

UC Merced

Journal of California and Great Basin Anthropology

Title

Acorn Exploitation in the Eastern Sierra Nevada

Permalink

<https://escholarship.org/uc/item/7fn2n7sp>

Journal

Journal of California and Great Basin Anthropology, 14(1)

ISSN

0191-3557

Author

Haney, Jefferson W.

Publication Date

1992-07-01

Peer reviewed

Acorn Exploitation in the Eastern Sierra Nevada

JEFFERSON W. HANEY, Anthropological Studies Center, Sonoma State Univ., 1801 East Cotati Ave., Rohnert Park, CA 94928.

THIS paper investigates the nature of, and potential changes in, the flow of prehistoric populations, technology, and ideas between the eastern and western sides of the central Sierra Nevada. Previous studies of trans-Sierra interaction usually have focused on obsidian, which occurs at several sources in the eastern Sierra Nevada. Artifacts made of obsidian from these sources are found at archaeological sites in the eastern and western Sierra Nevada and results of obsidian hydration analysis have shown temporal variation in tool production, marked by a distinct decline on both sides of the Sierra Nevada (Hall 1983; Jackson and Dietz 1984). A re-evaluation of data from eastern Sierra Nevada sites concluded that this decline occurred after 1,000 B.P. (Hall 1984). The decline in obsidian production often has been interpreted as reflecting a decrease in the movement of people across the crest of the Sierra Nevada (Hall 1983; Bouey and Basgall 1984), although the trend may be due, in part, to changing stone working technology (Ainsworth and Skinner 1988).

The current study evaluates trans-Sierra interaction from a different perspective and investigates the occurrence of bedrock mortars in the Mono Basin-Long Valley region of the eastern Sierra Nevada (Mono County, California). Bedrock mortars (BRMs) are mortar holes that occur on large, immobile boulders or rock outcroppings. The use of BRMs, generally thought to have originated in the western Sierra Nevada, is related to the development of acorn-based economies among populations in

this region (Basgall 1987). The oak groves nearest to the Mono Basin-Long Valley region occur in the western Sierra Nevada. If BRMs in the eastern Sierra Nevada were used to process acorns, the presence of BRMs may reflect trans-Sierra Nevada interaction in a way similar to the distribution of eastern obsidian. The exploitation of either resource by groups residing on opposite sides of the Sierra crest could relate to basic subsistence needs and/or to the maintenance of social relations. The investigation also considers other explanations of BRM use in the eastern Sierra Nevada, such as a technological innovation adapted to local resources or as facilities made and used by visiting western Sierra Nevada populations.

The study requires a functional analysis of BRMs in the eastern Sierra Nevada to link these features with acorn processing. Ethnographically-described populations throughout California used milling tools to process a variety of resources, although archaeologists may be able to distinguish the processing of staple resources from incidentals through an examination of ethnographic analogy, resource characteristics, the quantity and combination of milling tools within a site, and environmental associations (e.g., Mikkelsen 1985). The current study uses this combination of ethnographic and archaeological data, and also investigates the distribution of BRM sites in Mono County, the number of mortar holes at these sites, variability in the depth of mortar holes, and comparative data from Inyo County, California.

ETHNOGRAPHIC EVIDENCE

The processing of acorns with mortars is related to the oily quality and tannic acid content of this resource which make pulverizing and leaching necessary. Among Native American populations in California, Gifford (1936) noted a uniformity in the leaching process which involved the placement of the meal in a lined sand basin or basket and successive strainings of water through the meal. Alternative processing techniques could be used to reduce the tannic acid; however, among populations intensively exploiting the acorn, pulverizing and leaching was faster and more efficient in removing tannic acid.

The only area along the eastern Sierra Nevada where published ethnographic descriptions of acorn processing exist is the Owens Valley in Inyo County, where small stands of oak trees occur within the narrow riparian corridors of creeks that flow out of the mountains. Two species of oak trees, the black oak (*Quercus kelloggii*) and the canyon live oak (*Q. chrysolepis*), are reported to grow within Owens Valley (Griffin and Critchfield 1972), although one historical account of acorn use in the valley suggests that few acorns could be harvested from these trees (Chalfant 1933:80). Acorn processing techniques among groups in Owens Valley involved pulverizing acorns in BRMs and leaching the meal in lined pits (Steward 1933:246). Similar methods are described ethnographically among many Californian populations, particularly groups in the central and southern Sierra Nevada, including the Miwok, Western Mono, Yokuts, and Tubatulabal.

Few published descriptions of the use of acorns and/or BRMs exist for populations living along the eastern Sierra Nevada north of Owens Valley. For example, Steward (1933:246) briefly noted the use of acorns among Mono Lake groups, particularly during winters spent in Yosemite Valley. More detailed ethnographic

descriptions exist in unpublished notes compiled by Hulse (MS). These data show that acorns were used throughout the eastern Sierra Nevada and that expeditions were made to the western Sierra Nevada to gather acorns. A Paiute born near Long Valley recalled a trip to the San Joaquin Valley to gather acorns; the group stayed the entire winter subsisting on acorns, fish, and rabbits. A Round Valley Paiute described women pounding acorns in BRMs for an entire month in the Mammoth area of western Long Valley. Another consultant, born in the town of Lee Vining in Mono Basin, described an apparently annual acorn expedition that followed the Mono Trail through Bloody Canyon to Yosemite Valley. The men hunted along the way and the group camped at Tenaya Lake where recently killed game was presented to local western Sierra Nevada groups in return for some acorns and permission to gather more acorns. The harvest was very intensive; men would climb trees to knock down acorns which were gathered by women and transported to a camp where the acorns were spread out to dry. Shelling of acorns continued late into the night and, after a few hours sleep, work resumed. Before returning to Mono Basin some of the harvest, used during the winter, was cached in trees and was brought back to the basin later in the fall when a large festival was held. The Bridgeport Paiute, north of Mono Basin, also used acorns gathered from a grove in Hetch Hetchy Valley (Merriam MSa:72, MSb:239-240).

Ethnographic descriptions of BRM use in the eastern Sierra Nevada show that these facilities were used to process a variety of resources in addition to acorns. Davis (1965) reported that nonacorn resources, including berries and dried meats, were processed in BRMs among groups living in Mono Basin. A Bridgeport Paiute described the processing of both pine nuts and sunflower seeds within BRMs (Hulse MS). These accounts of multiple

use are in accord with ethnographic descriptions of central and southern Sierra Nevada groups which show that BRMs were used to process many different resources including pinyon pine nuts, seeds, bulbs, berries, medicinal plants, and dried meat and fish (Barrett and Gifford 1933; Voegelin 1938). Additionally, these ethnographies indicate that mortar holes with certain depths are more suitable for processing different types of resources. For example, the Miwok of the Yosemite Valley region considered mortar holes deeper than five inches to be unsuitable for pounding acorns, although deeper mortar holes were still useful for processing other resources (Barrett and Gifford 1933:143, 208). Voegelin (1938:17) noted that the Tubatulabal thought BRMs deeper than 10 inches were unusable.

