An Ethnographic Review of Grinding, Pounding, Pulverizing, and Smoothing with Stones

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Abstract

This paper reviews some of the ethnographic literature describing the use of metates, manos, mortars, and pestles and the materials processed using these implements. The data presented herein are taken primarily from ethnographic literature from southern California, although some literature from bordering areas was also consulted. As archaeologists, we often make assumptions about ground stone implements, their use, and the inferences that can be drawn from their occurrence in a prehistoric site assemblage. The over 70 items described herein that were processed in these implements suggests that we should look more closely at our assumed use of these items and that microbotanical and protein residue analyses may be necessary to test our hypotheses.

Archaeologists often infer that metates were used for grinding seeds and grains and that mortars were used for processing acorns, mesquite, and piñon nuts. Although these may be the primary uses, other items were equally important and should not be ignored. California, as a whole, prehistorically was a rich state leading Kroeber (1925:239) to note that the native Californian had a "fairly liberal margin between needs and acute want ... [and] did not go for long without procuring food, but the very diversity and multifariousness of supply gave him comparative security against want." It is this diversity that archaeologists are ignoring in their assumptions about food processing with ground stone implements. In addition, the material being processed probably was correlated with the shape and type of implement employed. According to Kroeber (1908:12), "Food and mode of subsistence were of course most directly dependent on environment, and the implements of their gathering and preparation varied accordingly." In order to document the wide range of material processed with various grinding, ethnographic literature from southern California and some contiguous areas was reviewed.

Metates and Manos

Although various shapes of metates have been reported for different groups, the data are often contradictory. Drucker (1937:14) reported that the Serrano, Cahuilla, Cupeño, Luiseño, Diegueño, Yuma, and Chemehuevi used rectangular metates on only one side. Kroeber

(1908:51) described the Cahuilla metate in more detail, saying that it was a flat stone, oval or somewhat rectangular in outline and only very slightly hollowed. It was made of granitic or metamorphic rock and was never sandstone. Spier (1923:335), for the southern Diegueño, agreed somewhat with Drucker. He described the Diegueño metate as a granitic rectangular slab with dimensions around 45x30 cm and a slight depression on one face. For the Diegueño, Drucker (1941:121) later described the metate as an oval that sometimes had a narrow proximal end, used also by the river Cocopa, Maricopa, Pima, Papago, Yaqui, northeastern Yavapai, Walapai, and Shivwits Paiute.

Kroeber (1925:324-325, 411) described the Maidu metate as “nothing but a slab” and that of the Modoc as a lava slab with an even surface and “irregular or circular in shape.” A flat portable slab was also reported for the Gabrielino (Johnston 1962:31) whereas others (Akwa'ala, Mohave, Pima, Papago, northeastern Yavapai) used a squared block (Drucker 1941:121). According to Stewart (1942:262), the Goshute, Ute, southern Paiute, and northwestern Navaho used “thin, oval metates with grinding on one side only and always from the same end” although the Utes also had deep metates and the southern Paiute used bedrock metates. For the Costanoan, Salinan, Kitanemuk, Fernandeño, and Gabrielino, Harrington (1942:12) related that the metate was “more or less oval” and used both unifacially and bifacially. Driver (1937:69, 116) reported the same variability in side usage for the Mono, Yokuts, Tübatulabal, Kawaiisu, Panamint, and Owens Valley Paiute. The metate itself was described as sometimes squared and sometimes the natural shape of the rock and that very few were completely squared.

Steward (1933:240) gave more detail for the Owens Valley Paiute. He described the metate as a slab with dimensions of 12x18 inches (30.5x45.7 cm) and a thickness between 2 and 5 inches (5 to 12.7 cm). Dimensions were also given for the Tübatulabal metate. It was an oval or roughly rectangular implement made from granite or black slate, and was 14 to 20 inches (35.6-50.8 cm) long, between 10 and 15 inches (25.4-38.1 cm) wide, and had a thickness that varied between 2 and 4 inches (5-10 cm); it was used on only one side and the grinding surface was flat or only slightly concave (Voegelin 1938:17).

Considerable variability was also reported for manos, sometimes called “mullers”. The Cahuilla, according to Kroeber (1908:51), used several shapes of manos including thin and flat ovals, narrow and twice as thick ovals, some longer, and squares with equal width and thickness as well as unshaped natural cobbles with one side ground flat. The mano of the Owens Valley Paiute was rectangular and used on both sides (Steward 1933:240). The Mohave, River Cocopa, Maricopa, Pima, Papago, and northeastern Yavapai used a long mano with a cylindrical cross-section whereas the Diegueño, Akwa'ala, Pima, Papago, Walapai, and Shivwits Paiute used a short mano (Drucker 1941:121). The most common shape, however, was an oval, reported used by the southern Diegueño, Costanoan, Salinan, Chumash, Kitanemuk, Fernandeño, Gabrielino, Mono, Yokuts, Tübatulabal, Kawaiisu, Panamint, and Owens Valley Paiute (Spier 1923:335; Driver 1937:69; Harrington 1942:12). Dimensions of the ovoid southern Diegueño mano were 23 by 9 by 6 cm (Spier 1923:335) and those of the ovoid Tübatulabal mano were 3 to 4 inches long (7.6 to 9.1 cm), 3.5 inches wide (8.9 cm), and 2 inches thick (5 cm) with flat faces on both sides (Voegelin 1938:17).

Special shapes include the biscuit shaped mano of the Honey Lake Paiute (Riddell 1972:64) used to de-husk seeds. The 2-horned muller of the Modocs also needs to be mentioned (Kroeber 1925:324-325). It was described as having a “round base and two horns

or a single peak bifurcated at the peak" (Kroeber 1925:324-325). Another form, smaller with a circular base, no horns, and a hemispherical configuration (plano-convex) was also in use by the Modocs.

Both the Gabrielino and Luiseño used portable metates and transported them to new locations when they moved (Cuero 1970:31; Johnston 1962:31), suggesting that the lack of metates at sites with manos may be purposeful. Scavenging from older sites may also have been a common occurrence. For the Maricopa, Pima, Papago, Yaqui, and Northeastern Yavapai, manos were found and used (Drucker 1941). The trough type metate of the Pima and Papago was found, not made (Drucker 1941:121).

Motion of Use

For several groups, the metate was set on a slant with a basket at one end to catch the ground material. Drucker (1937:14) reported that the Serrano, Cahuilla, Cupeño, Luiseño, Diegueño, and Yuma tilted one end by placing a pile of rocks underneath the metate. The Diegueño, Akwa'ala, Mohave, River Cocopa, Maricopa, Pima, Papago, Northeastern Yavapai raised the proximal end with a pile of dirt, sticks, and/or stones. The Tübatulabal slanted the metate away from the worker (distal end) by placing a flat rock (about 2 inches-5 cm) under the end with a flat basketry tray under that end to catch the ground meal (Voegelin 1938:17). The Gabrielino, according to Johnston (1962:31), got the same effect by sinking one end into the ground. In contrast, Spier (1923:335) reported that the Southern Diegueño set the metate level with the ground. The occurrence of a pile of rocks under the end of a metate can be ascertained archaeologically and should be noted as part of a feature.

