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The Function of Pitted Stones: An Experimental Evaluation

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The function of pitted stones, one of the most common artifacts on the central coast of California, has never been clear. Suggested functions have included use as a hammer or anvil to crack nuts, process acorns, open shellfish, or reduce cobble cores, but most researchers favor a function related to processing coastal resources. Here we report multiple lines of evidence to suggest that the primary use of pitted stones along the coast was to crack open California sea mussels and occasionally turban snails. An evaluation of their spatial distribution showed that pitted stones are concentrated on open rocky coasts, and are under-represented inland and at estuaries. An experiment involving processing mussels with a hand-held stone and anvil showed a remarkable similarity between the experimental anvil and archaeological pitted stones. Finally, we point out that most accounts of food consumption in native California emphasize soups, gruels, and stews prepared for groups. Mass processing of raw mussels via a pitted stone produces a quantity of shellfish meat that could be readily used as part of a stew prepared for such groups.

In 1929, the Los Angeles County Museum excavated a 32-foot-long trench at CA-SLO-50 on the Pecho Coast of San Luis Obispo County in central California (Fig. 1). The yield from the excavation was so poor that the project was never written up by the original investigators, but was instead summarized briefly by Tom King (1970: Appendix I) 40 years later, who noted that the most abundant artifacts were 35 "pitted hammerstones." In 1954, Wallace reported pitted stones as part of the Milling Stone assemblage from CA-VEN-1 and suggested that they might have been employed "in smashing molluscan shells in order to extract the meat" (Wallace 1954:114). Since then, thousands of pitted stones (also referred to as dimple stones, pitted hammerstones, acorn crackers, acorn anvils, and pitted anvils) have been recovered from as far north as Mendocino County (White 1989) and at least as far south as San Diego (Shumway et al. 1961). The artifacts are especially common on the central California coast, where Greenwood reported 1,249 examples from six sites at Diablo Canyon in San Luis Obispo County in 1972. At CA-SLO-2 (Fig. 1), the oldest and most heavily investigated of the Diablo sites, pitted stones were the single most abundant formal artifact present, representing 26.6% of the overall site assemblage. All four temporal components in the 10,000-year occupational sequence (10,300–300 cal B.P.) contained pitted stones, accounting for between 17% and 32% of the formal artifacts in each (Jones et al. 2008:297).

While pitted stones are abundant and common, their function has never been clearly established. Lathrap and Hoover (1975) suggested they may have been used for a variety of hammering purposes, with the pits serving as finger holds. Uses as hammers or anvils for cracking nuts, processing acorns, opening shellfish, or reducing cobble cores have all been suggested (e.g., Abrams 1968; Bouey and Basgall 1991; Greenwood 1972; Harrison and Harrison 1966; Hines 1986; Jones and Waugh 1995). By far the most widely accepted hypothesis was put forward by Strudwick (1995), who suggested that while probably serving multiple functions, pitted stones were used primarily to smash open black turban snails. His idea was a more specific extension of one advanced by Breschini and Haversat, who suggested that pitted stones were generic, multifunctional tools used to exploit and process a variety of marine resources (Breschini and Haversat 1988:47, 1989:69).

Here we rely on four lines of evidence to suggest that while pitted stones indeed must have had multiple functions, their primary use along the coast was to crack open California sea mussels (*Mytilus californianus*) and occasionally turban snails (*Chlorostoma* spp.). Mussels and turban snails are among the five mollusks that consistently make up at least 95% of the shell in middens on the exposed rocky coast of central California (the others being red abalone, black abalone, and limpets).

Our study area is the southern half of the central California coastal region between Point Sur and Point San