While many studies have attempted to relate variability in the depths of BRMs to functional differences, most have concluded that mortar depth is related to sociocultural differences, the amount of use a BRM was subjected to, and/or the hardness of the base rock (Johnson 1967; Farnsworth and Armstrong 1984; White 1985). McCarthy et al. (1985) were able to relate variability in depth to functional differences through a study of processing methods among contemporary Western Mono populations living in the western Sierra Nevada. While a variety of resources could be processed in BRMs, the acorn was once a staple resource among the Western Mono and the black oak acorn was by far the most preferred species; therefore the processing technology among the Western Mono was most strongly related to the qualities of this species. Acorns are oily, especially the black oak acorn, and, if these acorns are processed in a mortar too deep, the meal will become solidly packed in the bottom and will eventually become inedible. Initial stages of mashing could be done in shallow BRMs, but the final pounding required more force and was done in a mortar deep enough to contain flying debris, but not too deep. Deep mortars were preferred

for the pounding of seeds, since they could contain seeds to a greater extent than possible in shallower mortars (McCarthy et al. 1985:342).

Western Mono consultants identified three functional types of BRMs (starter, finishing, and seed mortars) at BRM sites at Crane Valley in the central Sierra Nevada. McCarthy et al. (1985) found these categories to be statistically significant and concluded that variability in mortar depth could be related to functional differences. Western Mono consultants also indicated that the high frequency of starter mortars across the landscape reflects the ease of manufacturing shallow mortars (H. McCarthy, personal communication 1991). Acorns could be processed without finishing mortars, although starter and finishing mortars were used at locations where acorns were processed in large quantities over a longer period of time. In this paper the categories of mortar types among the Western Mono will be applied to data from Mono County after an examination of archaeological evidence regarding milling tool use in the eastern Sierra Nevada.

ARCHAEOLOGICAL EVIDENCE

An analysis of potential resources processed within BRMs along the eastern Sierra Nevada requires a study of the distribution and nature of BRM sites in the region, the presence of other types of milling tools at sites, and the environmental associations of these sites. The data used in this study were generated through a record search of all recorded sites in the region which contain milling equipment. Information was collected from the records on site location and vegetation, types of milling tools represented, the number and dimensions of bedrock milling features, and type of base rock used for bedrock milling features. Whenever possible, this data base was supplemented with information culled from reports of archaeological investigations conducted within the eastern Sierra Nevada. It was recognized that site records

represent an imperfect data base due to incomplete and potentially erroneous information and the unevenness of research conducted within the region. Despite these deficiencies, some general patterns were identified and were useful in addressing the current research problem.

Milling Tool Sites in Mono County

Bedrock mortars occur at 212 recorded sites throughout Mono County and represent 48% of the 442 sites in the county which contain milling equipment. The majority of BRM sites contain 1-4 mortar holes and frequently co-occur with other bedrock and portable milling tools. The environmental associations of these sites were analyzed through a study of the plant species reported at sites, although some records were incomplete and changes in native plant communities have occurred as a result of livestock grazing and related activities. Changes in plant communities due to paleoenvironmental shifts are considered unlikely for BRM sites, since (as will be argued later) these facilities are late prehistoric in age. It is, of course, recognized that immediate plant communities do not necessarily reflect the types of resources exploited at a site, since resources could have been collected from adjacent areas and brought back to a site.

Sagebrush (*Artemisia tridentata*) was found to be almost omnipresent at sites, and therefore sites present in open sagebrush scrub communities were distinguished from sites which contain sagebrush as part of the understory. Three general plant communities could be identified through the study (pinyon woodland, coniferous forest, and an open scrub community), however, no direct association was found to exist between BRM sites and a particular plant community (Table 1). Almost half of the BRM sites contain pinyon pine trees, but sites with more than 10 BRMs occur more frequently within coniferous forests and open scrub communities.

A potentially more meaningful pattern is the geographic distribution of BRM sites which con-

tain different frequencies of mortar holes (Fig. 1); while BRM sites have been recorded in all parts of the county, sites containing more than 10 mortar holes are confined to a few areas along the base of the Sierra Nevada in western Long Valley and, to a lesser extent, the northwestern edge of Mono Basin. Undoubtedly, the distribution of BRM sites is influenced by the occurrence of suitable rock formations. However, the limited distribution of sites with relatively high frequencies of mortar holes seems to be related to factors other than the presence of such formations. Bedrock mortars at these sites occur within a variety of base rocks (including granite, vesicular basalt, and rhyolitic tuff) and the distribution of sites containing one to four mortar holes shows that these formations occur over a broad area.

Various other kinds of bedrock milling features have been reported in Mono County, with the most common consisting of slicks and bedrock metates. Archaeologists do not consistently use these two terms in describing features. Smooth milling areas on a rock surface (slicks) are sometimes distinguished from milling areas that are worn below the natural surface of the base rock (bedrock metates). Both terms are often used to describe the same type of feature and, for the purpose of this study, the two types of features were lumped together as slicks.

Slicks are present at 192 (43%) of the sites with milling equipment, and these sites frequently contain other bedrock milling features. Therefore, the geographic distribution of these sites is similar to BRM sites, although there is a higher number of sites with slicks in the Volcanic Tablelands (in the south-central part of the county). Sites containing slicks are numerous in Long Valley and most commonly co-occur with BRMs, whereas these sites in the tablelands infrequently contain BRMs.

Most of the sites with slicks occur in open scrub communities, although some are present

Table 1
 PLANT ASSOCIATIONS AND FREQUENCIES OF BEDROCK MORTARS
 AT SITES IN MONO COUNTY, CALIFORNIA

| Number of BRMs | Pinyon Trees | Conifer Trees | Pinyon/ Conifer | Open Scrub | Ot he r | Unknown | Tot als |
|-------------------|-----------------|------------------|--------------------|---------------|---------------|---------|------------|
| 1-4 | 34 | 21 | 26 | 33 | 6 | 10 | 130 |
| 5-10 | 2 | 6 | 5 | 8 | 1 | 2 | 24 |
| 11-19 | 0 | 2 | 0 | 2 | 0 | 1 | 5 |
| 20-30 | 1 | 2 | 0 | 1 | 0 | 1 | 5 |
| 31+ | 2 | 1 | 1 | 0 | 0 | 0 | 4 |
| Unknown | 13 | 7 | 5 | 10 | 2 | 7 | 44 |
| Totals | 52 | 39 | 37 | 54 | 9 | 21 | 212 |

among pinyon trees (Table 2). However, 70% of the sites that contain only slicks without BRMs occur within open scrub communities and the number of slicks at these sites tends to be greater than at similar sites among pinyon trees.

