period consists of a total of 7 sherds from six vessels on one site (Heidke 2006: 7.22). Over time pottery abundance increased, but initially the growth was very slow and still only at a few sites.

Figure 5 shows sherd density on sites in the Tucson Basin starting 900 years after those first 7 sherds. Note that the vertical scale is logarithmic so that it is not until the first century A.D. that densities approximate levels of ubiquity of the ceramic periods recognized prior to the 1990s. The earliest vessels, which Heidke calls "Incipient Plain Ware," are small, of simple poorly finished construction with untempered clay body. They are also mostly open forms-bowls or even plates. A disproportionate percentage of the early vessels may also come from ceremonial or non-domestic contexts (Heidke 1999,

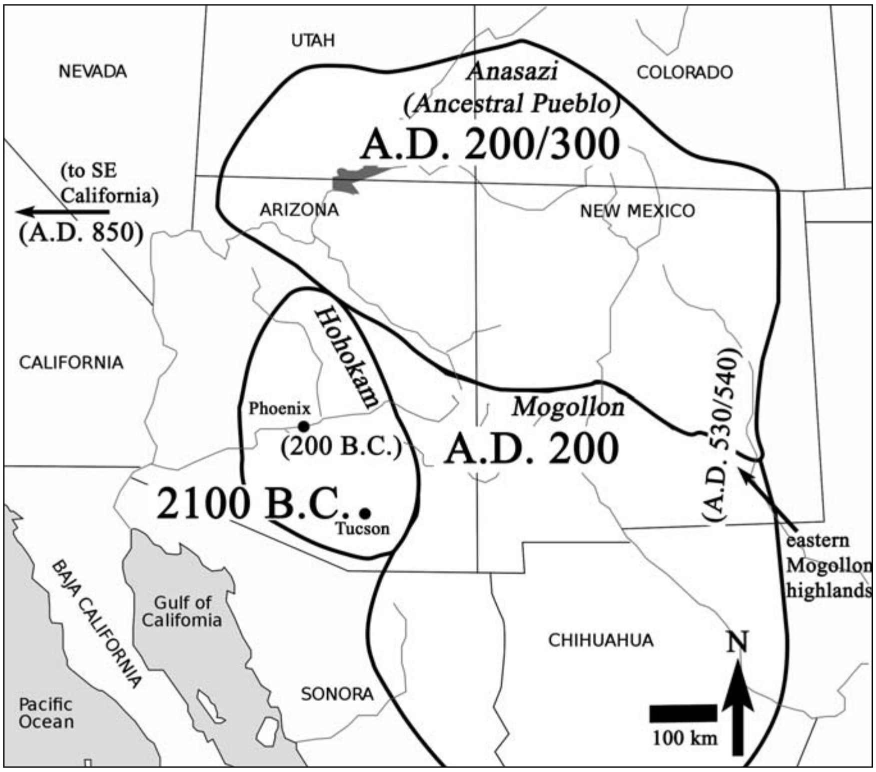

FIGURE 4. The earliest pottery in the Mogollon area is dated ca. A.D. 200, in the Anasazi/Ancestral Pueblo area ca. A.D. 200 or 300, and in the Tucson Basin area of the Hohokam area ca. 2100 B.C.; modified from *Figure 3* after Heidke (2006). Map also indicates the Phoenix Basin (pottery ca. 200 B.C.), the eastern highlands portion of the Mogollon region (pottery ca. A.D. 530 or 540), and southeastern California (pottery ca. A.D. 850); see text for discussion of these areas. Map modified from base map http://en.wikipedia.org/wiki/File:Anasazi-en.svg.

Heidke, Habitche-Mauche 1998) and the previously noted high percentages of non-container ceramic forms such as figurines are also suggestive. So the earliest ceramic technology in the Tucson Basin was not primarily associated with food preparation or storage and was accompanied by figurines or symbolic ceramic forms (Heidke 1999, 2005, 2006, Heidke, Habicht-Mauche 1998). Heidke argues for an initial shift to well made vessels, primarily used for storage, at the start of the first millennium A.D. some 2000 years or more after the first pottery containers. Further, he suggests that based on vessel form, pottery did not come to be heavily used for cooking prior to around A.D. 500, two and a half millennia after the rare early examples of pottery made their first appearance.