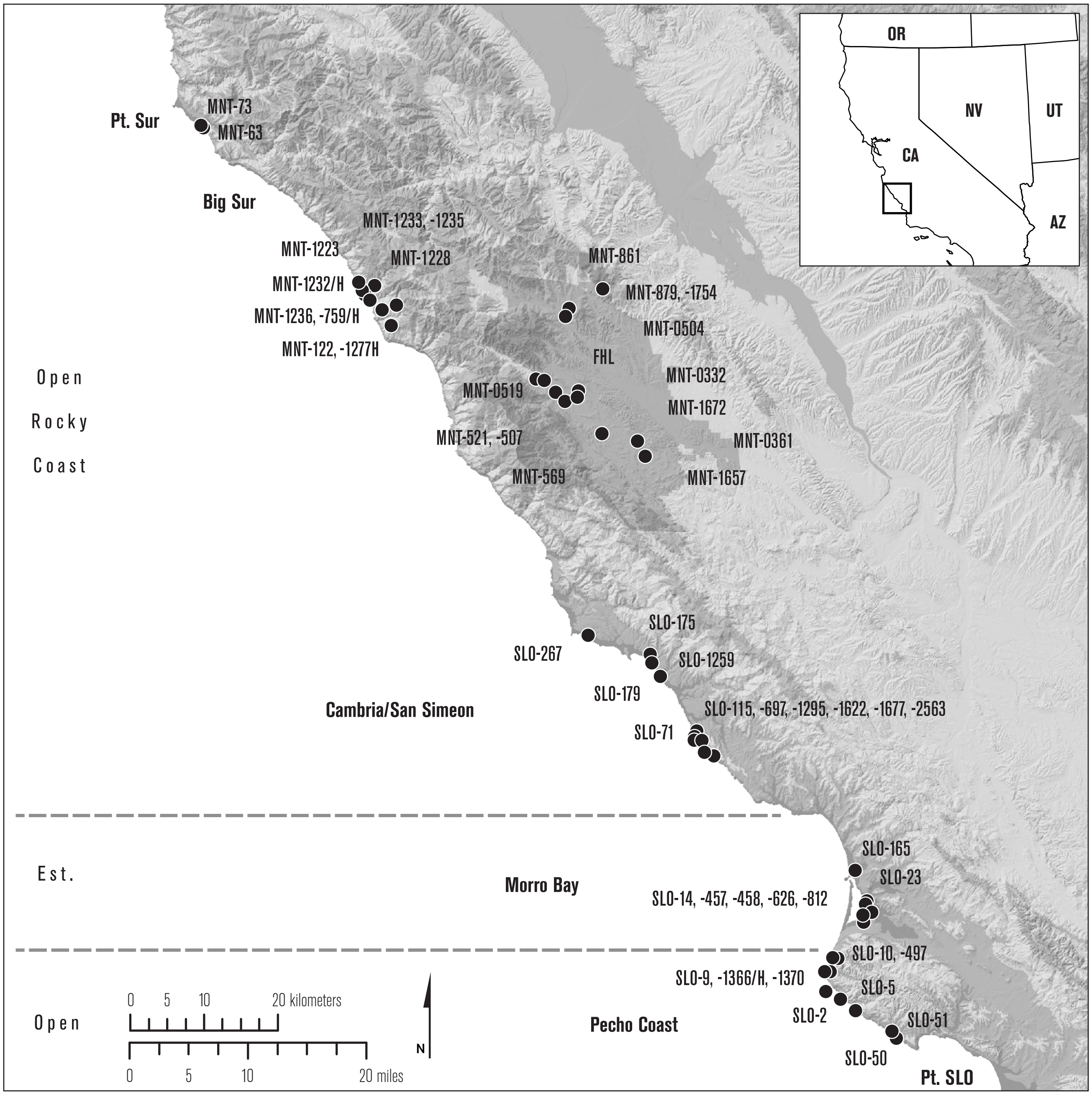

Figure 1. Archaeological sites and shoreline types of the central California Coast discussed in the text (Est.=Estuary).

Luis Obispo (Fig. 1). It includes stretches of open rocky shoreline in the vicinity of Big Sur, Cambria/San Simeon, and the Pecho Coast, as well as the Morro Bay estuary, and the interior valleys within Fort Hunter-Liggett in southern Monterey County. We first evaluated the spatial distribution of pitted stones in this area to confirm, as others have suspected, that pitted stones are heavily concentrated on the coast, suggesting a function related to marine resources. Second, we offer a more refined evaluation of the spatial patterning to show that they are heavily concentrated on open rocky coasts favored by California sea mussels (and turban snails), and are under-represented at estuaries. This suggests a narrower range of resources associated with the implement. Third, we present the results of an experiment in which we processed mussels with a hand-held stone and anvil. The stones used to crack open the mussels, particularly the anvil, are remarkably similar to archaeological pitted stones. Finally, we point out that while the ethnographic record is silent on the specifics of how mussels were consumed, many accounts of food consumption in native California emphasize soups, gruels, and stews prepared for groups. Mass processing of raw mussels produces a quantity of shellfish meat that could be readily used as part of a stew prepared for multiple individuals, as in an extended family or kin group. Modern consumption of shellfish in restaurants provides a poor analog for the use of mollusks on an everyday basis in the prehistoric past.