Portable milling tools were identified at 270 of the 442 (61%) sites with milling equipment and over half of these sites co-occur with bedrock milling features. Sites with portable milling tools are broadly distributed throughout the county and almost 70% of the sites contain grinding slabs. The remaining sites mostly contain handstones, while portable mortars and pestles are relatively rare. Portable mortars, usually described as portions of bowl mortars or small paint mortars, were reported at 20 sites. It is noted that wooden bowl mortars have recently been identified within pinyon woodlands of the Mono Lake area and were apparently used to process acorn and pinyon (Reynolds and Woolfenden 1991). Pestles, usually described as minimally modified cobbles, were present at 40 sites and are strongly associated with BRM sites.

Sites containing portable milling tools without bedrock milling features occur most commonly in pinyon woodlands and are less frequent in open scrub communities. Since most of these sites contain grinding slabs, the archae-

ological data are in accord with most ethnographic descriptions regarding the use of metates to process a variety of resources, including pinyon and various seeds found within scrub communities (Steward 1938).

In sum, the most evident pattern of BRM sites in Mono County is not an association with a particular plant community, but the infrequency of sites containing large numbers of mortar holes and the distribution of these sites in a few discrete areas. Differences between types of bedrock milling features suggest that plant resources in the tablelands were processed through grinding on broad, flat surfaces, while resources in western Long Valley were more frequently pounded in BRMs. The tablelands were described by Steward (1933) as an exceptionally productive seed-gathering area which may account for the abundance of slicks and portable metates reported on site records for this area. The presence of slicks in areas outside of the tablelands suggests that either the same resource(s) was processed less intensively or that different resources were processed in a similar way. A similar argument can be made for the use of BRMs, although no particular resource is unusually abundant in western Long Valley, except for the pandora moth larvae, which was not processed using milling tools.

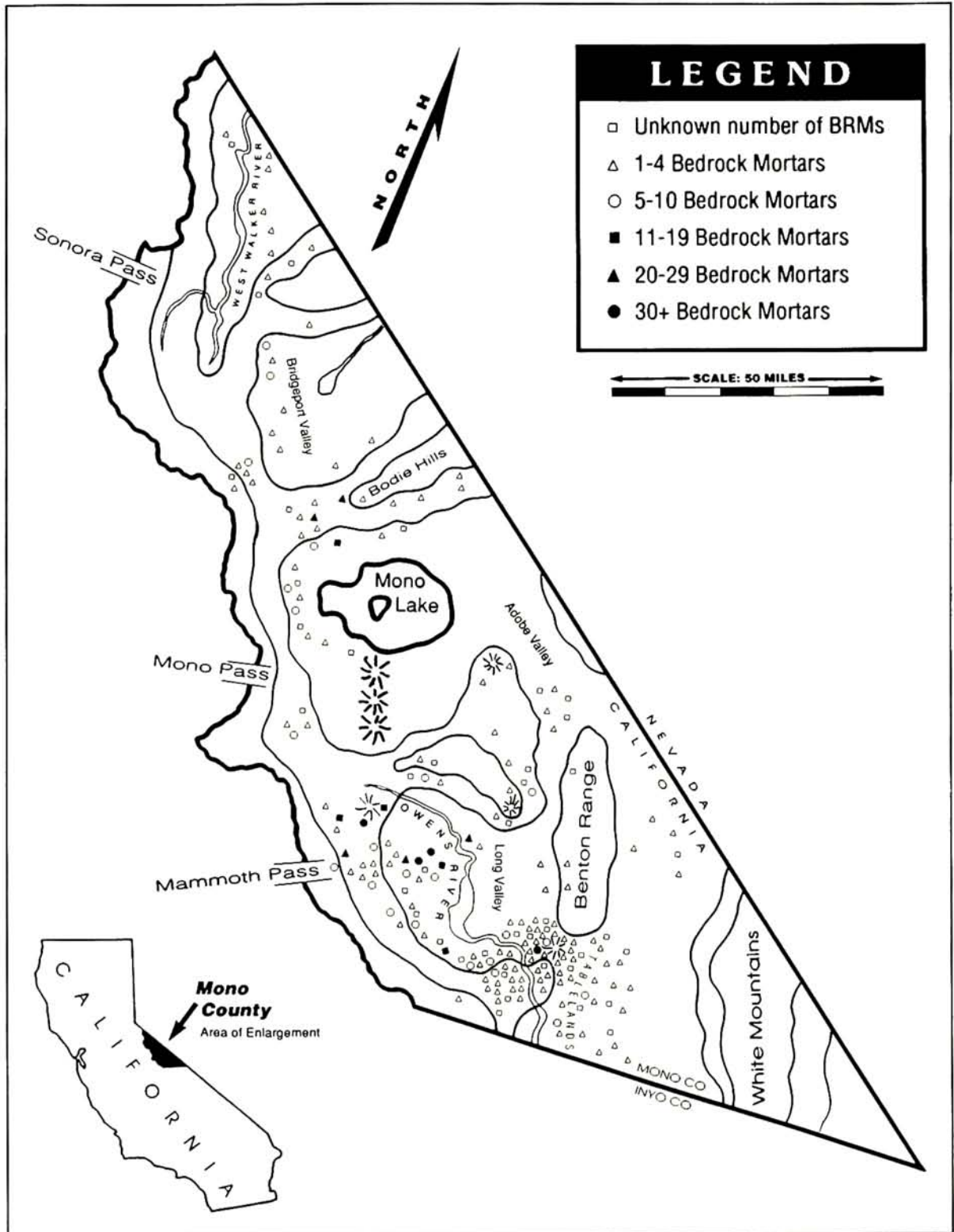


Fig. 1. Distribution of bedrock mortar sites in Mono County, California.