Two types of motion are described: a back-and-forth motion and a circular motion. The back-and-forth motion was described for 26 groups; the Serrano, Cahuilla, Cupeño, Luiseño, Diegueño, Yuma, Chemehuevi (Drucker 1937:14), Southern Diegueño (Spier 1923:335), Akwa'ala, Mohave, River Cocopa, Maricopa, Pima, Papago, Northeastern Yavapai, Walapai, Shivwits Paiute, (Drucker 1941:121), Goshute, Ute, Southern Paiute, Northwestern Navaho (Stewart 1942:262-3), Honey Lake Paiute (Riddell 1978:64), Tübatulabal, Kawaiisu, Panamint, and Owens Valley Paiute (Driver 1937:69). The circular motion was described for only 6 groups; Costanoan, Salinan, Chumash, Kitanemuk, Fernandeño, and Gabrielino (Harrington 1942:12).

Both motions were reported for the Modoc (Kroeber 1925:324-325), Tübatulabal (Voegelin 1938:18), Mono, and Yokuts (Driver 1937:69). Voegelin (1938:18) went on to describe how roasted piñon nuts were first crushed with a small mano using a rotary motion to loosen the hulls and then the nut meats were ground using a larger mano in a back-and-forth motion. The Modoc, according to Kroeber (1925:324-325), used the 2-horned mano to crack the seeds of *wokas* (water lily) in a back-and-forth motion. The smaller circular mano was used in a rotary motion to process other seeds. Driver expanded on the notion of correspondence between motion and material being processed:

> It might be supposed that back and forth motion is associated with sq metates, but schedules have several negative instances. I suspect that material ground has something to do with it. L.P. (Mono) says manzanita berries ground with a circular motion, perhaps with one hand, and only mashed a little to make cider. Fine grinding of hard seeds would require both hands and a

> pressure that could best be maintained with a straight push away from the body. Although this motion is usually associated with the grinding of maize, the large number of occurrences in non-maize area shown here cannot all be errors. Lowie (1924:204) reports back and forth motion for nonagricultural basin tribes associated with fine grinding. He also describes a hulling process with a sideways motion added, which shows the relation between the kind of grinding and the motion [Lowie in Driver 1937:116].

Material Processed Using Manos and Metates

Very few references for the use of manos and metates to specific materials can be found. What is present, however, is enlightening (Table 1). It is generally assumed that manos and metates were used for processing seeds; however, they were used for shelling piñon nuts by the Tübatulabal (Voegelin 1938:18), Cahuilla (Bean and Saubel 1972:104), Goshute, Ute, Southern Paiute, northwestern Navaho (Stewart 1942:251), and Owens Valley Paiute (Steward 1933:242). The Cahuilla used a metate to grind the piñon nut meat and to grind acorns, another process assumed to have been accomplished only in mortars. Metates were also used to grind mesquite by the Walapai (Drucker 1941:96) and the Southern Paiute (Stewart 1942:250).

Specifically, the Tübatulabal used the metate to grind mentzelia, bunch grass, and manzanita berries (Voegelin 1938:18-19), and the Cahuilla ground chia seeds (*Salvia columbariae*) on the metate (Bean and Saubel 1972:137). The Goshute, Ute, Southern Paiute, Navaho (northwestern), in addition to using the metate to process piñon nuts, ground wild seeds, tubers, and berries on the metate (Stewart 1942:262-263). According to Stewart (1942:339), the Southern Paiute used one side of the metate to grind seeds and the opposite side to grind berries, and according to Lowie (in Driver 1937:116), one side was used for hulling and the other for grinding.

Non-vegetal materials were also processed using metates. For the Ute and Paiute, Steward (1933:253) reported that meat was first roasted, and then pulverized by pounding on the metate with the mano. Riddell (1978:52-53) recounted that the Honey Lake Paiute gathered Mormon crickets and locusts, roasted and dried them. The head and legs were discarded and the body ground into a flour using the mano and metate. The Goshute, Ute, Southern Paiute, and northwestern Navaho also ground insects (cicadas, crickets, and grasshoppers) on the metate (Stewart 1942:245).

Non-consumable materials ground using the metate and mano include clay and temper for ceramics and paint. The Ute and Southern Paiute used bedrock metates to grind paint (Stewart 1942:263, 339) and the Owens Valley Paiute processed clay and temper on “a large boulder with a smooth depression used as a metate with a muller” (Steward 1933:266).

The use of the ends of the mano as a hammer was reported by Driver (1937:116) for the Mono and Yokuts and pounding with a mano was reported by Stewart (1942:253) for the Ute and Southern Paiute. Rejuvenation of metate surfaces was described by Riddell (1978:64) for the Honey Lake Paiute. “When the metate became too slick through use, a sharp, broken stone was used to peck the surface, supposed to have been good for all winter after sharpening” (Riddell 1978:64).

Metates were cleaned using various methods including water and brushing with the fingers. Brushes include porcupine tail, *Artemisia* bark, mescal fiber, grass, and sticks (Stewart 1942:263). The occurrence of some phytoliths or pollen on a metate may be the result of the cleaning mechanism rather than the processing mechanism.

Table 1. Materials Specifically Referenced as Processed Using the Metate

Material	Tübatulabal	Cahuilla	Southern Diegueno	Walapai	Goshute	Ute	Southern Paiute	Modoc	Owens Valley Paiute
Piñon Nut shelling	X	X			X	X	X		X
Piñon Nut grinding	X	X			X	X	X		X
Digger Pine Nuts shelling	X								
Acorns shelling									
Acorns grinding		X			X				
Mesquite				X			X		
Wild Plums cracked			X						
Mentzelia	X								
Bunch Grass	X								
Manzanita Berries	X								
Chia seeds		X							
Insects					X	X	X		
Wild seeds					X	X	X		
Tubers					X	X	X		
Berries					X	X	X		
Water lily seeds								X	
Meat						X	X		
Paint ground						X	X		

Mortars and Pestles

The ethnographic literature discusses six types of mortars: bedrock, basket hopper, portable stone, wood, pit, and ceremonial. As with the metates, the type of mortar depends in part on the material on hand to make the mortar. The size of the pestle and sometimes the shaping appears to be dependent on the type of mortar being used.

Bedrock Mortars

Bedrock mortars were used by almost all groups. Specific mention is made for 24 groups (Table 2). This list is not complete in that often the bedrock mortars were not mentioned. The list is based on specific mention of bedrock mortars by Drucker (1937:13; 1941:121), Johnston (1962:31), Spier (1923:335), Stewart (1942:262), Harrington (1942:11), and Driver (1937:68).

