The Significance to California Prehistory of the Earliest Mortars and Pestles

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Introduction

At the time of initial contact with European colonists, most California native groups used stone mortars and pestles for milling acorns into flour. The prevalence of these implements in aboriginal California generally reflects the considerable significance of acorns to the aboriginal diet. Mortars and pestles have a long prehistory in California, and as Basgall (1987) has pointed out, their initial use and increasing importance through time reflects subsistence intensification in that acorn processing requires considerable labor investments, much more per unit of food value than many other plant foods.

On the basis of Kroeber's (1925:411-412) observation that mortars and pestles were used throughout California for mashing acorns into flour, whereas metates and manos were used for small dry seeds, archaeologists typically have equated the presence of mortars and pestles in archaeological sites with acorn processing, and by extension, the initial occurrence of mortars and pestles with the earliest utilization of acorns as a food resource (e.g., Basgall 1987:30; Glassow et al. 1988:67). However, there are reasons to doubt the argument that mortars and pestles always were used primarily for acorn processing throughout the several thousand years of their prehistory. First, California ethnography is full of instances in which mortars and pestles were used for crushing or pounding other food products (e.g., Kroeber 1925; Schroth 1996). Second, the presence of acorn remains in archaeological deposits seldom has been reported, largely because recovery and identification of macrobotanical remains has only recently come into its own in California (e.g., Hammett 1991). Third, analogy with the ethnographically documented use of mortars and pestles is increasingly more tenuous with increasing antiquity. Considering that the earliest subsistence systems including mortar and pestle technology, dating perhaps in excess of 5000 years ago, were quite different from those reported ethnographically, the value of an ethnographic analogy is minimal unless the analogy leads to evaluating hypotheses about the contexts in which mortars and pestles were used (Binford 1967).

Consequently, it is reasonable to ask a series of related questions: What products were crushed in mortars and pestles at the time these implements began to be used in California

between 5000 and 6000 B.P.[1]? Specifically, were acorns the dominant product processed with mortars and pestles, and if not, was another product dominant? If it can be ascertained that mortars and pestles were used to process another food product or products, what may be said about the course of subsistence intensification? If acorns were not the dominant food product processed with mortars and pestles, when did acorn processing become important? The objective of this paper is to address these questions. Considering that virtually no macrobotanical remains currently are associated with the earliest use of mortars and pestles, I must pursue other lines of evidence. In doing so, I will consider the larger context of mortar and pestle use by looking at other aspects of subsistence systems and the ways in which subsistence activities are related to settlement systems.

Dates of the Earliest Use of Mortars and Pestles

California archaeologists have offered a variety of dates for the earliest use of mortars and pestles in various regions of California. Kaufman (1980:175-180) reports that a pestle was associated with a human burial dating in excess of 10,400 B.P. discovered at site LAK-381, located about 3 km south of Clear Lake in northern California. However, the radiocarbon date derived from one of the bones of this burial may be questioned in light of research demonstrating that bulk collagen samples extracted from human may contain contaminants and may yield spurious results using conventional radiocarbon dating involving decay-counting procedures (Taylor 1987:55-56; Taylor et al. 1985:138). In fact, the pestle associated with this burial is a carefully shaped, tapered form typical of periods after about 3000 B.P. in central California. Elsewhere in California, King (1990:88) proposes that mortars and pestles were used in small numbers as early as the initial phase of the Early Period (7500-6000 B.P.) of the Santa Barbara Channel region, although no definitive data support this conclusion.

Seemingly the best documented early occurrence of mortars and pestles, both in the Santa Barbara Channel region and in California generally, is the assemblage from the Aerophysics site, CA-SBA-53, adjacent to the margin of a former enclosed bay or estuary, the vestiges of which are the modern Goleta Slough. In his excavations at this site in 1956-1957, Harrison collected 69 mortars (either whole or large enough to be classified) and 57 whole and fragmentary pestles from deposits associated with three radiocarbon dates ranging between 4620 and 4980 B.P. (Harrison and Harrison 1966:24-28, 34). Mortars in the collection are large, unshaped or slightly shaped cobbles, and most have a pit with a profile approximating a parabola (see Dills 1975). Pestles also are unmodified or slightly modified cobbles, these having a natural shape approximating a cylinder. The working ends are abraded, as are the sides of some, apparently the result of use as manos as well as pestles (Harrison and Harrison 1966:27). In the Santa Barbara Channel region, the lack of significant shaping of these mortars and pestles sets them apart from later forms, which generally were extensively shaped by pecking and abrasion. Recently, Erlandson (i.p.) reported that mortars and pestles occur as early as 5800 B.P.; however, the details of this occurrence are not yet available.