Table 2
 PLANT ASSOCIATIONS AND FREQUENCIES OF SLICKS
 AT SITES IN MONO COUNTY, CALIFORNIA

| Number of Slicks | Pinyon Trees | Conifer Trees | Pinyon/Conifer | Open Scrub | Other | Unknown | Totals |
|------------------|--------------|---------------|----------------|------------|-------|---------|--------|
| 1-4 | 26 | 13 | 4 | 37 | 4 | 3 | 87 |
| 5-10 | 1 | 3 | 1 | 12 | 1 | 0 | 18 |
| 11-19 | 1 | 2 | 0 | 7 | 0 | 0 | 10 |
| 20-30 | 1 | 0 | 0 | 1 | 0 | 0 | 2 |
| 31+ | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Unknown | 17 | 9 | 3 | 39 | 3 | 3 | 74 |
| Totals | 46 | 27 | 8 | 97 | 8 | 6 | 192 |

Milling Tool Sites in Inyo County

Inyo County was considered the area most likely to yield further information on BRM use in the eastern Sierra Nevada because a limited number of oak trees grow within Owens Valley and use of BRMs to process acorns in this area was described ethnographically. Over 1,000 recorded sites in Inyo County contain milling equipment, but records for only 683 of these sites were available since site records for Death Valley are currently being revised. With the absence of the Death Valley area, the two counties are comparable in size.

The Inyo County sites were not investigated in as much detail as those in Mono County; however, obvious differences exist with respect to bedrock milling features (Table 3). Fewer sites in Inyo County contain bedrock milling features and these sites contain mostly slicks. In comparison, a greater number of BRM sites occur in Mono County and these sites represent a greater proportion of the total milling tool sites within the county. The majority of BRM sites in Inyo County, like those in Mono County, have one to four mortar holes; however, the highest number of mortar holes at a single Inyo County site is 16, while nine sites in Mono County have 20 or more mortar holes. The Chance Wells site (CA-Mno-458/630) in

Mono County contains the highest number of mortar holes (60) reported at a site in the eastern Sierra Nevada (Haney 1992).

Most of the BRM sites (approximately 60%) in Inyo County, with available information, occur within scrub communities and only 14% of the sites contain pinyon pine trees, despite the presence of pinyon woodlands throughout surrounding mountain ranges. Differential survey coverage of each environmental type may account for the under-representation of pinyon woodlands among these sites (M. Basgall, personal communication 1993). Oak trees were present at four of the 89 BRM sites in the county and mesquite was noted at three sites.

The majority of sites with milling tools in Inyo County contain portable milling tools, which occur either alone or with bedrock milling features. Grinding slabs are the most common portable milling tool, being present at 424 (62%) of the total sites with milling equipment. In comparison, grinding slabs in Mono County are present at 186 (42%) of the milling tool sites. Portable mortars and pestles, as reported on site records, are equally infrequent in both counties.

The archaeological data on milling tool use from Inyo and Mono counties reveal that the grinding of plant resources was a common processing method in both areas and that the

Table 3
COMPARISON OF MILLING TOOL SITES IN INYO AND MONO COUNTIES, CALIFORNIA

| County | Sites with only BRMs | Sites with only slicks | Sites with both slicks and BRMs | Sites with only portable milling tools | Total number of sites with milling tools |
|-------------------|----------------------|------------------------|---------------------------------|--|--|
| Inyo ^a | 49 (7%) | 177 (26%) | 40 (6%) | 417 (61%) | 683 |
| Mono | 119 (27%) | 98 (22%) | 94 (21%) | 131 (30%) | 442 |

^a Site records for the Death Valley region of Inyo County were not available for this study.

pounding of resources occurred more frequently or more intensively in Mono County. Based on environmental associations, this conclusion would seem counter-intuitive since mesquite pods and acorns, resources that were described ethnographically as having been processed in mortars, occur in Inyo County, but not in Mono County. If BRMs in both areas were used to process the same resource, then this resource was not being processed as intensively or in the same quantities in Inyo County. If this resource was the acorn, then more were being transported into Mono County than were being gathered and/or brought into Inyo County. It is possible that acorn flour, rather than whole acorns, was more commonly imported into Inyo County. It also is possible that BRMs in Mono County represent a technology adapted to the processing of local resources which were more typically ground with a mano and metate in other parts of the Great Basin. The potential use of BRMs in Mono County to process local resources (such as seeds, berries, roots, or tubers) can be explored through an analysis of the distribution of mortar hole depths at sites. If the model developed by McCarthy et al. (1985) for mortar types among the Western Mono is relevant to Mono County data, then mortar depths should exhibit a polymodal distribution.

Analysis of BRM Depths

As described above, variability in the depth of mortar holes among the Western Mono has

been related to functional differences (McCarthy et al. 1985). Measurements of mortar hole depths were available for 36 sites in Mono County. These sites are broadly distributed over the county, although a large portion occur in Long Valley and Mono Basin. The sample consists of measurements from a total of 309 mortar holes and 77% of the total sample is derived from sites with 10 or more BRMs. The distribution of mortar depths is polymodal (Fig. 2) and a chi-square analysis rejected the possibility that the variations in recorded depths could be accounted for by random chance ($\chi^2 = 232.02$, $p < .005$, $df = 12$). The nature of the distribution is in remarkable accordance with the depth ranges of mortar types developed by McCarthy et al. (1985) from distinctions made by Western Mono consultants. These types and ranges include starter mortars (0-5.5 cm.), finishing mortars (5.51-9.5 cm.), and seed mortars (9.51+ cm.). Within the Mono County data, a clear delineation is apparent between starter and finishing mortars, and a peak occurs at 7-8 cm., although there is no sharp break between finishing and seed mortars. An apparent break does occur at 13 cm. for the Mono County data and, in comparison, the Crane Valley data had a peak between 12 and 13 cm. The complete range of seed mortar identified by Western Mono consultants was between 8-16.99 cm. (McCarthy et al. 1985:328).