According to Johnston (1962:13), the Gabrielino used mortars where they found them and regarded them as supernatural in origin. The Ute and Southern Paiute also used bedrock mortars as they found them, rather than making them (Stewart 1942:262). For the Mono, Yokuts, Tübatulabal, and Kawaiisu, some bedrock mortars were believed to have been made by Coyote or Puma and some by humans, although the Panamint and Owens Valley Paiute believed all were made by humans (Driver 1937:68). The Southern Paiute used bedrock mortars that they found already made and sometimes made bedrock mortars (Stewart 1942:250).

When the Luiseño made a new bedrock mortar, it was not completely hollowed out at once. First a slight cavity was chipped into the rock, then a basin-shaped basket without a bottom (basket-hopper) was placed over it and glued into place with a mastic such as asphaltum or pitch. The purpose of the basket-hopper was to aid in retaining the material being pounded. With use, the cavity became deeper until the basket-hopper was no longer needed. When the mortar reached a depth of about 12 inches (30 cm), it was abandoned (Sparkman 1908:207). The Tübatulabal bedrock mortar was usually abandoned at about 10 inches (25 cm) with the average mortar ranging in depth from 2 to 10 inches (5-25 cm) with a surface diameter of 3 to 5 inches (7.6-12.7 cm) (Voegelin 1938:17). Other than the normal acorns, piñon nuts, and mesquite, for the Tübatulabal, specific materials processed in bedrock mortars include chia, wild oats, heads of *Polypogon*, wheat, corn, juniper berries, box thorn berries, rush roots, and clay (Voegelin 1938:18-19, 34).

Portable Stone Mortars

Almost all groups had both bedrock mortars and portable stone mortars (see Table 2). Portable mortars were reported for 30 groups, 22 of which also used the bedrock mortar (Drucker 1941:121; Stewart 1942:262; Harrington 1942:11; Driver 1937:68; Drucker 1937:13). Rough finishing or shaping the exterior was reported for the Serrano, Pass and Mountain Cahuilla, Cupeño, Luiseño, Diegueño, and Chemehuevi (Drucker 1937:13). According to Drucker (1937:14), these groups also believed that found mortars were made by other humans, not supernatural entities.

Table 2. Mortar Types by Native American Group

Native American Group	Bedrock	Portable	Basket Hopper	Wood	Pit	Ceremonial
Akwa'ala		X				
Cahuilla	X	X	X	X		
Chemehuevi	X	X		X	X	
Chumash	X	X				
Cocopa				X		
Costanoan	X	X				
Cupeño	X	X				
Diegueño	X	X	X	X	X	
Fernandeño	X	X				
Gabrielino	X	X	X	X		
Kawaiisu	X	X	X	X		X
Kitanemuk	X	X	X			
Luiseño	X	X				X
Maricopa		X		X	X	
Mojave	X	X		X		
Mono	X	X	X	X		
Owens Valley Paiute	X	X		X		X
Paiute		X			X	
Panamint	X	X		X		X
Papago	X	X			X	X
Pima		X		X	X	
Salinan	X	X				
Serrano	X	X				
Shivwits		X				
Southern Diegueño	X					
Southern Paiute	X	X				
Tübatulabal	X	X	X	X	X	X
Ute	X	X				
Yaqui		X		X		
Yavapai	X	X				
Yokuts	X	X	X	X		
Yuma		X		X	X	

According to Drucker (1941:121), the Mojave made their mortars and the Maricopa occasionally made mortars, but for the most part, the Maricopa, Pima, Papago, Yaqui, and Yavapai used what they found rather than manufactured mortars. Stewart (1942:262) reported that the Ute and Southern Paiute also used what they found rather than making their own mortars.

For the Costanoan, Salinan, Chumash, Kitanemuk, Fernandeño, and Gabrielino, Harrington (1942:11) described the mortar as a hollowed spheroid with the outside roughly hewn and ground smooth. He also noted the use of a slab mortar with the basket-hopper attached using asphaltum. These groups, according to Harrington (1942:11), believed that found mortars were made by recent people not by Coyote or myth people.

The Mono, Yokuts, Tübatulabal, Kawaiisu, Panamint, and Owens Valley Paiute used portable mortars with natural exteriors and mortars with exteriors shaped by grinding (Driver 1937:68). Some were simple river boulders with holes pecked into them, thick sides, and asymmetrical shapes, but others were more finely shaped (Driver 1937:115). The dichotomy appears to be related to location of the habitation. The better shaped mortars were more common in the floor of the San Joaquin Valley, whereas in the foothills where bedrock and bedrock mortars were more common, Driver (1937:115) found that less care was taken in shaping portable mortars.

According to Sparkman (1908:207), the Luiseño portable mortar was made primarily from granite or tufa rock from near the coast. The portable mortar was used when no bedrock was nearby or inside shelters during inclement weather. Drucker (1937:14), however, said that the Luiseño believed that the portable mortars found in their area were made by Coyote or myth people. Although they sometimes traded for some portable mortars, others were made. When made, a well-rounded boulder of approximately the correct size was selected and small protuberances on the outside were pecked away (Drucker 1937:48).

The Gabrielino portable mortar was formed in stages starting with the selection of a spherical stone. First, a circular groove was pecked around one end creating a large knob. Then, two perpendicular grooves were pecked across the knob. These four quarters were then removed separately. The process was repeated as necessary to form the top of the bowl. The interior was shaped by pecking (McCawley 1996:137).

The Cahuilla woman could have as many as three or four portable mortars. These were left at gathering sites where they were used as needed. After use, they were cleaned with a grass or hand broom and turned upside down with the pestle left under them (Bean and Saubel 1972:127). Forming the hole in the mortar was similar for both bedrock and portable mortars. The depression was started by heating the area of the rock to be removed to loosen the matrix and then chipping the heated area with a sharp rock. This was repeated until a small concavity was formed. The formed depression was then ground with a pestle, and a basket-hopper used until the depression was deep enough to contain the material being processed (Bean and Saubel 1972:127). When a woman died, her mortar was broken and buried with her (Bean and Saubel 1972:128).

According to Harrington (1942:11), the Costanoan, Salinan, Chumash, Kitanemuk, Fernandeño, and Gabrielino ground the inside of portable mortars and only roughly shaped the exterior. These were roughly spheroid in configuration. The portable mortar of the Panamint was spherical in shape and about 10 inches (25.4 cm) in diameter. The mortar hole

had a diameter of about 4 inches (15.2 cm) with a depth of about 6 inches (15.24 cm) (Steward 1933:24). That of the Tübatulabal was made by "pecking out depression in a round soft gray stone with a harder, pointed rock" (Voegelin 1938:29). Although said to range from 6 to 35 inches in exterior diameter (15.24 to 88.9 cm), the larger end of the scale would not be considered very portable. Small mortars, however, were transported to piñon forests (Voegelin 1938:13).