Phoenix Basin

The Phoenix Basin, only about 150 km northwest of Tucson and also within the Hohokam tradition archaeological area (*Figure 4*), displays a contrasting pattern. There, pottery appeared only around 200 B.C., roughly 2000 years later than near Tucson (Garraty 2011). As in the Tucson basin, sherd density showed a rapid increase, but these sherds were not the incipient "software" plain ware of Tucson; the pottery was already well made by 200 B.C., with thin walls and sand temper. The earliest identifiable vessel forms dated to near the start of the first millennium A.D. were mostly jars rather than open forms. Complementing the data from vessel form, sherds also exhibit soot, indicating that they were used for over-fire cooking by this period. So, while perhaps an as yet undiscovered period of poorly made ceramics precedes this sequence, currently Phoenix lacks the earliest software horizon pattern seen in nearby Tucson and lags by nearly two millennia in its earliest pottery, but shows the transition to heavy use for cooking centuries earlier.

Although these areas of Arizona display the earliest pottery currently known in the Southwest and these southern Arizona basins also have some of the earliest

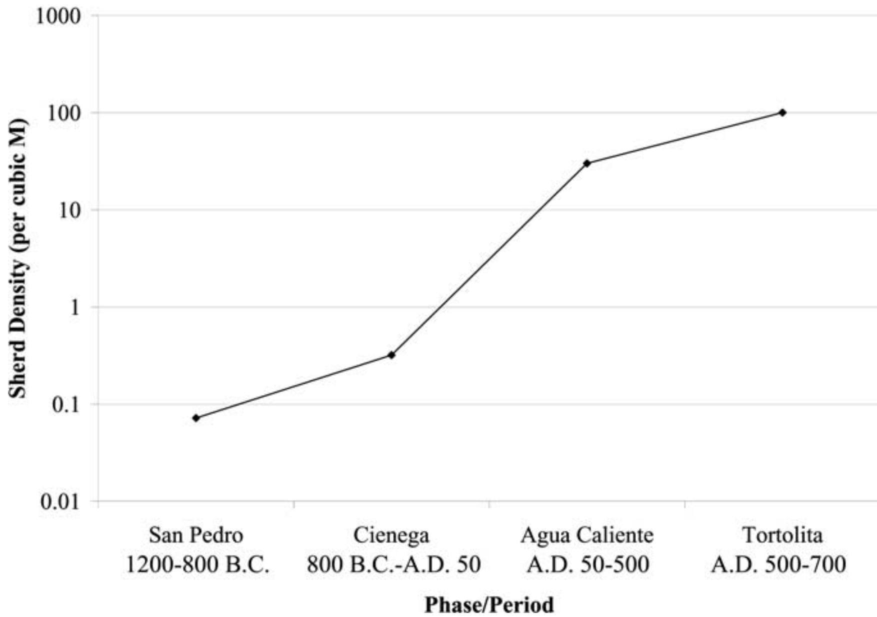

FIGURE 5. Increase in sherd density over time in the Tucson Basin; vertical axis is logarithmic sherds per cubic meter. After Heidke (2005: 198).

evidence of farming, it appears that in both of these cases (as well as elsewhere in the Southwest) the adoption of pottery was *not* associated with the initial spread of agriculture in any consistent way. Maize appears in small quantities widely across the Southwest from sites dating slightly before 2000 B.C. In Tucson the first seven ceramic sherds do occur in the same period as the earliest maize, but the transition to more abundant and improved pottery and to the use of ceramic vessels for storage or cooking came over two millennia later; evidence of canal irrigation agriculture is already present over a thousand years before the ceramic increase (Mabry 2008). In the Phoenix Basin, pottery is unknown until roughly two millennia after the introduction of maize.

Ancestral Pueblo (Anasazi) region

Further north, the Anasazi or Ancestral Pueblo area shows a pattern similar in some respects to that of the Phoenix Basin, but different in others. From its first appearance, Anasazi pottery was dominated by closed jar forms, and was fairly well made with thin walls and slightly polished exteriors, though generally without temper. Vessel forms, soot and internal abrasion are all consistent with multiple functions including cooking, perhaps storage, but intriguingly, perhaps fermentation as well (Reed *et al*. 2000, Skibo, Blinman 2008). Pottery first appeared around A.D. 200, or roughly 400 years after its adoption to the south, and was so rare that traditionally the archaeological period up to A.D. 500 or 600 was named the "Basketmaker II" stage characterized by the *absence* of pottery. Pottery abundance increased only after this period, along with an expansion in the use of temper, diversification in vessel forms and use of painted decorations. So, similarly to the south, there was a period of limited investment in rare pottery followed by substantial growth in its ubiquity and elaboration; in this northern area this happened four hundred years later than in the Phoenix basin, but closer in time to the corresponding change in the (slightly more distant) Tucson area. As in the south, neither the appearance nor subsequent expansion of pottery production is linked to the adoption of farming; maize agriculture was present prior to 2000 B.C. in the Ancestral Pueblo area as well as in southern Arizona.