Findings of the Crane Valley study suggested that more acorns than seeds were pro-

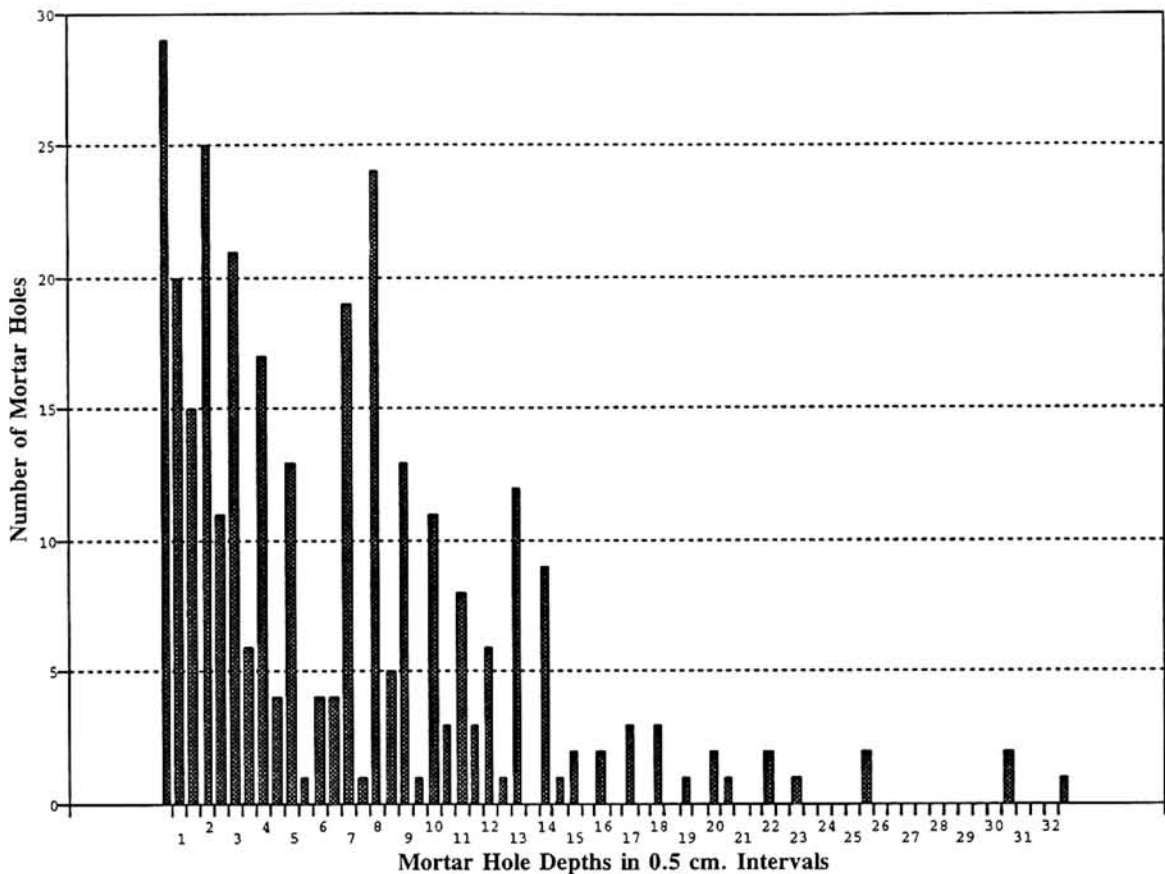


Fig. 2. Bar graph showing variability in the depths of mortar holes at bedrock mortar sites in Mono County, California.

cessed at these sites and that the relative proportions of mortar types were possibly typical for food processing at major village sites in a transitional zone containing many black oak, but where a wide variety of processing activities occurred (McCarthy et al. 1985:331-332). The percentages of different mortar types present at sites in the eastern Sierra Nevada are similar to the Crane Valley percentages, especially the Long Valley data (Table 4). The large number of mortar holes at some sites in the Mono Basin-Long Valley region and the variation in mortar depths suggest that these facilities were used to process a resource exploited in large quantities. If this resource was seeds, then deep mortars would have been better represented in the sample. The different depths of

mortars among the Western Mono is due largely to the characteristics of black oak acorns (the most abundant oak species throughout the Sierra Nevada) and the separation of mortar types in the eastern Sierra Nevada would appear unnecessary unless large amounts of acorns were imported into the Mono Basin-Long Valley region. It is equally possible that use of BRMs in the region was more tied to social preferences than to the physical characteristics of any resource(s).

Temporal Considerations

Undoubtedly, temporal variation in the use of different types of milling tools occurred in the eastern Sierra Nevada and, while a complete analysis is beyond the scope of the current

Table 4
COMPARISON OF THE PERCENTAGES OF
MORTAR TYPES AT SITES IN LONG VALLEY,
MONO BASIN, AND CRANE VALLEY

| Mortar Type | Long Valley | Mono Basin | Crane Valley ^a |
|-------------|-------------|------------|---------------------------|
| Starter | 46% | 63% | 52.3% |
| Finishing | 23% | 34% | 18.9% |
| Seed | 31% | 13% | 28.9% |

^a McCarthy et al. (1985)

study, the chronological parameters of BRM use in the region were evaluated to the extent possible. BRMs are thought to have developed in the western Sierra Nevada at approximately 1,100-1,000 B.P., based on data from the Shaver Lake-Balsam Meadows area of the west central Sierra Nevada (Jackson and Dietz 1984), and therefore the inception of BRM use in the eastern Sierra Nevada is expected to have occurred after this date. The dating of BRMs in the eastern Sierra Nevada is hindered by the difficulty of relating these surface features to archaeological deposits, especially at multi-component sites. For example, archaeological investigations have been reported for eight Mono County sites that contain BRMs. All of these sites are dominated by obsidian production activities related to the Newberry Period (3,150-1,350 B.P.), but contain components related to the Haiwee (1,350-650 B.P.) and/or Marana (650 B.P. to contact) periods.

Two sites, Snowcreek (CA-Mno-3) and Chance Wells (CA-Mno-458/630), contain BRMs in proximity to well-dated site components. At the Snowcreek site, it was suggested that the BRMs are associated with an activity area which represents a Haiwee Period subsistence-related base camp (Burton and Farrell 1990). Obsidian hydration values from this activity area had a range of 1.2-4.0 microns and most readings were 2.5 microns. Therefore, most of the readings relate to the late Haiwee

Period at approximately 700 B.P., using the conversion rate for Casa Diablo obsidian established by Hall and Jackson (1989). Many of the BRMs at the Chance Wells site are associated with a midden area and two radio-carbon assays (220 ± 60 RCYBP [Beta-12944]; 90 ± 60 RCYBP [Beta-12945]) from the midden reflect late prehistoric to proto-historic occupation although obsidian samples from the deposit had mean values of 1.5 to 3.8 microns and a temporal range of 270 to 1,500 B.P. (Burton 1985).

An understanding of the intensity of BRM use in the region is also hindered by recurrent site use, since mortar holes could relate to different episodes of site use. For example, BRMs present on rock outcroppings that are widely separated over a large lithic scatter may create a misleading impression of a relatively high frequency of mortar holes associated with intensive processing activities at the site. Available data suggest that most sites containing more than 20 BRMs consist of related groupings of mortar holes and reflect intensive use of these features. In sum, BRM use in the eastern Sierra Nevada could have begun after 1,000 B.P. during either the Haiwee or Marana periods; however, further research is needed to establish a tighter temporal framework for the inception and use of this technology in the region.