Processing of material other than piñon nuts, mesquite, and acorns is reported by several groups. Voegelin (1938:13) reported that old people used mortars and flat rocks to pound livers of deer to tenderize them. A small portable mortar was also used for mixing tobacco and lime. The pestle for this mortar was between 3 and 5 inches long (7.6 to 12.7 cm) (Voegelin 1938:31, 37). According to Kroeber (1925:323), few oak trees are present in the country occupied by the Modoc, and consequently, mortars and pestles are rare. What were found were small mortars used by older people to pound fresh and dried meat and fish. The Maidu also processed meat products in mortars, crushing deer vertebra and salmon backbones in a mortar with the resultant paste shaped into cakes and dried near a fire (Kroeber 1925:407).

Basket-Hoppers

A mention should be made about the basket-hopper mortar. It was reported as being used until the depression was deep enough to contain the material being processed but also as a implement in its own right, used with a thin slab. As with shaping, the actual use of the basket-hopper probably was determined by circumstances. Schenck and Gifford (1952:379-380), however, specifically mention the use of a basket-hopper by the Karok to pound grains including the grasses, *Bromus hordeaceous* and *Bromus rididus*.

The Cahuilla purposefully made a special coiled basket without a bottom whereas the Yurok basket-hopper was a twined basket with the bottom cut out (Kroeber 1908:43). The Yokuts, Tübatulabal, and Kawaiisu also made baskets coiled especially for basket-hoppers although the Yokuts also adapted other baskets to the same use (Driver 1937:68). Driver (1937:116) described a basket-hopper found in Mono territory (UCMA-1-1408) as coiled with a maximum diameter of 22 inches (56 cm). The rim did not contain a hoop reinforcement and the basket-hopper was attached with asphaltum to a portable stone mortar. The stone mortar had an exterior height of 6.5 inches (16.5 cm) and a diameter of 12 inches (30.5 cm). The mortar hole had a depth of 5 inches (12.7 cm). Driver (1937:116) also described two from Cahuilla and Diegueño territory as similar but the mortar holes were more shallow. Measurements of 12 inches maximum diameter (30.5 cm), 10 inches minimum diameter (25.4 cm), and 6 inches depth (15.2 cm) were given for a Kitanemuk specimen, which was described as an old basket with the bottom cut out or worn out (Driver 1937:116). Driver also noted that although a coiled basket could be made without a bottom, if the twining technique was used to make the basket, the bottom had to be removed after the basket was finished. McCawley (1996:130) reported that the Gabrielino used a basket hopper to prevent the ground meal from scattering.

Mastic for attaching the basket-hopper varied with the environment and availability of glue. The Banning Cahuilla used a gum made from a bush (Kroeber 1908:43). The Mono basket-hopper described by Driver (1937:68) was attached with asphaltum, and McCawley

(1996:131) reported asphaltum use for the Gabrielino. Other material may also have been used, and specific mastics could be ascertainable through laboratory analyses.

Wooden Mortars

The use of wooden mortars is reported almost exclusively for the desert regions (Drucker 1937:14, 1941:120; Driver 1937:116), with wooden mortars specifically mentioned for 16 groups (see Table 2). The exception is the Gabrielino, reported by McCawley to have used a wooden mortar with a wooden pestle (1996:130). Two types are reported. For most, the log was hollowed out at one end with the opposite end pointed and set in the ground (Drucker 1937:14). This is the type described for the Cahuilla by Bean and Saubel (1972:106). It was made from a cottonwood log about 2.5 feet in length (76.2 cm) and was used for soft foods such as mesquite. Bean and Saubel also noted that wooden mortars made from mesquite logs as well as cottonwood and were called "*paal*". They were generally between 2 and 3 feet high (60 to 90 cm). The mortar hole was formed by firing the center and then chopping out the interior, sometimes to a depth of one foot (30 cm). The pestle used with the wooden mortar was long, almost as long as the log, and was used while standing rather than setting (Kroeber 1908:52; Bean and Saubel 1972:109).

Driver described three wooden mortars found at Stovepipe Wells, in Inyo County, Panamint territory. These were logs about one foot (30 cm) in diameter and about 2 feet high (60 cm). He also noted mortars made in sides of logs rather than ends, and described them as roughly rectangular in shape (Driver 1937:116).

Steward (1933:240) described a wooden mortar found in Death Valley as having the same dimensions as those found by Driver. One found at Furnace Creek, however, was only 12 inches tall (30 cm) and 10 inches in diameter (25.4 cm). The mortar hole had dimensions of 4 x 6 inches (10 x 15 cm).

According to Voegelin (1938:17), the Tübatulabal wooden mortar was made from a hard wood such as oak or juniper. The bowl was first burnt and then scraped and smoothed with a rock until a desired depth was reached. Although considered to be easier to manufacture than a stone mortar, it was not as easily transported because of its large size. Voegelin (1938:31) described a basket-hopper wooden mortar he saw in a log at a piñon nut gathering camp where no stone was present for a normal mortar. The small mortar was used for tobacco and lime mixing (Voegelin 1938:31).

An unusual wooden mortar was described for Mohave, Cocopa, and Maricopa. This was a "traveling" (i.e., easily transported) mortar made from arrowweed. It had a conical shape and was made from twisted stems (Drucker 1941:121).

Pit Mortars

Although pit mortars, like wooden mortars, appear to have been used when no appropriate stone was available for either bedrock mortars or portable stone mortars, some appear to be the preferred mortar type for a particular task. Pit mortars are reported for eight groups, all of which also used wooden mortars (see Table 2). A pit mortar was formed by excavating a small conical hole and lining it with rocks, although other materials were also used. The desert Diegueño and Yuma sometimes lined the pit with arrowweed and the desert Diegueño

and Chemehuevi lined the pit with a paste made from damp mesquite flour (Drucker 1937:14). These pits had a flat rock placed in the bottom.

The Mojave, Cocopa, Maricopa, Pima, and Papago used either arrowweed stems or meal and used the pit mortars for grinding large amounts of mesquite (Drucker 1941:186). The pit mortar of the Papago was lined with stones and was used primarily for pulverizing cooked mescal prior to drying (Drucker 1941:186). In contrast, the Tübatulabal appear to have used the pit mortar for all material that required pounding. They used the pit mortar to pound chia, wild oats, heads of *Polypogan*, wheat, corn, juniper berries, box thorn berries, and roots (Voegelin 1938:18-19). They also pounded clay in pit mortars (Voegelin 1938:34).

Special Mortars for Ceremonial Use

Three special uses for small mortars are recorded: use in the tolache ceremony for grinding jimson weed (*Datura meteloides*), use in grinding paints used in ceremonies, and use for tobacco concoctions (Strong 1929). The Luiseño called the mortar used for processing jimson weed a "*tamyush*" and that used for mixing paint the "*tamya-mal*." The *tamyush* was used almost exclusively by the medicine person (*met*) for pounding up the roots of the jimson weed. It was symmetrical, polished, and had ornamental grooves on the exterior. The *tamya-mal* was very small, almost exactly round, and lacked the decoration of the *tamyush* (Sparkman 1908:207; DuBois 1908). McCawley (1996:131, 139, 151) reported a similar dichotomy for the Gabrielino, with another use of a slightly larger mortar for tobacco.