THE PITTED STONE

Pitted stones are typically ovoid, with round, quarter-round, half-round, rectangular, or elongated shapes; irregularly shaped pitted stones are known but they are much less common (Breschini and Haversat 2001). A sample of 92 pitted stones from CA-SLO-697 and -792 in the Cambria/San Simeon Reef area exhibits typical dimensions: maximum diameter between 3.7 and 13.5 cm. (mean = 8.7 cm.), width between 3.7 and 13.0 cm. (mean = 6.7 cm.), thickness between 1.3 and 7.5 cm. (mean = 3.8 cm.), and weight between 40.7 and 1,359.5 g. (mean = 309.5 g.) (Breschini and Haversat 2001). These dimensions suggest one possible clue to the function of the implements in that they are generally of a size that fits comfortably within the hand. Another clue is that their consistently flat shape suggests they may have been rested on the ground to form some type of anvil (Jones and Waugh 1995).

The round, flattish morphology of pitted stones results from the use of naturally rounded river cobbles. The production of small, semi-spherical pits on one or multiple faces of a natural cobble transforms it into an actual artifact. The dimples or pits typically occur in the center of one face, although pitted stones with two pits per face are known. The pits or dimples are made by pecking, not grinding, and are distinct from doughnut stones or hopper mortars (Strudwick 1995). Pitted stones often exhibit battering, pecking, or grinding along their sides or ends (Breschini and Haversat 2001; McKusick and Warren 1959:142; Strudwick 1995). Variations in pitted stones include pitted manos, pitted pestles, and pitted anvils. Pitted anvils are often found along with pitted stones, but are distinguished by their larger size and lack of additional wear or pecking (Strudwick 1995:154). The dimple or pit on a pitted stone tends to be relatively uniform, with an average diameter of 2.2 cm. (Strudwick 1995). Based upon their sample of 92 specimens recovered from the Cambria/San Simeon area, Brescini and Haversat (2001) reported a range of pit depth from barely perceptible to 10 mm., with a mean of 2.3 mm.

Spatial Distribution

Thousands of pitted stones have been recovered from the central California coast over the last half century. Many sites from which a reasonable sample was recovered through excavation have produced at least one example. To plot the location of all of the finds would be a laborious task that seems unnecessary in order to define basic distributional trends. Instead, we report here findings from a select series of large projects from a range of environmental settings that seems adequate to delineate diagnostic locational patterns. The sample data include information from 57 sites with a combined recovery volume of 1,016.9 m.^{3}, from which a total of 1,515 pitted stones has been reported (Table 1). Thirty-seven sites represent the exposed rocky coast (Big Sur, Pecho, San Simeon), eight are situated on the Morro Bay estuary, and twelve are situated in the interior (within Fort Hunter-Liggett; see Fig. 1).

Patterning in this sample is fairly clear. The highest frequency of pitted stones is from sites situated adjacent to exposed rocky coasts, including an average of three pitted stones/m.^{3} from the Pecho coast in San Luis Obispo County. Statistically, the density of pitted stones is significantly greater at sites located on exposed rocky coastlines (Kruskal-Wallis chi-squared = 8.12, df = 1, p-value = 0.0044). Pitted stones are extremely uncommon from all other settings; eight estuarine sites produced a total of seven pitted stones from a recovery volume of 216.5 m.^{3} for a volumetric density of only 0.03 pitted stones/m.^{3}, while interior sites within Fort Hunter-Liggett in southern Monterey County produced 13 pitted stones from a recovery volume of 123.5 m.^{3} (volumetric density = 0.10/m.^{3}). The latter finding would seem to rule out any major role for pitted stones in acorn processing (at least on the central California coast), since the interior sites are all situated within oak woodland and many are associated with bedrock mortars and charred acorn remains (Jones 2003; Jones and Lebow 2015). If

Table 1

PITTED STONES RELATIVE TO HABITAT ON THE CENTRAL CALIFORNIA COAST

District	Environment	N Excavated Sites	Excavation Volume (m.^{3})	N Pitted Stones	Pitted Stones/m.^{3}	Reference
Big Sur Coast	Exposed rocky coast	13	102.9	26	0.25	Jones (2003)
San Simeon	Exposed rocky coast	11	244.1	461	1.89	Breschini and Haversat (2001); Jones and Ferneau (2002); Jones and Waugh (1995); Joslin (2006, 2010)
Pecho Coast	Exposed rocky coast	13	329.9	1,008	3.05	Greenwood (1972); Jones and Codding (In press)
Subtotal		**37**	**676.9**	**1,495**	**2.21**	
Morro Bay	Estuary	8	216.5	7	0.03	Far Western Anthropological Research Group (2016)
Fort Hunter-Liggett	Oak Woodland, 15–30 km. inland	12	123.5	13	0.10	Jones (2003)
Totals		**57**	**1,016.9**	**1,515**		

