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SEDENTISM, STORAGE, AND THE INTENSIFICATION OF SMALL SEEDS: PREHISTORIC DEVELOPMENTS IN OWENS VALLEY, CALIFORNIA*

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ABSTRACT

Many archaeological models describe the development of restricted residential mobility, or sedentism, in prehistoric settings. Sedentism is often part of a suite of cultural changes, often accompanied by seed intensification, storage, population increase, environmental degradation, establishment of social hierarchy, and agriculture. Most models describe these changes as a series of events, with one precipitating the next. As a result, sedentism is interpreted as either a direct byproduct or a causative trigger of other societal changes. Results of excavations at the village site of Sunga'va (CA-INY-3806) are used to examine the timing of sedentism in relation to the development of storage and seed intensification in the Owens Valley of California. The site, which has evidence for two separate occupations from a period that has heretofore not been the subject of intensive research, suggests that sedentism developed at the same time or just before storage and some 800 years before seed intensification. Data do not support social models, such as the activity of aggrandizers or the stabilization of long-distance exchange networks, in these developments.

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INTRODUCTION

The development of restricted residential mobility, or sedentism, in human societies has long been of interest to anthropologists. Indeed, this transition, which occurred prehistorically time and again the world over, dramatically changed how people made use of their environments and how they organized themselves socially. A range of theoretical models have been put forward to explain the shift to sedentism, including environmental stress, environmental abundance, population pressure, internal social factors, and/or multidimensional or coevolutionary models (Bender, 1985; Binford, 1983; Brown, 1985; Cohen, 1977; Hayden, 1990; Kaufman, 1992; Kelly, 1990; Lourandos, 1985; Madsen, 1982; O'Brien, 1987; Rafferty, 1985; Rosenberg, 1998; Smith, 2003; Stokes and Roth, 1999).

The topic is of particular interest because other fundamental changes, including the development of agricultural economies, social inequality, storage, territoriality, and the introduction of new material technologies, are often seen as being intricately linked to sedentism. In different models, sedentism is often either a direct precursor, allowing for these other changes, or a logical outgrowth of these other transitions. For example, in some models restricted mobility contributes to increased female fertility, which in turn increases population size, which in turn forces people to rely on lower-ranked resources (i.e., r-selected species) such as cereals that are eventually domesticated. Alternatively, other models see population pressure as forcing a greater reliance on r-selected species, which encourages territoriality and ultimately sedentism. The exact timing of these different transitions, then, is of great interest to archaeologists.

The Owens Valley of eastern California presents an ideal testing ground to evaluate some of these models. According to ethnographic data collected in the early 1900s, the Owens Valley Paiute were on the cusp of several of these fundamental changes (Driver, 1937; Steward, 1929, 1933, 1938; see also Lawton et al., 1976; and Liljeblad and Fowler, 1986). They lived in medium-sized (ca. 50-200 people) permanent villages, there were chiefs and other inherited positions of status, they made and used pottery, and they were heavily reliant on small seeds. Seeds, along with bulbs, were grown in small individually-owned plots that were fed by small irrigation systems. Thus, in all respects, the Owens Valley Paiute display many of the characteristics of an incipient "complex society." However, they did not develop these traits into the complex forms seen in many other areas of the world. Moreover, archaeological evidence indicates that these changes took place late in time, sometime during the last 1400 years of prehistory. This is ideal because the archaeological record encompassing this shift is easily accessible and relatively well preserved.

This article explores certain aspects of the origins of sedentism in Owens Valley through analysis of a key residential site with two separate and chronologically-distinct occupations that dates to this critical transition period. In particular,

I examine the timing of seed intensification, storage, and changes in material technology in relation to sedentism. That is, I ask whether these changes all take place at once in one large cultural shift, or if they are responses to one another and happen one at a time in sequence. Unfortunately, we currently lack the archaeological data to directly examine the development of social inequality, population pressure, and territoriality. However, I consider some of these aspects indirectly in the discussion.