DISCUSSION

The majority of BRM sites in Mono County, that contain one to four BRMs and are widely distributed, may represent a trait diffused through a broad social network that included inter-marriage between eastern and western Sierra Nevada populations. Under these circumstances, use of BRMs in the eastern Sierra Nevada would reflect a traditional western Sierra Nevada practice adapted to local resources, but would not have replaced local milling tool traditions unless it proved to be more efficient. The presence of some sites containing

large numbers of BRMs and the variability in the depths of mortar holes at these sites indicate intensive processing activities. If a locally occurring resource was being processed, BRM use would represent a shift among the more common milling practices reflected in the ethnographies and archaeology for most of the region.

The only locally occurring staple plant resource that could have been processed in amounts large enough to account for the nature of BRM sites in the region is singleleaf pinyon (*Pinus monophylla*). Pinyon seeds have a resinous quality and typically were roasted prior to grinding (Wheat 1967:32-33; Steward 1933:242). It is possible that pinyon could have been pulverized in a two-stage process within BRMs, although no ethnographic descriptions of this practice exist. Furthermore, the most productive pinyon woodlands in Mono County do not contain sites with high numbers of mortar holes, whereas the highest density of BRMs occur in western Long Valley, not known as a productive pinyon area (M. Hall, personal communication 1991).

Some of the BRMs in the Mono Basin-Long Valley region may have been manufactured and used by visiting populations from the western Sierra Nevada, which could account for the limited distribution of these features. The Northfork Mono made summer trips from the western Sierra Nevada to Owens Valley and sometimes harvested pinyon nuts in the eastern Sierra Nevada (Gifford 1932:19). During these expeditions, members of different Northfork villages would sometimes choose to stay a year or two in the eastern Sierra Nevada. As discussed above, the percentages of different types at sites in the Crane Valley were thought to reflect plant processing activities that occurred at main villages and it is unlikely that similar percentages of mortar types would be made in the Mono Basin-Long Valley region by visiting populations. The Western Mono frequently made the shallow starter mortars at various

locations, but starter and finishing mortars were used at locations where large amounts of acorns were processed over a longer period of time (H. McCarthy, personal communication 1991).

Use of BRMs by local populations in the Mono Basin-Long Valley region to process acorns imported from the western Sierra Nevada is supported through consideration of the potential role of acorns in the subsistence systems of these groups. Jackson and Dietz (1984) proposed that the Western Mono, a Numic group in the central Sierra Nevada who are linguistically related to Numic populations in the Great Basin, may have found the use of acorns comparable to pinyon exploitation. Most Great Basin ethnographies portray pinyon as an important resource during the lean winter months when groups had to rely largely on stored foods. Groups were willing to travel great distances (over 50 miles) in the fall to harvest pinyon and would sometimes spend winters at pinyon camps in the mountains or would cache a portion of the harvest and gradually transport the rest back to winter base camps (Steward 1933:239, 242, 1938:27). The accounts of acorn expeditions from Long Valley and Mono Basin to oak groves in the western Sierra Nevada (Hulse MS) are remarkably similar to pinyon expeditions. It is proposed here that use of acorns in subsistence systems of groups living in the Mono Basin-Long Valley region was similar to the role of pinyon among most Great Basin populations. Acorns may have enhanced this procurement system since the acorn is a more dependable resource.

In terms of dietary value, nuts from the singleleaf pinyon and acorns from the black oak are very comparable (Table 5; also see Farris 1982). Although the pinyon is higher in caloric value, the acorn is superior in a possibly more significant aspect: reliability. The black oak is a regular producer, averaging more than one good crop in two years, and each tree may produce 200-300 pounds (Wolf 1945). In contrast,

Table 5
DIETARY VALUES^a OF THE BLACK OAK
ACORN AND THE PINYON PINE NUT

| Species | Protein (%) | Fat (%) | Carbohydrates (%) |
|----------------------|-------------|---------|-------------------|
| <i>P. monophylla</i> | 10.0 | 23.0 | 54.0 |
| <i>Q. kelloggii</i> | 4.6 | 18.0 | 55.5 |

^a Wolf (1945:63); Lanner (1981:101)

a mature crop of pinyon requires three growing seasons and is vulnerable at several stages in its development (Lanner 1981:77-78). Cycles of good and poor crops of pinyon occur every three to seven years and a bumper crop is usually followed by one to two lean years. There is some debate among researchers regarding the regularity of pinyon crops and definition of a "good crop" (see Sutton 1984).

Expeditions from Mono Basin to oak groves in the western Sierra Nevada would have required greater effort, in terms of energy expended, than similar trans-Sierra Nevada trips from Long Valley. While stands of Black oak trees are within 50 miles of both areas, the western edge of Mono Basin is at approximately 7,000 feet above mean sea level and Mono Pass is at 10,604 feet. Most of western Long Valley is between 7,500 and 8,000 feet and Mammoth Pass lies at 9,200 feet.

In comparison with areas in Mono County, a similar trans-Sierra trip from Owens Valley may have been prohibitive in terms of energy expended in relation to energy gained. The valley lies between 3,500 and 4,000 feet and the Sierra Nevada forms a towering wall to the west with mountain passes at 10,000 feet or more. The abundance of seed resources in the region and the relatively high cost of importing acorns may account for greater emphasis on grinding versus pounding resources which characterizes the milling technology of Inyo County. In contrast, the Mono Basin-Long Valley region is

higher in elevation, has a shorter growing season, and is a less productive seed area. Therefore, the energetic cost of importing acorns to the region would be lower than similar costs for Inyo County, and this may explain the greater use of BRM technology in the Mono County.

The distribution of BRM sites along the eastern Sierra Nevada in Mono County supports the above cost-benefit analysis, which shows that greater costs would have been incurred through expeditions from Mono Basin to oak groves in the western Sierra Nevada relative to similar expeditions from Long Valley. Mono Basin contains fewer BRM sites, and fewer mortar holes are present at these sites in comparison with sites in Long Valley.