pitted stones were used as "nutting stones," it would be reasonable to expect greater numbers of them from these interior settings. The high frequency of pitted stones from the open coast confirms the longstanding suspicion (e.g., Breschini and Haversat 1988) that they are associated primarily with marine environments, and must have been used to process marine resources. The near dearth of pitted stones from estuarine sites, on the other hand, suggests an emphasis on resources that are more common to the open coasts than protected embayments. This would seem to rule out most of the birds, mammals, and fishes that are common to both settings, but highlights the variation in shellfish among these different habitats. California sea mussels are the dominant mollusk at nearly all of the exposed rocky coast sites (Table 2) and are minimally represented at the estuaries.

A closer examination of shellfish profiles relative to pitted stones over time shows more complex patterning (Table 2). Among the three rocky coast areas in the sample, Pecho and San Simeon show the highest frequency of pitted stones regardless of time period. A number of sites on the open rocky coast of Big Sur, however, produced no pitted stones. Big Sur components lacking or nearly lacking pitted stones are mostly dated to the Middle-Late Transition and Late periods (with only one specimen from 48.2 m.^{3} of recovery volume or 0.02 pitted stones/m.^{3}). This suggests that there could be a temporal/cultural dimension to the use of pitted stones in the Big Sur area relative to other rocky coasts. The components lacking pitted stones are all within Salinan ethnographic territory, and include the Salinan village of *Matilce* (CA-MNT-1277/H), which produced no pitted stones from a recovery volume of 8.5 m.^{3}. Elsewhere, particularly on the Pecho Coast, pitted stones have been recovered in abundance from Late Period contexts, but they may be restricted to Middle and earlier periods in Salinan territory.

Correlation with Molluscan Species

Perhaps more indicative of the possible function of pitted stones is their frequency relative to types of shellfish in middens. Specifically, our working hypothesis was that pitted stones tend to be most common at sites with high frequencies of mussels and/or turban snails. The two areas in the current sample with components that produced the greatest numbers of pitted stones are the Pecho Coast and Cambria/San Simeon Reef area. All Pecho Coast components are dominated by California sea mussels, but three sites also produced between 18% and 32% turban snail by shell weight (two dating to the Millingstone/Lower Archaic Period and one dating to Post-Contact). The Cambria/San Simeon area has also been recognized since at least the 1980s as an area where middens yield large quantities of turban snails (e.g., Rudolph 1985). Most recently, Joslin (2006, 2010) reported multiple sites in the Cambria/San Simeon area dominated by turban snails, including two Late Period components

Table 2

SHELLFISH AND PITTED STONE FINDINGS FROM SELECTED TEMPORAL COMPONENTS ON THE CENTRAL CALIFORNIA COAST[a]