OWENS VALLEY PREHISTORY AND CHRONOLOGY

The late Holocene in eastern California is usually divided into three distinct periods that are based on the presence of projectile point types (Bettinger and Taylor, 1974; see also Thomas, 1981). These include the Newberry period defined by Elko points (3500–1500 BP), the Haiwee period defined by Rose Spring points (1500–650 BP), and the Marana period defined by Desert series points (650 BP–contact). While the former and latter are relatively well studied, the middle Haiwee period is less well known. However, it is across this Haiwee period that many of the changes of interest seem to occur. For example, while people were relatively mobile during the Newberry period, they were quite sedentary by the time the Marana period began, relying on logistical mobility strategies instead (Basgall, 1989; Basgall and McGuire, 1988; Bettinger, 1975, 1978, 1989; Bettinger and Baumhoff, 1982; Delacorte, 1999). As well, while a range of foods were eaten in the Newberry period, including a significant amount of large mammal (Hildebrandt and McGuire, 2002) and some seeds, by the Marana period small seeds and piñon nuts were the dominant staples. Similarly, we see dramatic reductions in the production and consumption of toolstone, especially obsidian (Gilreath and Hildebrandt, 1997), a reduction in the amount of trans-Sierran trade (Hughes and Bennyhoff, 1986), and the addition of new technologies such as ceramics and the bow and arrow (Bettinger, 1999a; Eerkens et al., 1999) across the Newberry to Marana transition.

In order to understand the exact processes involved in development of sedentism in Owens Valley, we need to focus on the Haiwee period. Unfortunately, few single-component sites dating to this time period have been investigated and many sites containing Haiwee materials also contain Marana materials (though not always vice versa). In fact, discussions of regional prehistory often conflate the Haiwee and Marana into a single “late prehistoric” phase. Moreover, while the use of projectile points to date archaeological sites is helpful in a general manner, it limits our ability to track more detailed behavioral changes. Unless major shifts like sedentism, storage, and seed intensification happen to take place at the same time point styles change we will be unable to understand how and why these changes took place. For example, while the introduction of the bow and arrow brought about changes in projectile point forms, it was really the

repercussions of the new technology and associated hunting methods that brought about changes in social structure such as food hoarding and individualism (e.g., Bettinger, 1999a; Hildebrandt and McGuire, 2002). Thus important behavioral changes may come about many generations after the adoption of a new technology, and a focus on artifact styles to manage time may blur our ability to witness the development of different social institutions.

EXCAVATIONS AT HAIWEE VILLAGE

CA-INY-3806/H, or Sunga'va after the Owens Valley Paiute word for Cottonwood tree, is a small-medium sized site located at the southeastern margin of a large alluvial fan emanating from the Sierra Nevada (see Figure 1). The site sits atop a small bluff overlooking Cottonwood Creek, a perennial watercourse in prehistory (i.e., prior to water diversions by the city of Los Angeles) near the former shores of Owens Lake (also drained by Los Angeles). While modern vegetation is dominated by drought-tolerant species, especially shadscale (*Atriplex confertifolia*) and rabbitbrush (*Chrysothamnus nauseosus*), prehistoric vegetation would have been more productive and diverse, including willow (*Salix* sp.), wild rose (*Rosa woodsii*), stands of cottonwood trees (*Populus fremontii*), and other riparian species such as sedges and rushes. Though too saline for fish, the lake would have provided access to waterfowl and brine fly larvae.

Sunga'va has seen two separate phases of excavation. The first, in 1990, was part of a phase II evaluation for a fiber optic cable and included excavation of 7.0 square (5.0 cubic) meters of sediment (Delacorte and McGuire, 1993). The second, in 1991 and the focus of this article, was part of a University of California at Davis field school included excavation of 21.0 square (over 30.0 cubic) meters. Although the surface is sparse, the site contains a rich assemblage of artifacts and features 1–2 meters below the ground surface, including three house floors, three pits, and several hearths. A range of artifacts were found, including projectile points and other flaked stone tools, bone tools, pipe bowls, groundstone, shell beads, and two pieces of pottery (see Eerkens et al., 1999). As well, the site has excellent preservation and includes a rich assemblage of faunal and floral remains. Temporal control is anchored by seven radiocarbon assays, 54 hydration readings on obsidian artifacts from the Coso Volcanic Field, 32 diagnostic projectile points, and 13 marine shell beads that are thought to be temporally sensitive. Table 1 provides this information.