Mogollon

As noted previously, pottery appeared in much of the Mogollon region by around A.D. 200. However, the pattern in the eastern highland area of Mogollon country of east-central New Mexico shows an example of another pattern (*Figure 4*). Here again maize farming has a long history that extends back to at least 1100 B.C.; large storage pits found by the end of first century B.C. highlight the degree of agricultural dependence. Pottery, as well as substantial architecture, however, appear to be absent in this particular part of the Mogollon country until around A.D. 530 or 540 (Campbell, Railey 2008: 727, Rocek, Rautman 2012). Excavations at a well dated site in the area documents continuity in the use of large storage pits and maize from the pre-ceramic period but also construction of six to seven meter diameter houses and abundant well made large, heavily sooted cooking jars (Howey, Rocek 2008, Rocek 2007). So in this area, less than one human lifetime encompassed the adoption of abundant well-made pottery as well as investment in substantial houses. Given continuity in other cultural patterns, however, there is no reason to assume an influx of a new population, nor is it clear that the houses necessarily represent a significant decrease in mobility beyond that already suggested by the pre-ceramic period storage pits.

Southeastern California (Great Basin)

Finally, one more illustration of variation is a case of sporadic production of pottery followed by a dramatic increase on the western fringes of the Southwest in southeastern California (*Figure 4*) (Eerkens 2004, 2005, Eerkens, Glascock 1999). There, native populations remained hunter-gatherers into the historic period. Very rare sherds date as early as A.D. 850, but a substantial increase in pottery production came only around A.D. 1300 or 1400, just a few centuries before European contact. Vessels were mineral tempered, walls thin, mostly conical or oval jar forms; sherds have soot deposits and contain residues consistent with cooking of seeds as well as combinations of seeds, meat and other plant materials. This increased pottery production is not linked to ethnic replacement, the adoption of farming or a shift to sedentism. Rather, Eerkens (2004) has argued that it reflects the result of economic intensification in the collection of wild seeds, and a concomitant shift to emphasis on a privately owned resource, seeds, in contrast to other more broadly shared and less intensively harvested wild resources such as game animals.

IMPLICATIONS BEYOND THE U. S. SOUTHWEST

These examples serve to suggest a series of observations with implications beyond the particulars of the American cases. First, as noted previously, is the widespread pattern of the software horizon; a point elaborated below. Second, however, is the variation around this pattern, diversity that is clear in many cases around the world. And this variation, in turn, points to the importance of a range of factors underlying the pattern of adoption and change in ceramic technology, with implications regarding the process of cultural changes at the time of the appearance of pottery and the archaeological study of that process. These factors fall into at least four major categories: 1) issues regarding time scale and the acquisition of knowledge or skill, 2) the contexts of production and use, including evidence for social or ideological rather than directly economic reasons for pottery production, 3) site formation processes, and 4) the range of interactions among the variables underlying the transition to intensified production of ceramics after the software horizon.

A critical point highlighted by the diversity in the patterns of the spread of pottery (or other aspects of Neolithization) is the critical issue of time scale. As Wobst (1978) has argued, the scale of lived experience and ethnographic observation is vastly different from that of the archaeological record. Although lived experience might seem the "correct" scale to consider, modelling the archaeological record in terms of lived experience added many times over is not the best way to understand events in archaeological deep time. One can draw an analogy to the biological contrast between micro and macro-evolution; although macroevolution on the scale of millions of years results from the sum of generations of micro-evolution, the broad patterns of speciation, extinction, stasis and punctuation are best understood beyond the micro-level (Gould 1994).