Component	Setting	Cultural Period	Coastal type	Excavation Volume	N Pitted Stones	Dominant Shellfish Species	%	% Turban snails	Reference
MNT-63	Big Sur	Middle	Open Rocky	3.0	–	*Mytilus californianus*	79.1	6.1	Jones (1995, 2003)
MNT-63	Big Sur	Mission	Open Rocky	0.4	–	*Mytilus californianus*	74.8	12.8	Jones (1995, 2003)
MNT-73	Big Sur	Early	Open Rocky	20.9	12	*Mytilus californianus*	85.8	0.1	Jones (1995, 2003)
MNT-759/H	Big Sur	Late	Open Rocky	2.9	–	*Mytilus californianus*	97.0	1.1	Jones (1995, 2003)
MNT-1233	Big Sur	Middle-Late	Open Rocky	10.0	–	*Mytilus californianus*	93.1	2.2	Jones (1995, 2003)
MNT-1223	Big Sur	Late	Open Rocky	13.4	–	*Mytilus californianus*	94.2	0.7	Jones (1995, 2003)
MNT-1227	Big Sur	Late	Open Rocky	9.0	–	*Mytilus californianus*	88.5	1.5	Jones (1995, 2003)
MNT-1228	Big Sur	Early	Open Rocky	14.7	–	*Mytilus californianus*	98.0	<0.1	Jones (1995, 2003)
MNT-1232/H	Big Sur	Millingstone/ Lower Archaic	Open Rocky	5.4	–	*Mytilus californianus*	97.3	<0.1	Jones (1995, 2003)
MNT-1235	Big Sur	Late	Open Rocky	2.4	1	*Mytilus californianus*	94.4	<0.1	Jones (1995, 2003)
MNT-1236	Big Sur	Late	Open rocky	2.0	–	*Mytilus californianus*	98.0	<0.1	Jones (1995, 2003)
MNT-1277/H	Big Sur	Late	Open rocky	8.5	–	*Mytilus californianus*	90.5	1.9	Jones (1995, 2003)
SLO-51/H	Pecho	Post-Contact	Open rocky	1.2	3	*Mytilus californianus*	53.6	31.5	Jones et al. (2017)
SLO-2	Pecho	Late	Open rocky	29.0	387	*Mytilus californianus*	72.7	8.2	Jones et al. (2008)
SLO-1366/H	Pecho	Late	Open rocky	1.4	3	*Mytilus californianus*	82.4	8.5	Codding et al. (2013)
SLO-1370/H	Pecho	Late	Open rocky	2.2	–	*Mytilus californianus*	66.5	10.2	Hadick et al. (2012)
SLO-9	Pecho	M-L	Open rocky	34.3	4	*Mytilus californianus*	60.4	15.1	Codding et al. (2009)
SLO-2	Pecho	Middle	Open rocky	49.5	188	*Mytilus californianus*	88.1	3.8	Jones et al. (2008)
SLO-5	Pecho	Middle	Open rocky	10.3	8	*Mytilus californianus*	79.5	11.1	Jones and Codding (In press)
SLO-10	Pecho	Middle	Open rocky	10.5	10	Mytilus californianus	86.1	4.8	Jones and Codding (In press)
SLO-2	Pecho	Early	Open rocky	17.4	31	*Mytilus californianus*	88.3	5.9	Jones et al. (2008)
SLO-497	Pecho	Early	Open rocky	2.3	2	*Mytilus californianus*	83.4	7.9	Jones and Codding (In press)
SLO-1366/H	Pecho	Early	Open rocky	7.4	8	*Mytilus californianus*	77.2	8.5	Codding et al. (2013)
SLO-1370/H	Pecho	Early	Open rocky	8.8	3	*Mytilus californianus*	75.4	14.1	Hadick et al. (2012)
SLO-2	Pecho	Millingstone/ Lower Archaic	Open rocky	3.0	7	*Mytilus californianus*	88.3	17.9	Jones et al. (2008)
SLO-10	Pecho	Millingstone/ Lower Archaic	Open rocky	2.5	–	*Mytilus californianus*	65.7	29.2	Jones and Codding (In press)
SLO-697	San Simeon	Early	Open rocky	0.6	15	–	–	–	Breschini and Haversat (2001)
SLO-267	San Simeon	Middle	Open rocky	69.4	258	*Mytilus californianus*	84.9	8.9	Jones and Ferneau (2002)
SLO-179	San Simeon	Middle and Middle-Late	Open rocky	35.4	17	*Mytilus californianus*	85.1	4.9	Jones and Ferneau (2002)
SLO-175	San Simeon	Middle	Open rocky	74.9	58	*Mytilus californianus*	80.5	7.8	Jones and Waugh (1995)
SLO-1259	San Simeon	Middle	Open rocky	6.4	14	*Mytilus californianus*	73.7	7.4	Jones and Waugh (1995)
SLO-71	San Simeon	Late	Open rocky	1.2	3	*Tegula funebralis*	47.0	47.0	Joslin (2006)
SLO-115	San Simeon	Late	Open rocky	1.0	3	*Tegula funebralis*	38.8	38.8	Joslin (2006)

Table 2 (*Continued*)

SHELLFISH AND PITTED STONE FINDINGS FROM SELECTED TEMPORAL COMPONENTS ON THE CENTRAL CALIFORNIA COAST[a]