Based on the chronological data and field observations, the occupation at Sunga'va is divided into two distinct phases. The first dates around 1400 BP and encompasses House Floors 1 and 2 (HF1 and HF2 hereafter) in the south-central part of the site. Ten square (nearly 15 cubic) meters were removed from this area. The second occupation in the western part of the site includes House Floor 3 (HF3) and several nearby pit and hearth features. This component dates to roughly 1160 BP.

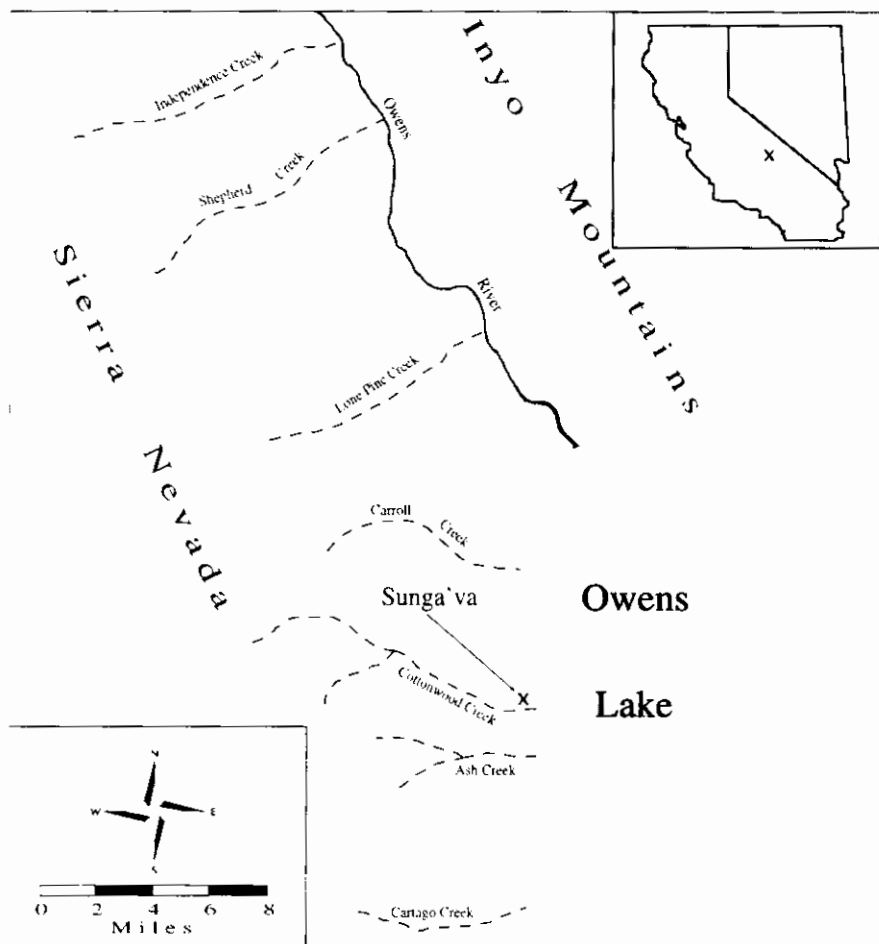


Figure 1. Location of Sunga'va (CA-INY-3806).

Early Component Features

Two of the house floors are in direct association with one another and date to the earlier component. HF1 was complete exposed during excavation and measured between 2.5 and 3.0 meters in diameter (Figure 2). In cross section, the floor had a saucer shape and was 30 cm deeper in its center than along the edge. The actual floor varied between 5 and 10 cm in thickness and was composed of a compacted dark-gray silty matrix with high densities of charcoal and occasional patches of orange oxidized sand. The floor directly overlay a culturally sterile light colored sandy matrix. Several charred posts were discovered during excavation. Charred

Table 1. Chronological Information for Sunga'va
(1990 and 1991 Excavations Combined)