Driver (1937:68) described small mortars used for processing tobacco by the Mono, Yokuts, Tübatulabal, Kawaiisu, Panamint, and Owens Valley Paiute. These were often made of steatite, were symmetrical and polished, and often looked more like bowls than mortars. The tobacco concoction was ingested directly from the mortars by licking the pestle (Driver 1937:116).

Use of Mortars

Specifically, mortars are mentioned most often in conjunction with the processing of piñon nuts, acorns, and mesquite, with the material being processed a function of environment rather than preference. There are, however, mention of other materials specifically being processed in mortars. Other vegetal material processed in mortars by the Cahuilla includes dried Palos Verde (*Cercidium floridum*) seeds ground for flour for mush and cakes and kernels of dried holly-leaf cherry (*Prunus ilicifolia*) fruit crushed and boiled into *atole* (Bean and Saubel 1972:45, 120). The southern Diegueño processed dried wild plums in rock mortars (Spier 1923:335), and the Tübatulabal continued to use the mortar for processing parched corn and wheat after the 3-legged metate and horned muller was introduced (Voegelin 1938:17).

In addition to vegetal material, the Luiseño cooked deer meat, rabbits, and jackrabbit in earth ovens and then pounded the meat in a mortar. This meat was sometimes stored for future use and sometimes eaten immediately (Sparkman 1908:196-198). The Southern Paiute also used the mortar and pestle to pulverize meat (Stewart 1942:253).

Non-consumable materials may also have been processed in mortars. Specifically, Drucker (1937:48) noted that "dry lumps of clay were pounded fine in a mortar and coarse particles removed with a winnowing tray."

Pestles

Although the majority of the groups appear to have used stone pestles, a surprisingly large number also used wooden pestles. Wooden pestles were reported for the desert Diegueño, Yuma, Chemehuevi, Mohave, Cocopa, Maricopa, Pima, and Papago for use with the pit mortar (Drucker 1937:14, 1941:121). Drucker (1941:121) also reported a wooden pestle used by the Mojave, Cocopa, and Yaqui with log mortars, and Harrington (1942:12) recorded wooden pestles for the Costanoan and Chumash. McCawley (1996:130) described the use of stone pestles with stone mortars and wooden pestles with wooden mortars for the Gabrielino.

Stone pestles range from finely shaped, long, cylindrical specimens to natural cobbles of convenient size and shape. Unmodified stone pestles were reported for the Diegueño, Akwa'ala, Pima, Papago, Yaqui, Yavapai, Pima, Papago, Yokuts, Miwok, Costanoan, Salinan, Chumash, Kitanemuk, Fernandeño, Gabrielino, Mono, Tübatulabal, Kawaiisu, Panamint, Luiseño, Cahuilla and Owens Valley Paiute (Kroeber 1908:43,52; Sparkman 1908:207; Driver 1937:69; Voegelin 1938:17; Drucker 1941:121; Harrington 1942:12). Archaeologists should be aware that the majority of the pestles will not be finely shaped cylindrical specimens.

For the Cahuilla, a long slender shaped pestle was reported for use with the wooden mortar (Drucker 1937:14), but a short, barely shaped or convenient cobble with one end dressed to fit the mortar used with the basket-hopper mortar. Similarly, for the Luiseño, most pestles were conveniently shaped stones but the pestle used for processing jimson weed was symmetrically shaped and polished (Sparkman 1908:207).

Some shaping did appear to have taken place. For the Banning Cahuilla, Yokuts and Miwok, Kroeber (1908:52) recorded one end was sometimes dressed to fit the mortar and one side may have been flattened. Stewart (1942:262) noted that the southern Paiute made stone pestles, and Harrington (1942:12) recorded that the Costanoan, Salinan, Chumash, Kitanemuk, Fernandeño, and Gabrielino made special long slender shaped pestles for use in deep stone mortars. Kroeber (1925:87) described an exceptionally long pestle (2-feet; 60 cm) of the Yurok that was considered a treasure and not for daily use. It has a ring or flange about one-third of the distance from the end.

Driver (1937:69) described a specimen (UCMA 1-19791) as 15.75 inches long (40 cm) and Steward (1942) described two from the Panamint: one, 12 inches (30 cm) long with a diameter of 3 inches (7.6 cm) and one, 3 feet (90 cm) long with a 2.5 to 3 inch (6.4-6.7 cm) diameter. The Tübatulabal pestles were described by Voegelin (1938:17) as roughly cylindrical cobbles picked up in river beds and used without modification. They were granite or slate and ranged in length from 5 to 20 inches (12.7 to 50 cm) and in diameter from 2.5 to 5 inches (6.4 to 12.7 cm).

In addition, some scavenging of older habitations appear to have taken place. The Pima, Yavapai, Ute and Papago re-used pestles as they found them (Drucker 1941:121, 186; Stewart 1942:262)

Anvils

Anvils as such are rarely mentioned; however, the use of rocks in similar manners were discussed in a few cases. Sparkman (1908:194) recorded that the Luiseño would place an

acorn on a rock and then strike it "with another stone with sufficient force to crack the hulls." Spier (1923:334) noted that the women and old men of the southern Diegueño would crack "nuts between two convenient stones to extract kernels." Bean and Saubel (1972:126) were more specific. They described the process of hulling acorns by placing the acorn on a flat rock with a small indent and striking it with a smaller rock. Sparkman (1908:194) also noted that the Luiseño cracked the shells of plums (*Prunus ilicifolia*).

Materials that were Ground

In addition to the materials that were specifically mentioned as being processed in metates and/or mortars, numerous accounts of material being ground are given. Although without specific mention of metates we cannot be positive of the implement being used, it is reasonable to assume that some form of grinding slab was utilized in this process. Table 3 lists 42 plants where seeds, nuts, berries, or roots were ground for food. This list excludes tobacco, piñon nuts, mesquite, and acorns, as the use of the grinding slab in their production is well documented.

When processing Spanish bayonet (*Yucca whipplie*), the Cahuilla cut the stalk near the ground and cooked it overnight in a rock-lined roasting pit. Then it was dried and ground and formed into cakes which could then be stored (Bean and Saubel 1972:15). The Baja natives used a similar process for San Miguel (*Antigonon leptopus*). The root that is the size of small peas was roasted and the kernel removed. It was then ground and eaten (Carter 1970:31). At Sierra de la Giganta in Baja, the seeds of "*pitaya dulce*" (*Lemaireocereus thurberi*) and "*pitaya agria*" (*Machaerocereus gummosus*) were eaten whole and often passed whole through the digestive tract. During famine, the seeds were retrieved from the excrement, roasted and then ground and eaten (Carter 1970:30).