While trans-Sierra Nevada travel from Mono Basin would require a greater energetic expenditure, the Mono Basin contains alternative resources, used during the winter, which are not available in Long Valley. These resources include the brine fly larvae, collected in large amounts, and a variety of waterfowl that traveled along the Pacific flyway (Browne 1865). Lawton et al. (1976) proposed that the combination of pinyon nuts and fly larvae, used as staple winter stores for groups in the vicinities of Mono and Owens lakes (in southern Owens Valley), was comparable to the combined use of pinyon nuts and the irrigated crops in the northern Owens Valley. In comparison, Long Valley lacked similar combinations of resources that could have been used for staples during the winter. Larvae of the pandora moth, present in Jeffrey pine forests, was an important resource for many groups in the eastern Sierra Nevada, but was available in large amounts only every other year (Weaver and Basgall 1986: 172). Therefore, groups residing in the Long Valley area may have been more dependent on acorns as a winter store, and the use of this resource may have provided a boost to local food supplies which was sufficient enough to

allow year-round occupation of Long Valley (R. Jackson, personal communication 1991).

The role of acorns among eastern Sierra Nevada populations could relate more to maintenance of social interaction with western Sierra Nevada groups than to strictly subsistence needs. Ethnographic descriptions indicate that an informal exchange system existed across the Sierra Nevada crest and that acorns were sometimes a part of these transactions (J. Davis 1961). This type of exchange among hunter-gatherers served many needs, such as sharing information, maintaining access to shared resources, and maintaining social ties. Social relations were especially important to groups in the Mono Basin-Long Valley region. For example, harsh winters in Mono Basin sometimes forced populations to seek refuge with distant relatives in Yosemite Valley (E. Davis 1965). However, processing small amounts of acorns acquired through ad hoc exchange would most likely involve methods that are less costly than pulverizing and leaching. Therefore, ad hoc exchange would fail to account for the distribution, frequency, and depth variability of BRMs in the eastern Sierra Nevada.

It has been suggested that a formal exchange system, involving obsidian, could have existed across the Sierra Nevada north of Owens Valley (Bettinger and King 1971). However, evidence for such a system is lacking, and proposed technological changes in stone tool production would have reduced the need for large amounts of obsidian in the western Sierra Nevada after 1,000 B. P. (Ainsworth and Skinner 1988). As stated above, available data suggest that the inception of BRM technology occurred in the western Sierra Nevada at approximately 1,100 to 1,000 B.P. and, therefore, evidence of acorn use in the eastern Sierra Nevada occurs after the peak period of obsidian production.

The data presented here suggest that acorn exploitation among eastern Sierra Nevada pop-

ulations was a viable procurement strategy, although travel to western Sierra Nevada oak groves probably included those benefits of social interaction that characterize ad hoc exchange networks. These benefits would counterbalance some costs associated with acorn procurement. Furthermore, if acorn expeditions coincided with other subsistence activities which occurred in the Sierra Nevada during the fall, then most gains derived from acorn exploitation could be delayed until the winter when few resources were available.

If the role of acorns in the subsistence systems of populations residing in the Mono Basin-Long Valley region was similar to the role of pinyon among most Great Basin groups, then the inception and intensification of this subsistence strategy may have had similar timing. Pinyon use in the eastern Sierra Nevada may have occurred early in time, but intensive exploitation of this resource within the western Great Basin began after 1,350 B.P. (Bettinger 1976; McGuire and Garfinkel 1976, 1979) and, in comparison, development of intensive acorn economies in the south-central Sierra Nevada began at approximately 1,100 to 1,000 B.P. (Jackson and Dietz 1984). Thus, the adoption of BRM technology and the exploitation of acorns in the Mono Basin-Long Valley region would have been related to intensification processes operating on a regional level. Use of imported acorns in the eastern Sierra Nevada may also have been an important factor in the movement of Numic populations (the Western Mono) into the western Sierra Nevada (Haney 1992).

CONCLUSIONS

The majority of BRM sites in Mono County represent a milling technology diffused through a broad social network and probably relate to processing local resources. Few sites in the region contain relatively large numbers of mortar holes and aspects of these sites, includ-

ing their distribution and variability in mortar hole depths, suggest intensive processing of acorns imported from the western Sierra Nevada. The use of acorns among populations in the Mono Basin-Long Valley region was probably a viable subsistence practice which also maintained social relations across the Sierra Nevada crest. The spread of BRM technology to the eastern Sierra Nevada after 1,000 B.P. indicates that trans-Sierra social interaction continued after the apparent decline in obsidian tool production. The role of acorns within eastern Sierra Nevada subsistence systems was probably as an augmentation to an existing procurement strategy focusing on pinyon nuts as a winter staple and, thus, acorn exploitation is an example of intensification processes which were operating on a regional level.

ACKNOWLEDGEMENTS

This paper is derived from my master's thesis and I acknowledge the contributions of my committee members: David A. Fredrickson, Matthew C. Hall, Robert J. Jackson, and David A. Peri. Assistance was also provided by Susan Alvarez, Bruce Dahlstrom, Terry Jones, Daniel McCarthy, Helen McCarthy, William Seidel, Paul Tapia, and Wallace Woolfenden.

REFERENCES

- Ainsworth, Peter W., and Elizabeth J. Skinner
1988 Ribbon Flaked Bifaces: The Trail of Debitage. Paper presented at the annual meetings of the Society for California Archaeology, Redding.
- Barrett, S. A., and E. W. Gifford
1933 Miwok Material Culture. *Bulletin of the Public Museum of the City of Milwaukee* 2(4):117-377.
- Basgall, Mark E.
1987 Resource Intensification Among Hunter-Gatherers: Acorn Economies in Prehistoric California. *Research in Economic Anthropology* 9:21-52.
- Bettinger, Robert L.
1976 The Development of Pinyon Exploitation in Central Eastern California. *The Journal of California Anthropology* 3(1):85-95.
- Bettinger, Robert L., and Thomas F. King
1971 Interaction and Political Organization: A Theoretical Framework for Archaeology in Owens Valley, California. *University of California, Los Angeles Archaeological Survey Annual Report* 13:137-150.
- Bouey, Paul D., and Mark E. Basgall
1984 Trans-Sierra Exchange in Prehistoric California: The Concept of Economic Articulation. In: *Obsidian Studies in the Great Basin*, Richard E. Hughes, ed., pp. 135-172. Berkeley: Contributions of the University of California Archaeological Research Facility No. 45.
- Browne, J. Ross
1865 A Trip to Bodie Bluff and the Dead Sea of the West. *Harper's Magazine* 31:274-284, 411-419.
- Burton, Jeff F.
1985 The Archaeology of the Chance Well Site (CA-Mno-458/630), Mono County, California. Report on file at the Eastern Information Center, University of California, Riverside.
- Burton, Jeff F., and Mary Farrell
1990 Archaeological Test Excavation at the Snowcreek Site (CA-Mno-3), Mammoth Lakes, California. Report on file at the Eastern Information Center, University of California, Riverside.
- Chalfant, Willie A.
1933 The Story of Inyo. Los Angeles: Citizens Print Shop.
- Davis, Emma L.
1965 An Ethnography of the Kuzedika Paiute of Mono Lake, Mono County, California. *University of Utah Anthropological Papers* 75:1-55.
- Davis, James T.
1961 Trade Routes and Economic Exchange among the Indians of California. Berkeley: University of California Archaeological Survey Reports No. 54.
- Farnsworth, Paul, and Douglas Armstrong
1984 An Analysis of Bedrock Features at Lake Isabella, Lake Success, Lake Kaweah, and Pine Flat Lake. In: *Isabella Lake Intensive Cultural Resources Survey by Clement Meighan*, pp. 560-637. Report on file at the Southern San Joaquin Valley Archaeological Information Center, California State University, Bakersfield.