Component	Setting	Cultural Period	Coastal type	Excavation volume	N Pitted Stones	Dominant shellfish species	%	% Turban snails	Reference
SLO-1622	San Simeon	Early	Open rocky	0.8	8	*Haliotis rufescens*	47.1	25.7	Joslin (2010)
SLO-1677	San Simeon	Early	Open rocky	1.5	21	*Tegula funebralis*	39.9	39.9	Joslin (2010)
SLO-1295	San Simeon	Early	Open rocky	2.2	29	*Mytilus californianus*	45.9	42.4	Joslin (2010)
SLO-2563	San Simeon	Middle-Late	Open rocky	0.7	6	*Tegula funebralis*	56.3	56.3	Joslin (2010)
SLO-812	Morro Bay	Millingstone/ Lower Archaic	Estuary	4.8	–	*Ostrea lurida*	44.5	0.3	Far Western Anthropological Research Group (2016)
SLO-812	Morro Bay	Early	Estuary	2.5	–	*Leukoma* sp.	36.1	0.3	Far Western Anthropological Research Group (2016)
SLO-23	Morro Bay	Early	Estuary	73.2	–	*Ostrea lurida*	26.7	1.9	Far Western Anthropological Research Group (2016)
SLO-458	Morro Bay	Early	Estuary	1.6	–	*Ostrea lurida*	31.5	0.5	Far Western Anthropological Research Group (2016)
SLO-812	Morro Bay	Middle	Estuary	4.0	–	*Neverita lewisii*	22.7	0.7	Far Western Anthropological Research Group (2016)
SLO-14	Morro Bay	Middle	Estuary	21.5	2	*Ostrea lurida*	35.1	2.5	Far Western Anthropological Research Group (2016)
SLO-457	Morro Bay	Middle-Late	Estuary	27.1	1	*Ostrea lurida*	53.7	8.6	Far Western Anthropological Research Group (2016)
SLO-23	Morro Bay	Late	Estuary	17.9	3	*Ostrea lurida*	36.4	2.7	Far Western Anthropological Research Group (2016)
SLO-626	Morro Bay	Late	Estuary	24.5	–	*Ostrea lurida*	30.4	4.8	Far Western Anthropological Research Group (2016)

[a]All components processed with 3 mm. (1/8 inch) mesh.

[b]Formerly *Mytilus edulis*.

[c]Formerly *Protothaca staminea*.

(CA-SLO-71 and -115) yielding 39–47% turban snails, one Early Period component (SLO-1677) showing 40% turban snails, and a Middle-Late Transition component (SLO-2563) yielding 56% turban snails. Several of these and other sites in the Cambria/San Simeon Reef area have also yielded large numbers of pitted stones, including 21 from SLO-1677 (14/m.^{3}; Joslin 2010), six from SLO-2563 (8.6/m.^{3}; Joslin 2010), and 15 from SLO-697 (25/m.^{3}; Breschini and Haversat 2001). While the overall large-scale pattern shows that the Pecho Coast has produced the highest frequency of pitted stones, and is dominated by mussels, individual components in the Cambria/San Simeon Reef area show the highest concentrations of pitted stones and turban snails (Table 2). Statistically, pitted stone density varies significantly as a function of the dominant shellfish species (Kruskal-Wallis chi-squared = 16.33, df = 7, p-value = 0.0223), with the greatest density found at sites dominated by turban snails or California mussels. Furthermore, careful analyses of turban snail remains from one site in the San Simeon area shows that the majority of these shells were broken (Ferneau 1998), indicating that this species was processed for consumption by smashing them open, as others have suggested (e.g., Raab 1992; Strudwick 1995). The co-occurrence of high frequencies of turban snail shells and pitted stones in the Cambria/San Simeon Reef area provides support for Strudwick's (1995) contention that pitted stones were used to process these mollusks. However, it should also be recognized that the vast majority of sites yielding pitted stones on the open coast are dominated by California sea mussels, including all sites on the Pecho and Big Sur coasts. Again, the former area has yielded over 1,000 pitted stones and exhibits the highest overall volumetric frequency of these artifacts.

Figure 2. Steps in the collection and processing of mussels: (a) Emma Cook with bucket at the Diablo Canyon mussel beds; (b) buckets of collected mussels; (c) hammerstone, anvil, and some broken mussel shells resulting from the processing; (d) bag containing 1,450 grams of raw mussel meat obtained from 303 mussels.

EXPERIMENTAL EVALUATION

Recognition of the apparent correlation between sites dominated by California sea mussels and high frequencies of pitted stones led us to the hypothesis that these implements may have been used primarily to process that species of shellfish. To evaluate this hypothesis we conducted an experiment, processing mussels with a hand-held cobble and similar-sized anvil.

Mussel Collection

Mussels were first collected from property of the Diablo Canyon Nuclear Power Plant, on the Pecho Coast in San Luis Obispo County (Fig. 2a). Collection was coordinated through the PG&E Cultural and Biology offices on-site at Diablo Canyon. Following permission and consultation, mussels were collected by one of us (Emma Cook) over two collection periods, the first on February 10, 2016 and the second on March 2, 2016. Two members of the Diablo Canyon Biology team assisted with the collection. Mussels were gathered in two 2-gallon buckets (Fig. 2b). Mussels were generally removed by hand by pulling or twisting, but a paint scraper was employed to help strip large mussels from the rocks, mimicking a bone pry or similar implement that likely would have been used prehistorically. A total of 303 mussels was collected in the buckets.