So, simply the knowledge of firing clay is not the critical issue in the invention or spread of pottery (e.g., Jordon, Zvelebil 2010: 49, Özdoğan 2009: 22, Rice 1999: 5), and limitations in knowledge of ceramic technology do not provide a good basis for interpreting the spread of pottery technology on a deep time scale. Hunter gatherers have at least indirect knowledge over very vast regions and recent research documents large scale mobility and interaction in the context of the earliest Neolithic (e.g., Borić, Price 2013). Furthermore, while learning to make pottery well during a human lifetime is difficult, explanations such as periods of "learning" or "experimentation" are poorly fitted to archaeological time scales; a human lifetime is often below radiocarbon precision and the learning process can be shortened even further by intermarriage. So, pottery use in the long run is much more likely to relate to issues of ideology, social organization, economy or environment rather than merely to knowledge; similarly those that don't use ceramics for centuries or more are not simply lacking in skill or knowledge.

Thus, the typically "crude" pottery of the software horizon should be analyzed in terms of the context of

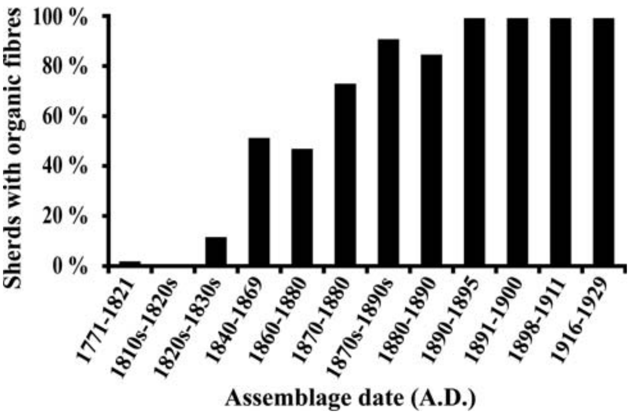

FIGURE 6. Increase over time in percentage of sherds with organic fibre temper in Tucson Basin historic O'odham pottery. After Miksa *et al.* (2006: 6.38).

production and use rather than interpreted as indicative of experimentation or ignorance. An illustration of this point comes from the work of Miksa *et al.* (2006) who show a transition by 19th century Tucson, Arizona area O'odham Indian potters away from mineral tempers (grog and sand), to organic fibre temper (horse manure, in this case), a characteristic often found in the "crude" pottery of the software horizon (*Figure 6*). But this was not the result of lack of knowledge of ceramic technologies; the O'odham technological shift came under colonial pressure that increased labour demands and eliminated access to mineral temper sources. A related example is Chagnon's (2013: 48–49, 166–168) description of Venezuelan Yanomamö Indian villagers who imported pottery from a partner village because, they explained, they had forgotten how to make pottery and lacked access to suitable clay – but who promptly "found" clay and "remembered" how to make ceramics after their trade partnership broke down. Similarly, in considering explanations based simply on knowledge as a limiting factor in pottery production, it is useful to recall worldwide examples of the abandonment of pottery production such as the Comb Ware of prehistoric Finnmark (Skandfer 2010) and Lapita pottery in the Pacific Islands (Skibo, Blinman 2008: 37).

Assumptions equating aspects of ceramic "crudity" of form with poorly developed pottery traditions are also undercut by considering parallel inventions in widely dispersed independent traditions – aside from the example of organic fibre-tempered pottery noted above in Arizona, the expertly made classic Southwestern Pueblo corrugated ware is interpretable in terms of functional considerations of thermal stress resistance, ease of cooking and handling, and stylistic variation (Pierce 2005) rather than as a crude hardware copy of a basketry software model; in fact visible coiling is not characteristic of early Pueblo pottery. The widespread appearance of conical based vessels among non-Puebloan groups of the Southwest as well as elsewhere in the world similarly is a reminder that such vessel forms have functional significance that at least in part accounts for the prevalence of such forms in the non-LBK European contexts; explanations purely in terms of cultural knowledge or cultural tradition must be considered critically (e.g., De Roever 2009: 160–162).

If limitations in skill are an insufficient basis for interpreting the initial stages in the appearance of pottery, a variety of authors have suggested a range of other factors. First, many authors (e.g., Clark, Gosser 1995, Garraty 2011, Heidke 1999, 2005, 2006, Heidke, Habitche-Mauche 1998, Pratt 1999, Rice 1999; for a recent summary of some of the most prominent sources, see Garraty 2011: 221) have pointed out that the forms, construction methods, context and use wear suggest that much software horizon pottery was not initially adopted for either cooking or storage. Ideological or social uses for the vessels are often cited, ranging from religious functions to serving or food preparation for competitive feasting. Such interpretations need to be considered on an attribute-by-attribute basis; in the Southwestern cases outlined above, specialized uses are implied for at least the Tucson Basin example. None of these cases fits status-related feasting equipment in either the ceramic attributes or their find contexts, though other models of status-seeking behaviour, such as imitation of more complex political groups is a possibility. Special uses such as alcohol production or consumption are intriguing possibilities for some of the examples where jar rather than shallow bowl forms dominate the early assemblages (a functional interpretation that might also apply to some of the LBK as well as non-LBK early ceramic assemblages in Europe).