- Farris, Glen
1982 Pine Nuts as an Aboriginal Food Source in California and Nevada: Some Contrasts. *Journal of Ethnobiology* 2(2):114-122.
- Gifford, Edward W.
1932 The Northfork Mono. University of California Publications in American Archaeology and Ethnography 31(2).
1936 California Balanophagy. In: *Essays in Anthropology Presented to Alfred L. Kroeber, R. H. Lowie, ed.*, pp. 27-98. Berkeley: University of California Press.
- Griffin, James R., and William B. Critchfield
1972 The Distribution of Forest Trees in North America. Berkeley: USDA Forest Service Research Paper PSW-82/1972.
- Hall, Matthew C.
1983 Late Holocene Hunter-Gatherers and Volcanism in the Long Valley-Mono Basin Region: Prehistoric Culture Change in the Eastern Sierra Nevada. Ph.D. dissertation, University of California, Riverside.
1984 Obsidian, Paleoecology, and Volcanism in the Eastern Sierra Nevada. Paper presented at the Great Basin Anthropological Conference, Boise.
- Hall, Matthew C., and Robert J. Jackson
1989 Obsidian Hydration Rates in California. In: *Current Directions in California Obsidian Studies*, Richard E. Hughes, ed., pp. 31-58. Berkeley: Contributions of the University of California Archaeological Research Facility No. 48.
- Haney, Jefferson W.
1992 *Written in Bedrock: Prehistoric Acorn Use in the Eastern Sierra Nevada*. Master's thesis, Sonoma State University.
- Hulse, Frederick S., compiler
MS *Ethnographic Notes from Fieldwork among the Owens Valley and Mono Lake Paiutes*. MS on file at the University Archives, Bancroft Library, University of California, Berkeley.
- Jackson, Thomas L., and Stephen A. Dietz
1984 Archaeological Data Recovery Excavations at CA-FRE-798 and CA-FRE-805, Siphon Substation 33kV, Distribution Line and Balsam Meadow Hydroelectric Project. Report on file at the Southern San Joaquin Valley Archaeological Information Center, California State University, Bakersfield.
- Johnson, Jerald J.
1967 The Archaeology of the Camanche Reservoir Locality, California. Sacramento Anthropological Society Paper No. 6.
- Lanner, Ronald M.
1981 *The Pinyon Pine: A Natural and Cultural History*. Reno: University of Nevada Press.
- Lawton, Harry W., Philip J. Wilke, Mary De-Decker, and William M. Mason
1976 Agriculture Among the Paiute of Owens Valley. *The Journal of California Anthropology* 3(1):13-50.
- McCarthy, Helen, Clinton M. Blount, and Robert A. Hicks
1985 A Functional Analysis of Bedrock Mortars: Western Mono Food Processing in the Southern Sierra Nevada. In: *Cultural Resources of the Crane Valley Hydroelectric Project, Madera County, California, Vol. I*, prepared by Theodoratus Cultural Research, Inc., pp. 303-356. Report on file at the Southern San Joaquin Valley Archaeological Information Center, California State University, Bakersfield.
- McGuire, Kelly R., and Alan P. Garfinkel
1976 Comment on "The Development of Pinyon Exploitation in Central Eastern California." *The Journal of California Anthropology* 3(2):83-85.
1979 The Nature and Antiquity of Pinyon Exploitation in the Southern Sierra Nevada. In: *Archaeological Investigations in the Southern Sierra Nevada: The Lamont Meadow and Morris Peak Segments of the Pacific Crest Trail*, A. Garfinkel, R. Schiffman, and K. McGuire, eds., pp. 97-104. Bakersfield: United States Bureau of Land Management Cultural Resources Publications.
- Merriam, C. Hart
MSa *Journal of Fieldwork in California, Vol. I*. MS on file at the Library of Congress, Washington, D. C.
MSb *Journal of Fieldwork in California, Vol. III*. MS on file at the Library of Congress, Washington, D. C.
- Mikkelsen, Pat
1985 A Study of Millingtool Form and Function Applied to the North Coast Ranges,

- California. Master's thesis, Sonoma State University, Rohnert Park.
- Reynolds, Linda A., and Wallace B. Woolfenden
1991 Wooden Bowl Mortars in the Western Great Basin Revisited. Paper presented at the annual meetings of the Society for California Archaeology, Sacramento.
- Steward, Julian H.
1933 Ethnography of the Owens Valley Paiute. University of California Publications in American Archaeology and Ethnology 33(3).
1938 Basin-Plateau Aboriginal Sociopolitical Groups. Bureau of American Ethnology Bulletin 120.
- Sutton, Mark Q.
1984 Pine Nuts and Modeling Great Basin Subsistence Strategies. Journal of California and Great Basin Anthropology 6(2):240-246.
- Voegelin, Erminie
1938 Tubatulabal Ethnogeography. University of California Anthropological Records 2(1).
- Weaver, Richard A., and Mark E. Basgall
1986 Aboriginal Exploitation of Pandora Moth Larvae in East-Central California. Journal of California and Great Basin Anthropology 8(2):161-179.
- Wheat, Margaret M.
1967 Survival Arts of the Primitive Paiutes. Reno: University of Nevada Press.
- White, David R. M.
1985 Settlement Pattern Implications of Bedrock Milling Implement Analysis: An Example from the Kern River, California. Paper presented at the Southwest Anthropological Association meetings, Chico.
- Wolf, Carl B.
1945 California Wild Tree Crops. Rancho Santa Ana: Botanic Gardens of the Natural Plants of California.