Mussel Processing

The collected mussels were brought back to the California Polytechnic State University, San Luis Obispo Archaeological Laboratory for processing. Two round, flat, unmodified river cobbles, similar in size and shape to archaeological pitted stones, were obtained from a local beach to process the mussels. One stone was laid on the ground to serve as an anvil, and the other was employed as a hammerstone. One at a time, mussels were placed on the anvil lengthwise, and the hand-held hammer was brought down on the shell to try to split apart the two shells containing the mussel meat. The initial hypothesis was that the stone used as a hammer would most likely develop a pit. The first mussels were processed with the hammer brought down flat, with the center face of the stone hitting the mussel umbo (beak). This method proved awkward because it was difficult to hold the hammerstone flat when bringing it down on the mussel. Further, we discovered that when hit on the umbo, the strong connective tissue of live mussels locks up, making it very difficult to remove the meat, even from completely smashed mussels. Owing to these difficulties, we switched to a different method, flipping the mussels so that the umbo rested on the anvil (Fig. 3). The hammerstone was no longer brought down flat upon the mussel, but instead was used to batter the edges and sides of each mussel to open it. No additional tools were used except for broken mussel shells, which were utilized as scoops and scraping tools to remove mussel meat and fiber from shells. This method began to produce a distinctive textured pit on the anvil stone, which grew deeper as more mussels were processed. As the pit deepened, it aided in the processing, acting as a cup for the mussel umbo. The texture from the pecking

Figure 3. Illustration of the preferred method for processing with each individual mussel placed umbo-down on an anvil stone with hammerstone used to crack open and split apart the two mussel shells. A distinctive pit formed on the anvil stone.

helped keep the upright wet mussels from slipping, stabilizing the mussel for processing. The net results of the process included a pile of broken mussel shells, an anvil stone with a distinctive pit, a hammerstone with less-patterned battering (Fig. 2c), and 1,450 grams of raw mussel meat (Fig. 2d). The anvil stone used in this manner to crack open 303 mussels produced a pit 21 mm. in diameter and 3.5 mm. deep (Table 3) that strongly resembles prehistoric pitted stones (Figs. 4 and 5).

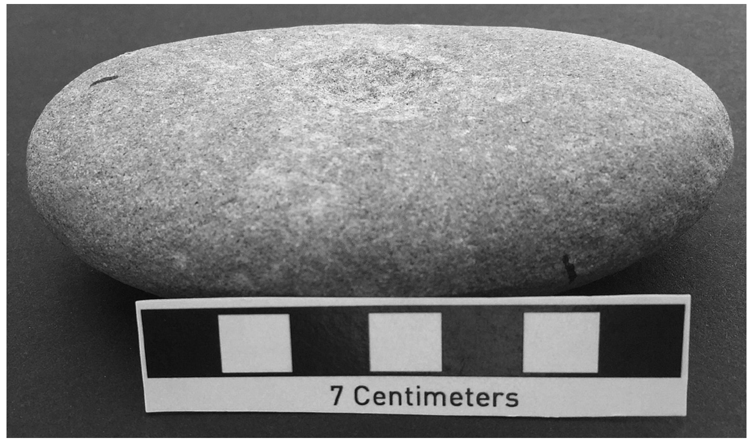

Figure 4. Experimental anvil stone after processing 303 mussels.

Figure 5. Experimentally-derived pitted stone on left; archaeological pitted stone from CA-SLO-51/H on right.

NATIVE CONSUMPTION

Native Californian groups were a combination of families and individuals which "intertwined across the landscape through various social, kin, political, and religious relationships" (Lightfoot and Parrish 2009:136). These groups had traditions of shared dances, meals, and gambling, and there are many ethnographic accounts of large gatherings that involved eating and participating in other activities together (Jones 1997:1; Peelo 2010). Foods were generally collected in bulk, as is best documented for plant resources such as grasses and acorns (Lightfoot and Parrish 2009:205). Game, fish, and shellfish were also collected and processed in large quantities; e.g., in northern California, the Pacific lamprey was collected "en masse" and prepared for large meals or storage with bone-awl tools (Drucker 1937:233; Kroeber 1937:85; Lightfoot and Parrish 2009:205).

On the central coast, multiple accounts refer to the consumption of gruels, soups, or "mush." One of the oldest such descriptions was recorded on December 11, 1595, by Sebastian Rodriguez Cermeño, near modern-day Avila Beach:

> …There were observed on the shore…many people on top of some bluffs…. I anchored in front of these settlements and I saw how the Indians had…many balsas made of tule, which were made like canoes, and with these they go fishing…. Shortly one came down from the bluff, and taking a balsa, got into it and came on board the launch, where we made much of him…. [T]hey then went ashore and brought some bitter acorns and mush made of these acorns in some dishes made of straw like large chocolate bowls… [Wagner 1924:15].