Other special use of grinding includes the grinding of material for soaps. The Luiseño ground up *Mesembrysanthemum crystalinum* from the beach areas (the complete plant) and the roots of *Yucca* sp. for soap (Cuero 1970:33). The Cahuilla ground up the shell of wild squash (*Cucurbita foetildessima*) for hair shampoo (Bean and Saubel 1972:57-58).

The grinding of meat is also well documented. In addition to the specific examples given with metates and mortars, the Yuman group in Baja California would grind fish to powder and store the powder in skin bags for preservation (Banks 1970:37). The Goshute, Ute, and Southern Paiute ground bones of rabbit, vertebra of large game, joints, feet, and leg bones to add to mushes and gruels (Stewart 1942:253).

Use of grinding extended into the medicinal sphere. Several unusual practices are noted, apart from the normal grinding of leaves and barks into teas and syrups. The Luiseño would crisp hide and then grind it to a powder to use to stop infection (Cuero 1970:30). The Cahuilla ground red shank twigs (*Adonostoma sparsifolium*) and mixed the powder with grease for a salve to place on sores and ground pepper grass seeds (*Descurainia pinnata*) for use as medicine for stomach ailments (Bean and Saubel 1972:30).

Other processing involved proofing clay and processing dyes and paints. Specifically, in addition to grinding hematite and limonite for paint, the Luiseño ground the kernel of the seeds of chilicoth (*Echinocystic macrocarpa*) for use in red pigments (Sparkman 1908:210). In Santa Catarina, Baja, the clay for ceramics was first crushed on a stone metate with a

Table 3. Plants Ground for Food

Plant	Plant Part
Aromatic sumac (*Rhus trilobata*)	berries - parched
Basin sagebrush (*Artemisia tridentata*)	seeds - parched
Beavertail (*Opuntia basilaris*)	seeds
Black sage (*Salvia mellifera*)	seeds - parched
Blazing star (*Mentizelia L.*)	seeds - parched
Box-thorn (*Lucum L.*)	berries - dried
Bulrush, tule (*Scirpus* sp.)	tuberous roots
California juniper (*Juniperus californica*)	berries - dried
Cat's claw (*Acacia gregii*)	pods - dried
Cat-tail (*Typha latifolia*)	roots - dried
Chia (*Salvia columbraiae*)	seeds
Chokecherry (*Prunus virginiana*)	pit
Cholla (*Opuntia* sp.)	seeds - parched
Clover (*Trigolium* sp.)	seeds
Desert mistletoe (*Phorandendron californicum*)	berries
Eriophyllum confertiflorum	seeds - parched
Fan palm (*Washingtonia filifera*)	fruit - dried
Glasswort (*Salicornia subterminalis*)	seeds
Gold fields (*Lasthenia glabrata*)	seeds - parched
Goldfields (*Baeria chrysostoma*)	seeds - parched
Goosefood (*Chenopodium fremontii*)	seeds - parched
Holly-leaf cherry (*Prunus ilicifolia*)	interior of nut
Iodine bush (*Allenrolfea occidentalis*)	seeds
Ironwood (*Olneya tesota*)	pods and seeds - parched
Jojoba (*Simmondsia chinensis*)	seeds - drink
Manzanita (*Archtostaphylos* sp.)	berries
Milkweed (*Asclepias L.*)	seeds - parched
Morman tea (*Ephedra nevadensis*)	seeds
Ocotillo (*Fourquieria splendens*)	seed pods - parched
Pigweed (*Amaranthus fimbriatus*)	seeds - parched
Pin cushion (*Chaenactis glabriuscula*)	seeds - parched
Prickly pear cactus (*Opuntia occidentylis*)	seeds - parched

Table 3. Plants Ground for Food, continued

Plant	Plant Part
Saltbush (*Atriplex lentiformis*)	seeds - parched
Seep-weed (*Suaeda suffrutescens*)	seeds
Sugar bush (*Sumac ovata*)	berries
Sunflower (*Helianthus annus*)	seeds - dried
Thistle sage (*Salvia carduacea*)	seeds - parched
Wheat & corn	seeds - dried
White sage (*Salvia apiana*)	seeds
White tidy tips (*Layia gladulosa*)	seeds - parched
Wild plum (*Conalia Parryl*)	Drupe and nutlet of drupe
Wild squash (*Cucurbita foetidissima*)	seeds

mano and then lightly ground. After winnowing to remove the coarse particles, it was ground very fine (Smith 1972:3). Stewart (1942:341) also reported grinding of clay for the Uintah, and Hooper (1920:359) for the Cahuilla.

Throughout mention has been made of shaping of manos, metates, pestles, wooden mortars, and portable stone mortars by grinding. In addition, Drucker (1937:48) noted that in southern California, a bow was ground to the desired thickness using pieces of sandstone. These grinding processes could result in use-wear similar to that of manos.

Pounding and Pulverizing

As with grinding and metates, numerous reports of pounding and pulverizing material are given without specifically mentioning the use of mortars. It can be assumed, however, that in at least some cases, the pounding and/or pulverizing was accomplished with the aid of either the mortar or a slab of rock.

Vegetal foodstuff is the most often reported material processed by pounding, with acorns, piñon nuts, and mesquite beans leading the list. Other vegetal foods include the cooked heads of mescal that were pounded into cakes prior to storage by the Cahuilla, desert Diegueño, and Chemehuevi (Drucker 1937:9). The roasted leaves and stalks of agave received the same treatment (Bean and Saubel 1972:34). The Diegueño, Akwa'ala, Maricopa, Pima, Yavapai, Walapai, and Shivwits Paiute dried the cooked mescal prior to pounding (Drucker 1941:96).

Other specific plants said to have been pounded for processing include wild oats which the Luiseño “stripped from the stalk, parched, and pounded into meal” (Sparkman 1908:196). According to Stewart (1942:251), the Goshute, Ute, and Southern Paiute mashed chokecherries along with their pits for food, and the Karok pounded western rye grass (*Elymus glaucus*) and cultivated oats (*Avena sativa*) into flour (Schenck and Gifford 1952:380).

Several plants were mashed prior to use in a drink. The Cahuilla mashed the pulp of the fruit of manzanita (*Arctostaphylos adans*), steeped it in water, and then strained the mixture to provide a drink. The seeds were dried and ground into flour which was then used in mush (Bean and Saubel 1972:41). Juniper berries were "pulverized" by the Diegueño, Akwa'ala, Yavapai, Walapai, and Shivwits Paiute prior to being used in a beverage (Drucker 1941:97), and the Shasta, Wintun, Yokuts and others ground manzanita berries for cider (Kroeber 1925:293).