Adequately dated assemblages of mortars and pestles as early as those at SBA-53 are difficult to find elsewhere in California. For that matter, equally early or earlier occurrences elsewhere in the Santa Barbara Channel region are impossible to demonstrate at the present

[1]Because of problems with calibrating radiocarbon dates obtained more than about a decade ago, dates in this paper refer to uncorrected radiocarbon years BP.

time. In central and northern California, confidently dated mortars and pestles are no older than about 4500 B.P. Fredrickson (1984:499, 514, 521) proposes that mortars and pestles were used perhaps as early as 5000 B.P. in the North Coast Ranges, although reasonably well dated contexts appear to be younger than 4000 B.P. Similarly, mortars and pestles may have been used as early as 5000 B.P. in the vicinity of San Francisco Bay, but dated contexts are much later in time, around 3000 B.P. (Gerow and Force 1968:65-68; Basgall 1987:32). By the time of the earliest manifestations of the Windmiller Pattern of the Delta region, dating between 4000 and 4500 B.P., mortars and pestles were in use. However, only one site clearly dates to this time (Ragir 1972). In light of the considerable accumulation of alluvial deposits in both the San Francisco Bay and Delta regions, the existence of yet earlier sites certainly is a possibility. In southeastern California (southwestern Great Basin), mortars and pestles began to be used during the Gypsum Period, perhaps by 5000 B.P. (Warren 1984:419). Despite the problems in dating the earliest occurrence of mortar and pestle use in many California regions, it is reasonable to suspect that this technology began to be used sometime between 5000 and 6000 B.P. in parts of both northern and southern California.

Factors affecting our ability to identify early uses of mortars and pestles, or most other distinctive artifact forms for that matter, are related to characteristics of California's archaeological record, particularly that portion dating earlier than approximately 4000 years ago. First, deposits in excess of 4000 B.P. are relatively rare due to low population numbers and the long periods of time during which erosion and other natural processes have acted to destroy or obscure archaeological deposits. Second, deposits of this age frequently are the lowermost strata of archaeological sites and therefore would be discovered only when research is focused on the sites' later deposits. Third, deposits of a variety of ages at a site frequently are so mixed through bioturbation and other pedogenic processes that associations between particular artifact forms and specific periods of site occupation are nearly impossible to ascertain. In particular, larger and heavier artifacts such as mortars and pestles (whether complete or fragmentary) tend to migrate downward to the maximum depth of soil disturbance. Fourth, such artifact categories as mortars and pestles are generally in low densities in archaeological deposits, and samples adequate for stratigraphic analysis are available only in instances where excavated volumes of deposits are very large. Fifth, the first mortars and pestles may have been of wood, similar to ones used by such groups as the Yokuts in early historic times. Finally, since determining of the earliest use of a particular artifact form is typically an inductive process dependent on the extent of empirical knowledge, there is no way of knowing whether an earliest documented occurrence of an artifact form really does represent the earliest use. Of course, many of these factors are not exclusive to California, and as a consequence it is not surprising that documenting the earliest use of mortars and pestles elsewhere in western North America is equally problematic.