Radiocarbon assays (uncalibrated)	1160 ± 90 BP (Beta-41115): agglomerated charcoal
	1160 ± 60 BP (Beta-113510): hearth on HF 3
	1180 ± 70 BP (Beta-113509): isolated hearth (feature 6)
	1340 ± 60 BP (Beta-135413): charcoal from HF 1
	1400 ± 80 BP (Beta-113508): burned timber from HF 2
	1490 ± 70 BP (Beta-135414): charred post from HF 2
	1600 ± 100 BP (Beta-38751): agglomerated charcoal
Obsidian hydration (Coso obsidian only)	4.63 ± 1.19 microns, including outliers: 1107 BP (<i>n</i> = 54) ^a
	4.44 ± 0.64 microns, including outliers: 1004 BP (<i>n</i> = 52) ^a
Projectile points	30 Rose Springs Corner Notched
	2 Humboldt Basal Notched
Beads (chronologically sensitive items only)	9 <i>Olivella</i> Tiny Saucer (G1): post 2600 BP
	2 <i>Olivella</i> Saucer or Wall Disk (G2a/J): post 2600 BP
	1 <i>Olivella</i> Split-drilled (C2a): 1250-950 BP
	1 <i>Olivella</i> Shelved punched (D1a): 1250-950 BP

^aObsidian hydration dates obtained by using the rate given by Basgall (1990; Basgall and McGuire, 1988). Shell bead types and dates are according to Bennyhoff and Hughes (1987).

Note: HF = House Floor.

grass matting was also apparent on the surface of the floor zone indicating the house may have been covered by a thatched grass roof supported by wooden posts. A radiocarbon date on charcoal directly from the floor of HF1 produced a date of 1340 ± 60 BP (Beta-135413).

HF2 was only partially exposed. The section excavated includes the northern edge, where it was adjacent to or slightly underlying the southern part of HF1. Based on this section, HF2 was at least 3.0 meters in length in the east-west direction and 1.2 meters north-south. However, based on curvature and assuming an elliptical or circular shape, the full size of the original house is estimated to be well over 5 meters in maximum diameter. A cross section across the floor (see Figure 3) suggests the house may have had an internal division demarcated by a slightly raised baulk. The floor zone is composed of compacted soil 5–10 cm thick and full of charcoal and occasional sections of oxidized sand, and overlies a sterile sandy matrix. The edges of this house on the northern side fall steeply into the interior of the house, over 20–30 cm, suggesting the house was partially dug into the underlying sediment. A discrete oval-shaped hearth measuring 40 by 25 cm was discovered on the floor in what would be the north-central section. A profile