Several examples of pulverizing meat are present in the literature. Drucker (1937:10) noted that meat was pulverized for the toothless by the Serrano, Cahuilla, Cupeño, Luiseño, Diegueño, and Chemehuevi. In addition, small mammals, bones and all, were often pulverized. These same groups pulverized larger cooked bones and venison. The Salinan, Chumash, and Kitanemuk also pulverized small mammals (Harrington 1942:9).

The Luiseño pounded abalone with rocks to tenderize it, a task aided by children (Cuero 1970:29, 57). In order to process rats, mice, lizards, and some snakes, these were pounded on a rock and then cooked in a stew. Roasted meat was pulverized on a flat stone by the Goshute, Ute Southern Paiute, and northwestern Navaho (Stewart 1942:253).

Pounding of jerked meat appears to fairly common and was noted for the Akwa'ala, Cocopa (River), Maricopa, Pima, Papago, Yaqui, Walapai (Drucker 1941:97), Mono, Yokuts, Tübatulabal, Panamint, and Owens Valley Paiute (Driver 1937:64). Pulverizing of dried fish was noted for the Yokuts, Kawaiisu, Owens Valley Paiute (Driver 1937:63), and the Shasta (Kroeber 1925:294).

Bean and Saubel (1972) recorded numerous examples of pounding or pulverizing material for medicinal or personal use by the Cahuilla. These include crushing the leaves and roots of saltbush (*Atriplex lentiformis*) for a soap to be used on articles for cleaning. In addition, the flowers, leaves, and stems were crushed and added to boiling water with the steam inhaled to relieve nasal congestion (Bean and Saubel 1972:45). A soap was also made from amole (*Cholorogalum pomeridianun*). The bulb was crushed and rubbed in water which produced a soap (Bean and Saubel 1972:46). The leaves of white sage (*Salvia apiana*) were crushed and mixed with water for hair dye, shampoo, and straightener. The crushed leaves were also used as a deodorant and were placed in armpits to eliminate body odors (Bean and Saubel 1972:136). Another soap was made by scraping and mashing the roots of Mohave yucca (*Yucca schidigera*) (Bean and Saubel 1972:151). Medicinal pastes were made by crushing parts of wild squash (*Cucurbita foetidissima*), jimson weed (*Datura meteloides*), and Yerba santa (*Eriodictyon trichocalyx*), with wild squash paste used especially for saddle sores on horses (Bean and Saubel 1972:58, 60, 71). Ear aches were aided by mashed croton (*Croton californicus*) and healing of wounds was promoted by a flour created by pounding the berries of juniper mistletoe (*Phoradendron ligatum*) (Bean and Saubel 1972:56, 101).

Of special interest is the use of pounding and pulverizing for non-food materials. Drucker described how, in southern California, *Apocynum* was processed for fiber. "The outer layer of stalks were scraped off, stalks were pounded, and fibers drawn" (Drucker 1937:48). The Cupeño, Diegueño, Yuma, and Chemehuevi had a special club for pounding agave or yucca leaves for cordage (Drucker 1937:21). Bean and Saubel (1972:35) gave a more complete description for agave processing by the Cahuilla. The agave leaves were pounded to release the fiber, which was then dried and separated by combing. The fibers were used for "nets,

slings, shoes, women's skirts, bowstrings, mats, cactus bags, cordage, cleaning brushes, snares, baby cradles, saddle blankets, needle and thread, and basket foundations" and were ranked with hemp in carrying strength (Bean and Saubel 1972:35). Of special mention is the note by Drucker (1941:114) that buckskin was pounded with a stone during processing, suggesting that large mammal protein residue found on implements may be the result of hide processing rather than meat processing.

The Cahuilla also pounded the stems of milkweed (*Asclepias L.*) to loosen the fibers which were then extracted by rubbing with the hands and rolled on the hips. These fibers were used primarily in nets, slings, and snares (Bean and Saubel 1972:44). According to Hooper (1920:357), the Cahuilla also pounded the bark of mesquite until it became soft. It was then used as diapers for babies and as skirts for women. Fibers were also extracted by the Karok from chain fern (*Woodwardia radicans*). The leaves were stripped from the stem which was then pounded with a stone (Schenck and Gifford 1952:378). The Karok also pounded and ground the bark of white alder (*Alnus rhombifolia*) to make a dye (Schenck and Gifford 1952:382).

Use of pounding and crushing to prepare material for ceramic production is recorded for several groups. The Panamint, Owens Valley Paiute, Yuma, Chemehuevi and Mojave crushed rock for use as temper (Driver 1937; Drucker 1937:22, 1941:107) and the Ute, Southern Paiute, Serrano, Cahuilla, Cupeño, Luiseño, Diegueño, Yuma, and Chemehuevi all pounded the dry clay to a fine powder (Drucker 1937:38; Stewart 1942:273). The Akwa'ala, Mohave, River Cocopa, Pima, Papago, and Yaqui also pulverized old ceramic sherds for temper (Drucker 1941:107). The use of cactus in ceramic production is documented in two different ways. The Ute pounded cactus for use as a vegetal temper and the Southern Paiute pounded cactus as a sheen on a fired pot (Stewart 1942:273).

Rubbing and Smoothing

Often cobbles are found at archaeological sites that exhibit use wear not consistent with food-processing use wear. These are often called “smoothing” stones or “rubbing” stones. Ethnographic recording of use of stones for rubbing and smoothing are mostly connected with ceramic production although other instances are given.

In ceramics, stones were used as anvils in the paddle-and-anvil smoothing technique. This is recorded for Diegueño, Akwa'ala, Mohave, Maricopa, Pima, Papago, Yavapai, Walapai (Drucker 1941:107), and Cahuilla (Hooper 1920:359). The Cahuilla work for the stone was “*paikwal*” which was placed inside the vessel to hold the vessel shape while the outer surface was smoothed by pounding with a wooden anvil. Cobbles were also used to smooth the outer surface, generally in combination with water. This use is recorded for Santa Catarina, Baja by Michelsen (in Smith 1972:7-8), and for the Akwa'ala, Diegueño, Maricopa, Pima, Papago, northwestern Yavapai, and Walapai by Drucker (1941:107).

Stone were used for hide processing by several groups. The Costanoan, Salinan, Chumash, Gabrielino, desert Diegueño, Yuma, and Chemehuevi used rubbing stones in skin dressing (Drucker 1937:15; Harrington 1942:13), and the Gabrielino placed hides over a blunted rubbing post and used a rubbing stone to aid in softening the hide (Johnston 1962:34).

Shaping of bows and possible other wooden objects also may have involved rubbing/smoothing stones. Steward (1933:259) described smoothing a bow by the Owens

Valley Paiute. The bow was smoothed with a rock that had been previously smoothed by rubbing it against another rock. Kroeber (1925:88) noted that the Yurok wood pipe was formed by rubbing with sandstone, and sharpening of digging sticks by rubbing on a stone are recorded for the Ute, Southern Paiute, and Karok (Kroeber 1925:88; Stewart 1942:252).