Nearly 200 years later, accounts by members of the Gaspar de Portolá expedition offer similar descriptions of gruels:

Table 3

DIMENSIONS OF STONES USED IN EXPERIMENT

	Anvil (Stone 1)	Hammer (Stone 2)
Pre-Experiment Weight (g.)	405.00	184.00
Post-Experiment Weight (g.)	402.00	178.00
Pit Diameter (cm.)	2.10	2.20 x 4.00
Depth of Pit (cm.)	0.35	0.30

> Close to the lake here we found a village of very well-behaved, friendly heathens who on our arrival presented everyone with a great handful of feathers, and afterward gave us some baskets of servings of the usual gruels [Juan Crespí 1769 in Brown 2001: 465].
>
> In the afternoon, the head chief, who at our arrival had not been at the village, came over with them all, bringing us large servings of a great many big bowls full of good gruels, a great many other full of very good mush, deer meat, a few fresh fish, and a bowl of a sort of white pies that they said were very good and looked as though made from rice (Juan Crespí 1769 in Brown 2001:477).

In these accounts gruels and/or stews are often mentioned along with fish, but there is never any note of shellfish either as a component of the stew or as a stand-alone dish. Such gruels would likely have consisted of any combination of communally collected and prepared bulk foods. We suggest that bulk processing of raw mussels with a pitted stone would have been consistent with the production of large quantities of food in the form of gruels or stews that would be suitable for consumption by a group. The recovery of many pitted stones from sites where mussels dominate midden deposits reflects the regularity with which these simple implements were used in everyday processing of one of the most common foods consumed by such groups.

SUMMARY AND CONCLUSION

Evaluation of the spatial distribution of pitted stones on the central coast of California shows, as long suspected, that these artifacts are uncommon in the inland valleys, and are heavily concentrated at shoreline sites. Furthermore, pitted stones are under-represented in estuarine contexts, but are found in great numbers at open, rocky coast sites, including those at Big Sur, Cambria/San Simeon, and on the Pecho Coast, among others. Five shellfish species in various combinations consistently represent at least 95% of the shell in middens on these exposed coasts: California sea mussels, turban snails, red abalone, black abalone, and limpets. In general, California sea mussels dominate throughout the region, and are especially abundant along the Pecho coast, where they occur at sites with the greatest combined volumetric density of pitted stones (>3/m.^{3}). This suggests a role for pitted stones in processing mussels. However, individual components in the Cambria/San Simeon Reef area have yielded exceptionally high frequencies of pitted stones (8.6–25/m.^{3}), and also show high frequencies (39–56% shell weight) of turban snails. This correlation suggests that pitted stones were also used to process this species. An experiment cracking open mussels with a hammerstone and anvil produced an anvil that essentially duplicates the morphology of archaeological pitted stones. In our mind, this leaves little doubt that pitted stones were used for processing mussels, and that this was their primary function. We did not complete a similar experiment with turban snails, but we suggest that mussels and turban snails were the only common shellfish that could be effectively bulk-processed by cracking them open with a hammer and anvil. Clams and oysters that frequent estuaries along the central coast seem not to have been processed in the same way, or if they were, the signature of processing must be different. Cracking open mussels and turban snails in bulk would have facilitated their use in soups, gruels, and stews prepared for groups of individuals, including extended families or other kin associations. The other most common shellfish on the open coast are univalves (e.g., abalones and limpets) that would not lend themselves to being cracked open, but perhaps were processed simply by scooping meat out of the shell or cutting it out with a flaked stone implement. Pitted stones are so numerous along the open coast because they reflect the regular, day-by-day processing of the two most commonly harvested shellfish collected along these shores. Wallace (1954) was essentially correct in his assessment of the function of these tools.

Caveat

We do not suggest that pitted stones had a single function—only that the particular use discussed here is the one most heavily reflected in the large numbers of these implements found on the open coast of central California. True and Baumhoff (1981) reported 12 pitted stones from Lake Berryessa in the North Coast Ranges, 110 km. inland from the open coast, while Olsen and Payen (1983) reported them from CA-MER-30, 80 km. inland, far from any sources of sea mussels or turban snails. Many other examples could be cited, but the fact is that other activities, including nut processing or the reduction of cobble cores, could potentially result in the same simple, pitted morphology. Further experimental work could perhaps serve to narrow the range of possibilities, and identify the function(s) of examples found far from the open sea coast.

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