Foods Processed with Mortars and Pestles

California ethnography documents the use of mortars and pestles for processing a wide variety of foods in addition to acorns. As summarized by Schroth (1996), these other foods include both animal and plant products. An example of the former is the Luiseño practice of pulverizing venison and both the meat and bones of rabbits with a mortar and pestle (Sparkman 1908:197, 198), while an example of the latter is the Cahuilla use of mortars and pestles to crush mesquite beans and the roots of bulrush and cattail (Bean and Saubel 1972:109-110, 139, 143). The use of mortars and pestles to process root products, generally

after drying, is particularly intriguing, given the broad geographic extent of this practice in California and on the Columbia Plateau (Garth 1978:243; Riddell 1978:374; Smith 1978:444; Spier 1930:164-165; Spier and Sapir 1930:189; Wilson and Towne 1978:389). Of specific interest is the use of the mortar and pestle by the Northern and Southern Valley Yokuts to pound dried bulrush (tule) roots into flour (Gayton 1948:14-15; Wallace 1978a:464, 1978b:450; Mayfield 1993:66-67).

Unfortunately, it is seldom possible to determine from ethnography how important the various foods processed with mortars and pestles were to the diets of different aboriginal groups in California. While acorns undoubtedly were the main food resource at the time of European contact in those regions of California where oaks were locally abundant, other food products were processed with mortars and pestles in areas where oaks were scarce or absent. It is apparent, for instance, that the Tachi Yokuts, living along the northern margins of Tulare Lake, depended on bulrush roots as a main staple (Gayton 1948:14), and their principal use of mortars and pestles probably was for crushing these roots.

Archaeological documentation of foods processed with mortars and pestles is still very limited. The main source of information, carbonized plant food remains from archaeological deposits, is indirect. Inferences about which food products preserved in carbonized form were processed with a mortar and pestle must be based on other sources of information, often ethnographic analogy. Furthermore, recovery of carbonized remains through such procedures as flotation has not yet been widely practiced in California, and many sites, particularly those with occupations earlier than 4000 B.P. contain very little or no carbonized plant remains. Despite these and other problems, carbonized macrobotanical remains do have the potential to provide a good deal of information relevant to learning about the nature of foods processed with mortars and pestles.

Hammett (1991) has summarized the plant species represented in carbonized remains from sites in the territory occupied by the Chumash. Identified plant remains (other than wood charcoal) include a wide variety of small seeds of plants in all major plant habitats, including grassland, marshland, chaparral, and disturbed ground. Larger seeds or nuts that are more likely to have been processed with a mortar and pestle include acorns (nuts and hull fragments), islay (wild cherry), walnuts, manzanita berries, and wild cucumber seeds. Remains of fleshy plant parts that also may have been processed with a mortar and pestle include fragments of soap plant bulbs, yucca parts, and various unidentified fragments of corms and bulbs. Four of the five sites from which Hammett's data were obtained date to the late prehistoric period and therefore are not directly relevant to addressing the kinds of plants processed with the earliest mortars and pestles. However, the remaining site, located in northern Chumash territory, dates to the period in question (Hammett 1991:191). Hammett identified acorns, islay pits, and yucca among the larger plant remains. The grass seeds from this site were of special interest due to their unusually large size, but Hammett suspects these would have been milled with a metate and mano.

A promising technique for inferring the use of mortars and pestles found in archaeological contexts is the detection of organic residues on the working surfaces of the implements. In California, immunological techniques have been used to identify the organic residues of various plant and animal taxa on milling implements (Sutton 1993:137). However, immunoassay techniques applied to archaeology are still under development, and some scholars have questioned whether organic residues are sufficiently preserved for reliable

identification (Downs and Lowenstein 1995; Eisele et al. 1995). Until these issues are resolved, the application of immunoassay techniques to determine the kinds of products processed with mortars and pestles probably should be held in abeyance.

A Proposed Earliest Use of Mortars and Pestles

From the perspective of optimal foraging theory and what might be called subsistence intensification theory, it seems implausible that acorns would be the first food product added to the diet. As Basgall (1987:28-29) convincingly demonstrates, acorn utilization requires rather high labor expenditures associated with hulling and leaching, let alone cooking (i.e., the handling time per unit of food value is relatively high). As a result, acorns would be ranked relatively low in relation to many other plant foods likely to have been processed with a mortar and pestle. For instance, in the Santa Barbara Channel area, islay fruit/pits are about as easy to collect as acorns but would not require the hulling and leaching efforts that acorns do. Likewise, even though many root products (bulbs, corms, tubers, and rhizomes) found in wetlands likely would require a greater effort to acquire than either acorns or islay fruits because they must be dug up an cleaned, transportation efforts are likely to be substantially lower because large quantities could be collected from relatively small patch areas, and again, no leaching would be required. In other words, given the variety of relatively abundant plant foods available that would be ranked higher than acorns but would require processing with a mortar and pestle, it makes little economic sense to jump over these when subsistence intensified by either the addition of new plant foods to the diet (expansion diet breadth) or a change in processing procedures of a food product or products already being utilized.