An additional factor in the rarity of software horizon pottery derives from site formation processes, both at the regional scale and on individual sites themselves. Simple variations in population density and occupation duration are important factors – small populations don't make much pottery. To the extent that early pottery functions only in special social or religious contexts (Gheorghiu 2009: 6, Heidke 1999: 328, Heidke, Habitche-Mauche 1998), its distribution is also limited, decreasing archaeological visibility. Rare undistinguished plain wares might also go unnoticed in mixed assemblages from multi-component sites. Preservation issues are also relevant and low fired pottery may differentially disintegrate (Heidke 2006: 7.34, Reid 1984) or may even be intended to do so, as suggested in the case of the Dolní Věstonice fired clay items (Vandiver *et al.* 1989).

The strongest explanations for the *post*-software horizon shift to more abundant, deeper, better tempered vessels seem to relate to intensification of food processing. These include a range of factors due to increased reliance on agricultural or other concentratable foods, decreased mobility, increased private-ownership, competitive or cooperative feasting, and increased labour demands on women; these in turn create pressure for exploiting the intensifiability of pottery production and its efficiency for cooking, serving and social signalling (e.g., Braun 1983, 1987, Crown, Wills 1995, Eerkens 2004, Garraty 2011, Heidke, Habicht-Mauche 1998). Just as the initial adoption of limited use software pottery must be understood in the social context of its production and use, the large scale production of well developed cooking, storage and serving vessels involves technological considerations of the vessels' functions, social and political questions of production and distribution, and the feedback implications of the pottery on the economic and social conditions under which increased use of ceramics occurs. Increased investment in pottery production shifts the allocation of labour, for instance, which in turn impacts economic conditions such as intensified food production that in turn relate to the need for increased pottery production. Similarly, investment in pottery may constrain settlement mobility, again feeding back on the economics of food production as well as on the conditions shaping social and power relations. Eerkens' (2004) example of intensification of privately owned resources implies another example of complex feedback, as pottery itself can become an accumulatable privately owned resource. The diversity of cases just within the Southwestern U. S., however, show that even for this second stage of Neolithization, no single set of variables will cover all cases.

DISCUSSION AND CONCLUSION

To conclude, I offer two brief examples of how this comparative perspective might be fruitfully brought to bear in considering the initial appearance of ceramics in central Europe. One aspect of the LBK that appears to not have received a great deal of theoretical attention is the presence of organic temper – or the absence of added non-plastic inclusions altogether – in a significant number of early Linear Pottery vessel clay bodies (e.g., Pavlů 1997: 87, Lička 2011: 42–53). In part, this pattern may fairly be argued to reflect the origins of the LBK in the Balkans, and the occurrence of organic temper in the Starčevo ceramic tradition (e.g., Milisauskas 2011, Stadler, Kotova 2011). However, this observation is an insufficient explanation for a number of reasons.