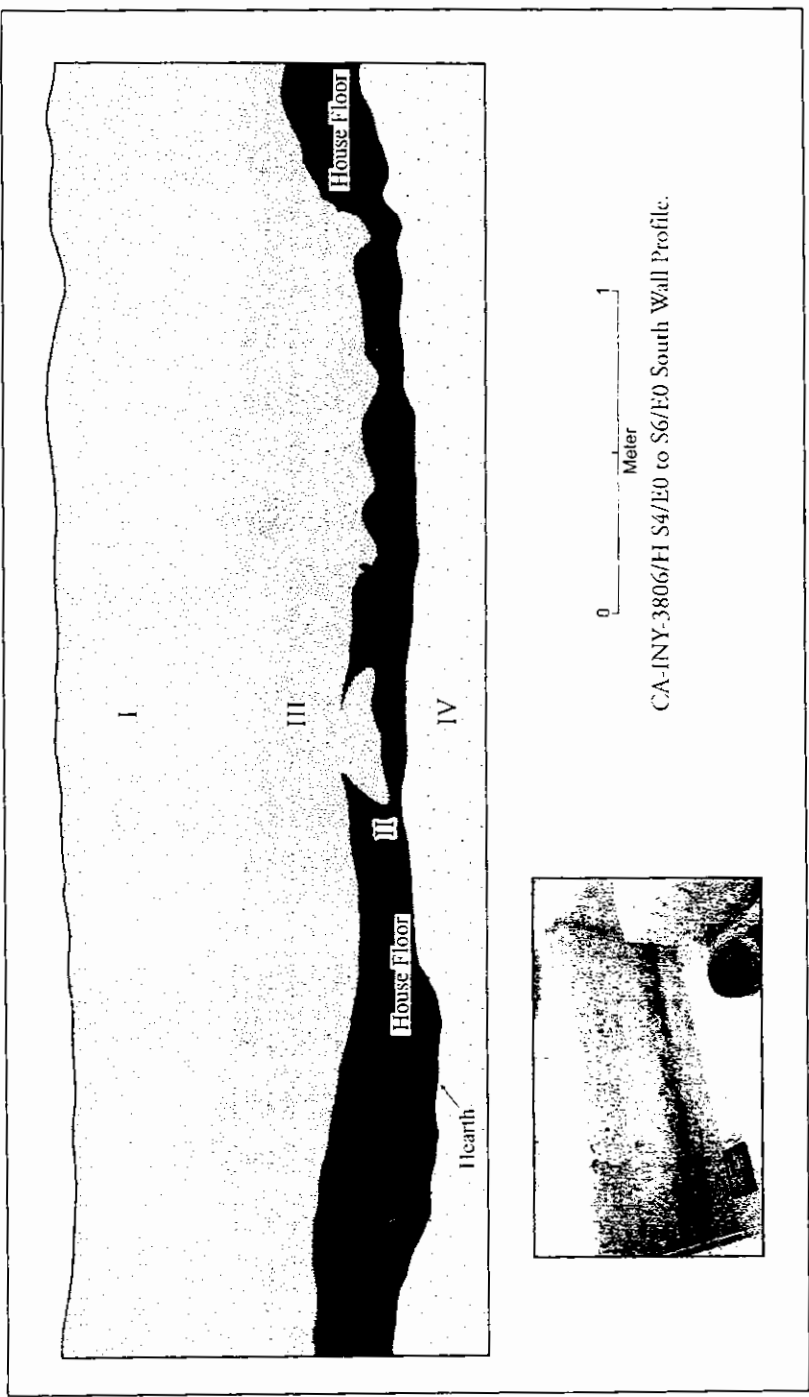


Figure 3. Profile of House Floor 2, early component.

along the southern wall of HF2 is provided in Figure 3. Two radiocarbon dates from large sections of timber lying directly on the floor zone produced uncorrected dates of 1400 ± 80 BP (Beta-113508) and 1490 ± 70 BP (Beta-135414) respectively (averaging 1445 ± 60 BP according to the procedure outlined by Long and Rippeteau 1974). These dates overlap in their 95% confidence intervals, and also overlap with the date from HF1. Based on this and their spatial distribution, HF1 and HF2 are interpreted as contemporaneous, and represent the first component of Sunga'va.

Later Component Features

The later component in Sunga'va was investigated with several units 15 to 35 meters northeast of HF1 and HF2. A third house floor (HF3) was found in this area, exposed in cross section by a 6×1 meter trench. In diameter this house is over 5 meters and has a slight saucer shape, being deeper in its center than along its rim. The cross section indicates the house was partially excavated into the soil, suggesting a semi-subterranean structure. Four wooden posts, paired in twos, were exposed along the eastern rim and two small hearths approximately 25 by 30 cm were discovered on the eastern and western parts of the floor. Charcoal from the former produced a date of 1160 ± 60 BP (Beta-113510). Two V-shaped pits are associated with HF3. One of these was excavated into the floor along the eastern edge, measures 50 cm in diameter, and extends some 35 cm into the sterile substrate. The other is outside the house, some 25–30 cm above the floor, and measures 60 cm in diameter by 30 cm deep. Being directly adjacent to the exterior of the house, it is likely that this pit would have been accessible and visible to all within the community. Figure 4 provides a plan and profile view of HF3 and one of the pit features.

Two additional units were excavated to the northwest of HF3 and produced a high density of lithic reduction materials, as well as two small hearths measuring 25 and 40 cm in diameter respectively and a third pit. A charcoal sample from one of the hearths produced a date of 1180 ± 70 BP (Beta-113509), suggesting it and other materials in these units are contemporaneous with HF3. The bowl-shaped pit was partially exposed, was capped by a flat stone, and is approximately 75 cm in diameter by 40–45 cm deep. However, it did not contain any artifacts or other noteworthy materials (i.e., it appears to be empty). This pit may have served as an exterior storage facility that was subsequently emptied of its contents. Figure 5 shows a cross section of this pit.