I propose that one of the major uses, if not the major use, of the earliest mortars and pestles in the Santa Barbara Channel region was for processing root products. This proposal is based on the recognition of a relationship between the unusually large numbers of mortars and pestles in the collections from CA-SBA-53 and the site's environmental context. At the time that this site was occupied, what is now the Goleta Slough probably was an enclosed bay that had reached its maximum extent as a result of eustatic sea level rise during the 5,000 years following the end of the Pleistocene (Stone 1982). More than likely, it was surrounded by freshwater and brackish water marshlands harboring extensive stands of bulrush (tule, *Scirpus* spp.) and other marsh plants; indeed, small patches of dense bulrush still exist along the margins of the wetlands.

The roots of bulrush, as well as cattail (*Typha* spp.), typically are prepared by pounding the cleaned rhyzomatous root segments, either fresh or dried, with a mortar and pestle. A modern technique for preparing bulrush or cattail entails crushing after drying, removing the fibers, and cooking the flour that remains in hot water (Clarke 1977:142-145). The Tachi Yokuts used a somewhat different procedure:

> The lake Indians made an almost pure starch from the tule roots. The women waded into the water and dug the roots out with pointed sticks. Other women pulled the roots out onto the bank. There the women cut the roots from the stalks.
>
> The roots were thrown into stone mortars and were pounded into a soft mass. The pounded roots were then thrown into a large cooking basket and were covered with hot water. The mixture was stirred with the looped stirring stick

> for an hour or so. Then the crush roots were raked out and were thrown away. In an hour or two, the starch had settled to the bottom of the basket. The water was then poured off. They obtained in this way a cake of starch two inches in thickness, and eight or nine inches in diameter. It had little taste but was very rich (Mayfield 1993:66-67).

In the absence of botanical remains of bulrush or other marsh plants from site contexts, testing this hypothesis must rely on other lines of evidence that unfortunately are much more circumstantial. For instance, if indeed the mortars and pestles of CA-SBA-53 were used for processing bulrush root, contemporaneous sites not associated with extensive marshlands should contain either no mortars and pestles or lower densities of these artifacts. Such a pattern may exist, although it is nearly impossible to generate meaningful comparative information due to the small volumes of excavation at most sites roughly contemporaneous with CA-SBA-53 and the likelihood of mixture with earlier or later deposits. A volume of 115.8 m^3 was excavated at CA-SBA-53, and very little evidence of any later occupation was encountered or is present in the collections. In contrast, volumes of excavations at other sites dating between about 5500 and 4500 B.P. are typically under 10 m^3, and evidence of earlier or later occupation frequently is present (Glassow i.p., Appendix 1). Nonetheless, the boulder mortars and unshaped pestles typical of the CA-SBA-53 assemblage are very rare in other Santa Barbara Channel collections, leading to the suspicion that CA-SBA-53 indeed does stand out as relatively unique with regard to its abundance of mortars and pestles.

Mortars and pestles dating after about 4500 B.P. or even later entailed more manufacturing effort. The exteriors of bowl-type mortars were pecked to a globular form, and pestles were pecked and abraded to a tapered cylindrical shape. Basket hopper mortars also came into use sometime after 4500 B.P. Considering that basket hopper mortars are closely associated with acorn milling, these morphological changes may indicate that acorns began to be utilized for the first time. Later in time, apparently after about 2200 B.P., metates and manos were used only minimally, if at all, in coastal settings, leaving mortars and pestles as the exclusive milling implements (Gamble and King i.p.). The reason why metates and manos apparently were completely abandoned is perplexing, for the coastal Chumash at the time of European contact were utilizing a variety of small hard seeds that would have appropriately been milled with metates and manos (Landberg 1965:77-81; Timbrook 1984).