First, the very fact that LBK temper composition changed over time is a reflection of the obvious fact that while traditions sometimes maintain a constant technology or style, they also sometimes change them – and thus the *retention* of this particular aspect of LBK technology is as much in need of explanation as is the *reduction* in such paste composition in later LBK ceramic assemblages. Second, the fairly extensive technological literature on organic tempers demonstrates that such inclusions have significant performance consequences affecting heat conductivity, impact resistance, abrasion resistance, and thermal stress resistance, as well as modifying the constraints operating during production of the pottery vessels (e.g., Sassman 1993, 1995, Skibo 2013, Skibo *et al.* 1989). Thus, if analysis proceeds beyond the assumption that technology is merely a reflection of adherence to tradition or of limited knowledge, then the retention of organic temper in LBK pottery must be examined as reflecting choices relating to the economic or broader social contexts of production and use of the vessels (for a similar recent suggestion regarding the potential for examining implications of early LBK organic temper based on comparative and technological considerations, see Lička, Mach 2011: 72). Finally, the broader observation that organic tempered or untempered pastes are characteristic of many examples of the "software horizon" worldwide reinforces the implication that such a pattern requires functional explanation. This point is particularly notable since the initial Neolithic intrusion into central Europe derives from a cultural tradition that had produced pottery for around a millennium. In some ways this is analogous to the situation in the U. S. Southwest, where pottery to the south is earlier than in the Southwest. In the central European case, however, the pottery arrived as part of a clear coherent package that demonstrably involved significant population movement, even if the degree and pattern of intermixing of indigenous and migrant populations remains a matter of debate (this is in contrast to the Southwestern pattern where pottery is not part of a clear broader cultural package and the existence of significant migration around the time of the appearance of pottery and the actual source area of its introduction remains much more ambiguous and disputed). Thus while a "learning" model *might* be argued for the simplicity of the clay body composition of some of the earliest examples of pottery in the Southwest, the pattern of temper in early central European ceramics must be understood in terms of worldwide parallels of a pioneering adaptation rather than parallels in stages of invention or learning. In summary, then, the comparative perspective raises important questions about the reasons for the technical characteristics of early LBK pottery, undermines some of the simplest explanations for them, and suggests alternative considerations such as changes in seasonal mobility or in diet or food preparation practices.

A second example of the implications of a comparative view is the demonstration of the potential for the sparseness of software horizon ceramics to result in their being overlooked altogether. The examples from the Southwest show this effectively: even if the first 900 years in the Tucson basin currently documented by only seven sherds are set aside, many of the other regional cases illustrate delayed archaeological discovery of ceramics due to the rarity of early sherds. They also demonstrate the great diversity in the patterns of the earliest pottery and of subsequent increasing ceramic production following the software horizon. Therefore, what appears to be a dramatic and abrupt appearance of pottery may mask more complicated histories of the introduction, adoption, and shifting uses of the technology (Garraty 2011, cf., rejection of the idea of a "prepottery Neolithic" in southeastern Europe in Milisauskas 2011: 163). The rarity of "software" ceramics is exacerbated not only by their limited and specialized uses (quickly made and disposable in some cases (e.g., Leonard 1904: 167); limited to feasting or ceremonial contexts in others (e.g., Hayden 2010, Heidke, Habicht-Mauche 1998, Pratt 1999), but as noted previously also by low populations with relatively high mobility who produce low artefact densities and by the porous paste of the ceramics which makes them susceptible to post-depositional destruction (Heidke 2006: 7.34, Reid 1984). These observations point to the possibility of easily missed pottery use and production by Mesolithic populations in the context of the early Neolithic. A variety of European non-LBK ceramic traditions have been found to be associated to varying degrees with the period of the early Neolithic, though mostly north or west of central Europe – traditions such as La Hoguette, Limburg, as well as temporally and spatially more diverse Narva, Sperrings Comb Ware, Swifterbant, and Ertebølle traditions (e.g., chapters in Gheorgiu 2009, Harz *et al.* 2011, Jordan, Zvelebil 2010, Whittle, Cummings 2007). These examples highlight the multiple patterns of borrowing, incorporation, reaction, indirect influence, and even independently developed ceramic traditions among LBK using farmers and surrounding non-farming populations. The observation of the diversity and obscurity of software horizon ceramic assemblages in comparative context worldwide suggests the importance of continued research on overlooked ephemeral ceramic patterns closer to the heart of central Europe.

The parallels between the Southwest and central Europe, or more broadly among ceramic traditions worldwide, do not suggest that the cases are identical or even closely similar. Rather, the core point is that multiple patterns exist within each regional sequence of ceramic development, associated with multiple causal factors. Regional intellectual traditions of archaeological analysis tend to focus on a subset of these factors, and even when questioned, local orthodoxies of interpretation often appear as the obvious and only plausible explanations. Demonstration of the effects of the diversity of patterns and their parallels worldwide (e.g., the frequent but not universal appearance of a "software horizon" and the alternative functional roles of early pottery) as well as their consequences (e.g., the near invisibility of some patterns of early ceramic use, the potential for "regressive" as well as "progressive" shifts in ceramic technology, and the technological choices involved in pottery production) play a useful role in encouraging analyses that question the most obvious answers and either look for additional data (such as occasional sparse sherds that might be ignored as anomalous or intrusive) or investigate seemingly obvious patterns (such as why some "primitive" technological features persist or reappear in a ceramic tradition) that offer promising directions for understanding the context and consequences of the adoption of ceramic technologies in central Europe as well as elsewhere.

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