Table 4. Non-vegetable Materials Processed in Ground Stone Implements or by Grinding or Pounding

Material	Use	Group
Insects	Roasted/dried and ground to flour	Honey Lake Paiute, Goshute, Ute, Southern Paiute
Meat	Roasted and pulverized by pounding	Ute, Paiute, Luiseño, Southern Paiute, Goshute, Serrano, Cahuilla, Cupeño, Diegueño, Chemehuevi, Gabrielino
Clay	Ground fine for ceramics	Owens Valley Paiute, Tübatulabal, Luiseño, Cahuilla, Ute, Southern Paiute, Serrano, Cupeño, Diegueño, Yuma, Chemehuevi, Gabrielino
Temper	Ground fine for ceramics	Owens Valley Paiute, Tübatulabal, Luiseno, Cahuilla, Panamint, Yuma, Chemehuevi, Mojave
Paint	Ground fine	Ute, Southern Paiute, Luiseño, Gabrielino
Deer livers	Pounded by old people to tenderize	Tübatulabal
Tobacco/lime	Mixed and pounded	Tübatulabal
Dried Meat	Pounded by old people to tenderize	Modoc, Serrano, Cahuilla, Cupeño, Luiseño, Dieguieño, Chemehuevi
Dried Fish	Pounded by old people to tenderize	Modoc, Yuma
Deer Vertebra	Crushed into a paste	Maidu
Salmon backbones	Crushed into a paste	Maidu
Jimson weed	Hallucinogen	Luiseño
Tobacco	Processed in implement	Mono, Yokuts, Tübatulabal, Kawaiisu, Panamint, Owens Valley Paiute, Gabrielino
Abalone	Pounded on rock to tenderize	Luiseño
Jerked Meat	Pounded to tenderize	Akawa'ala, Cocopa, Maricopa, Pima, Papago, Yaqui, Walapai, Mono, Yokuts, Tübatulabal, Panamint, Owens Valley Paiute
Dried Fish	Pounded to pulverize	Yokuts, Kawaiisu, Owens Valley Paiute
Ceramic sherds	Pulverized for temper	Akwa'ala, Mohave, Cocopa, Pima, Papago, Yaqui

Summary

The above discussion of ground stone implements and the varieties of materials processed using items we often term “manos, metates, pestles, mortars, anvils, and smoothing stones” is far from complete. By expanding the geographical area, more and diverse examples could be added. The discussion does, however, serve to provide an example of the diversity of utilization of these implements. We cannot assume that manos and metates are only seed-grinding implements and that mortars and pestles are only acorn, piñon nut, mesquite bean processing tools. Table 4 lists some of the non-vegetable materials processed using these implements. Their occurrence in an archaeological deposit may not have anything to do with the narrow interpretations based on acorn, piñon pine nuts, and mesquite processing. More in-depth analysis of actual wear-patterns and shapes of utilized surfaces are needed along with special analyses geared to determining the material being processed. Replications geared to determining different patterns or similar patterns from processing different materials will be necessary for real interpretations of the archaeological record.

References Cited

Banks Thomas J.
1970 Aboriginal Inhabitants of Isla de Cedros, Baja California, 1540-1732. *Pacific Coast Archaeological Society Quarterly* 6(1):34-40.

Bean, Lowell J., and Katherine S. Saubel
1972 *Temalpakh: Cahuilla Indian Knowledge and Usage of Plants*. Malki Museum Press, Banning, California.

Carter, Annette
1970 Some Ethnobotanical Notes on the Plants of the Sierra de la Giganta, Baja California Sur. *Pacific Coast Archaeological Society Quarterly* 6(1)29-33.

Cuero, Delfina
1970 *The Autobiography of a Diegueño Woman: As Told to Florence C. Shipek*. Dawson’s Book Shop, Los Angeles.

Driver, Harold E.
1937 Culture Element Distribution: VI; Southern Sierra Nevada. *University of California Anthropological Records* 1(2):53-154.

Drucker, P.
1937 Culture Element Distribution: V; Southern California. *University of California Anthropological Records* 1:1-52.
1941 Culture Element Distribution: XVII; Yuman-Piman. *University of California Anthropological Records* 6(3):91-230.

DuBois, Constance G.
1908 Religion of the Luiseño Indians. *University of California Publications in American Archaeology and Ethnography* 8:69-186.

Harrington, John P.
1942 Culture Element Distributions: XIX; Central California Coast. *University of California Anthropological Records* 7(1):1-46.

Hooper, Lucile
1920 The Cahuilla Indians. *University of California Publications in American Archaeology and Ethnology* 16(6):315-380.

Johnston, Bernice Eastman
1962 *California's Gabrielino Indians*. Southwest Museum, Los Angeles.

Kroeber, Alfred L.
1908 Ethnography of the Cahuilla Indians. *University of California Publications in American Archaeology and Ethnology* 8(2):29-68.
1925 *Handbook of the Indians of California*. Bureau of American Ethnology Bulletin 78. Reprinted 1976, Drover Publications, Inc., New York.

Lowie, Robert H.
1924 Notes on Shoshonean Ethnography. *Anthropological Papers of the American Museum of Natural History* 20(3):185-314.

Meigs, Peveril III
1974 Field Notes on the Sh'un and Jat'am, Manteca, Baja California. *Pacific Coast Archaeological Society Quarterly* 8(1):19-28.

McCawley, William
1996 *The First Angelinos: The Gabrielino Indians of Los Angeles.* Malki Museum Press, Banning, California, and Balleno Press, Novato, California.

Riddell, Francis A.
1978 Honey Lake Paiute Ethnography. *Nevada State Museum Anthropological Papers* No. 4, Carson City. Second Printing.

Schenck, Sara M., and E. W. Gifford
1952 Karok Ethnobotany. *University of California Anthropological Records* 13(6):366-392.

Smith, Helen
1972 The Making of Paddle and Anvil Pottery at Santa Catarina, Baja California, Mexico. Photographs by Ralph C. Michelsen. Captions adapted from Michelsen’s field notes. *Pacific Coast Archaeological Society Quarterly* 8(1):2-9.

Sparkman, P. S.
1908 The Culture of the Luiseño. *University of California Publications in American Archaeology and Ethnology* 8:187-234.

Spier, Leslie
1923 Southern Diegueño Customs. *University of California Publications in American Archaeology and Ethnology* 20(16):297-358.

Steward, Julian H.
1933 Ethnography of the Owens Valley Paiute. *University of California Publications in American Archaeology and Ethnology* 33(3):233-350.

Stewart, Omer C.
1942 Culture Element Distributions: XVIII; Ute-Southern Paiute. *University of California Anthropological Records* 6(4):231-360.

Strong, William D.
1929 Aboriginal Society in Southern California. *University of California Publications in American Archaeology and Ethnology* 26(1).

Voegelin, Erminie
1938 Tübatulabal Ethnography. *University of California Anthropological Records* 2(1):1-90.