If the earliest mortars and pestles were used for processing underground plant parts, why were such food resources as bulrush rhyzomes apparently not important to the Chumash at the time of European contact (Timbrook 1984:145)? In other words, what advantages did acorns have that would have induced Santa Barbara Channel populations to minimize the use of underground plant parts such as bulrush? One possibility is that the extent of marshlands supplying bulrush and other such plants diminished over the millennia due to infilling of lagoons and estuaries with alluvium, while at the same time human population density increased. Bulrush roots generally are available all year round and therefore would not have to be a stored food resource even during the lean winter season. However, the decreasing yields per capita population eventually would have to be supplemented with some other relatively abundant resource, particularly during the winter season. Considering the rarity of resources that have relatively stable productivity all year, a supplemental resource more than likely would have to be one that is storable. Of course, acorns would have been such a resource.

Some Thoughts on the Origins of Mortars and Pestles and the Process of Subsistence Intensification

Mortars and pestles were used prehistorically in a wide variety of habitats in western North America, and their antiquity in some regions is at least as great as in the Santa Barbara Channel region. However, reliable data concerning both the occurrence and the antiquity of mortars and pestles are still too few in most regions to be able to discern spatiotemporal patterns in their distribution. In southern Arizona, mortars and pestles began to be used minimally during the Chiricahua Stage of the Cochise Culture, which dates between 8000 to 3500 B.P. (Sayles 1983:114). Although dating is imprecise, Sayles (1983:69) implies that mortars and pestles became more popular during the latter half of the time span of the Chiricahua Stage, perhaps after about 4500 B.P. Of interest is that the mortars of the Chiricahua Stage are often modifications of basin metates and that pestles are either unmodified cobbles or manos used as pestles. These mortars and pestles give the impression of being developed through experimentation with existing technology. Mortars and pestles with more formal shapes became a much more definitive component of artifact assemblages during the succeeding San Pedro Stage, dating between 3500 and 2000 B.P. (Sayles 1983:129).

The Plateau area encompassing the Columbia River and adjacent drainages also has a long prehistory during which mortars and pestles were used. In his synthesis of the prehistory of this area, Jennings (1989:179) indicates that mortars and pestles were used during the Cascade Phase, dating between 7500 and 5000 B.P. It is not clear whether mortars and pestles were used during this whole interval of time, but in the Surprise Valley region of the northwestern Great Basin, immediately south of the Plateau area, O'Connell (1975:33) reports distinctive forms of mortars and pestles dating perhaps as early as 6500 B.P.

Although dating of the earliest use of mortars and pestles in western North America still is very sketchy, there does seem to be temporal priority in the north, specifically in the northwestern Great Basin and Plateau areas. If this is so, one might ask whether the mortar and pestle was associated with a distinct food procurement system (*sensu* Flannery 1968) first developed along the river canyons of the Plateau or around the lakes of the northwestern Great Basin. This speculation seems consistent with arguments regarding expansion of Penutian-speaking populations from the Plateau region southward into California sometime around 4500 B.P., the earliest apparent archaeological manifestation supposedly being the Windmiller Pattern (Moratto 1984:552; see also Ragir 1972:137-150). However, if mortar and pestle use in southern California, dating sometime between 5000 and 6000 B.P., is associated with marshland-adapted Penutian speakers, the beginning of this expansion would have to be pushed back in time perhaps 1000 years. An earlier date for this expansion certainly is not out of the question, given that the initial occupation of the delta region, the home of the Windmiller Pattern, might yet to be discovered. Alluvial aggradation of the Central Valley easily could have buried the earliest sites associated with the Windmiller Pattern or a cultural manifestation preceding it.

If my arguments regarding the earliest use of mortars and pestles in the Santa Barbara Channel region are correct, the food procurement system to which I referred above would have included various root crops found in abundance in marshlands adjacent to rivers, lakes, and coastal bays and estuaries. In other words, the populations expanding from the north would have focused much of their subsistence on marshland plants and perhaps also fish and

shellfish in nearby shallow waters. At least in some regions, however, this food procurement system was used alongside an earlier one entailing the use of metates and manos to process seeds.

Returning to the topic of subsistence intensification, it is important to recognize that three fundamentally different sources or contexts of cultural change may result in intensification, seen from the perspective of a particular region such as the Santa Barbara Channel. First, intensification may come with a population expanding into the region whose culture includes a more complex subsistence system, similar to the Numic expansion throughout the Great Basin as conceived by Bettinger and Baumhoff (1982). Second, it may be the product of a region's population "borrowing" the food procurement system from a neighboring population. Third, it may be a product of indigenous development. The latter two typically would be the result of a region's population experiencing subsistence stress, either through population growth or environmental change. The first, however, would not necessarily be associated with subsistence stress, at least not in the region into which the population expanded.

Because the Chumash languages are presumed to be very ancient (Moratto 1984:546), it seems reasonable to conclude that a major population expansion into the Santa Barbara Channel, similar to that of Penutian speakers into the Central Valley, did not occur at any time during prehistory, at least not after about 8000-9000 B.P. Even though there probably was not population replacement, certainly it is conceivable that foreign populations may have entered the Santa Barbara Channel at times during prehistory and formed enclaves. In fact, a few archaeologists have proposed that migrations did take place around the time that mortars and pestles came into use (Harrison and Harrison 1966:68-69; Warren 1968:8). If foreign populations did enter the Santa Barbara Channel at this time, the only significant difference between this expansion and an expansion into a region such as the Delta region of the Central Valley might be that a substantial resident population already was living in the Santa Barbara Channel region whereas few or no people were living in the Delta prior to the entry of Penutian speakers.

If women were the segment of the population collecting roots or other food products and processing them with mortars and pestles, which they manufactured, acquisition of foreign women as marriage partners by resident male channel-dwellers may have been the mechanism by which a new food procurement system was brought to the Santa Barbara Channel. In this scenario, it would have been only adult women, as opposed to whole social units such as bands, expanding into new regions, perhaps not always willingly. The point is, however, that the contexts of subsistence intensification are quite variable, and a region-specific explanation of an instance of intensification requires evaluating hypotheses that consider one or another of these contexts.

Conclusion

Basgall (1987:30) cites macrobotanical remains of acorns that may be as early as 4200 B.P., but the date when acorns first were processed with a mortar and pestle, or were in any way part of the prehistoric diet of any California group, remains an open question due to the paucity of definitive evidence of acorn utilization. Considering the wide variety of other food resources that might be processed effectively with mortars and pestles, some being locally

quite abundant, the incorporation of acorns into the prehistoric California diet may have occurred much later than we imagine.

Regardless of when acorns first were eaten, the new forms of subsistence tied to the use of the mortar and pestle undoubtedly did represent subsistence intensification. Furthermore, it seems reasonable to propose that this intensification is tied to population growth. However, the discovery of a correlation between subsistence intensification and population growth does not help us much with explaining why intensification occurred. Looking at the broad sweep of prehistory, one could legitimately argue that population growth was the engine behind subsistence intensification. Nonetheless, in specific instances of intensification, that is, intensification occurring within a region, population growth may not have had much to do with it. Food procurement systems, particularly those entailing the use of new technology and perhaps also new ways or organizing and scheduling labor, often may have had their source in population expansions, which may have been triggered by discrete environmental events. On the other hand, certainly new technology and new food procurement systems did have geographic origins, and the development of mortars and pestles in southern Arizona may be an example of an origin independent of the putative origin in the Plateau area. Although prehistory at the time mortars and pestles began to be used in different parts of western North America still is very murky, the origin and expansion of mortar and pestle use is an interesting case of subsistence intensification that deserves closer attention.

Acknowledgements

I thank Mari Pritchard Parker for asking me to contribute this paper to this volume of the *PCAS Quarterly*. As well, I appreciate the helpful comments of an anonymous reviewer of an earlier draft of this paper.

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