Macrobotanical Remains

Eleven flotation samples comprising 17 liters of sediment were analyzed from the site features for charred seeds to help reconstruct prehistoric diet and plant use. Five samples totaling 7 liters were processed from House Floors 1 and 2, and represent the earlier component. Within these samples 111 charred seeds

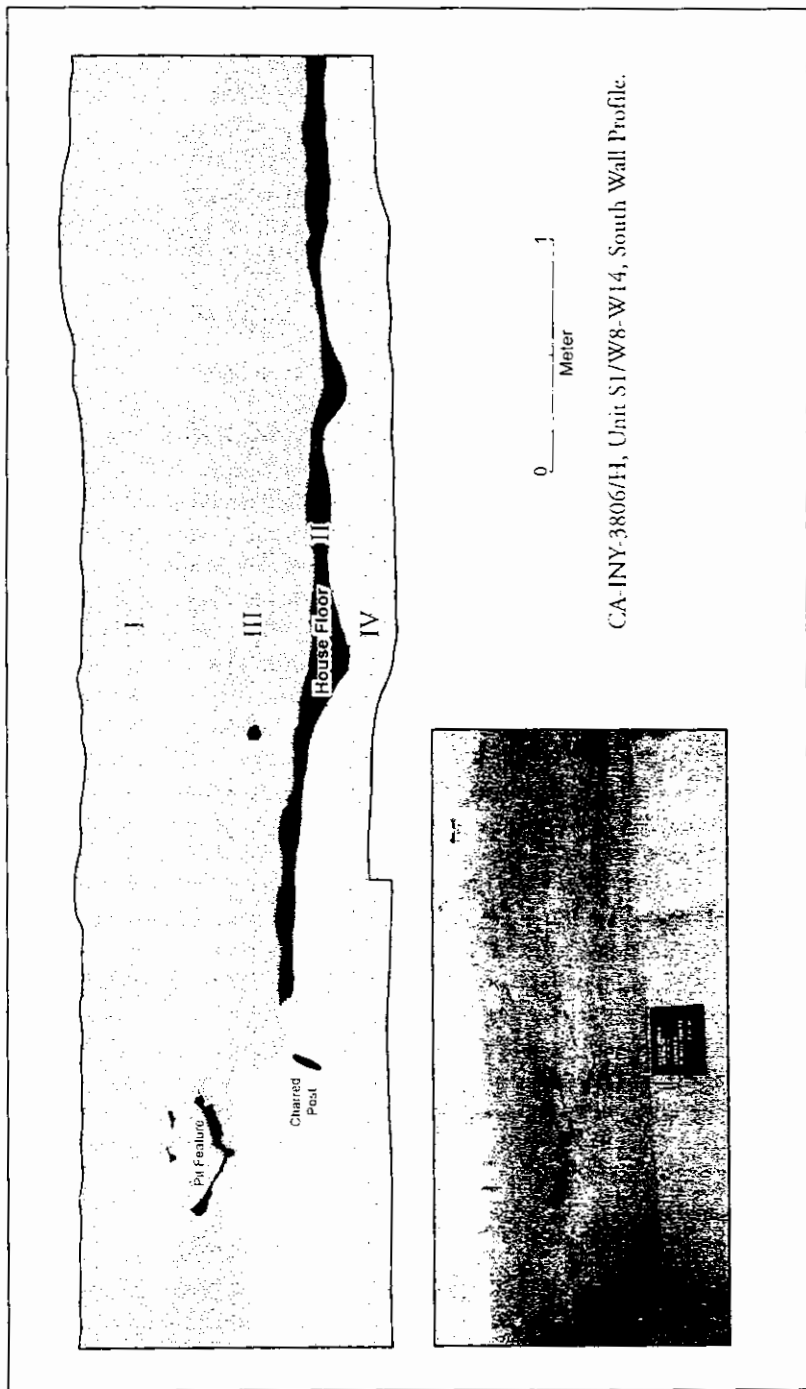


Figure 4. Profile of House Floor 3, late component.

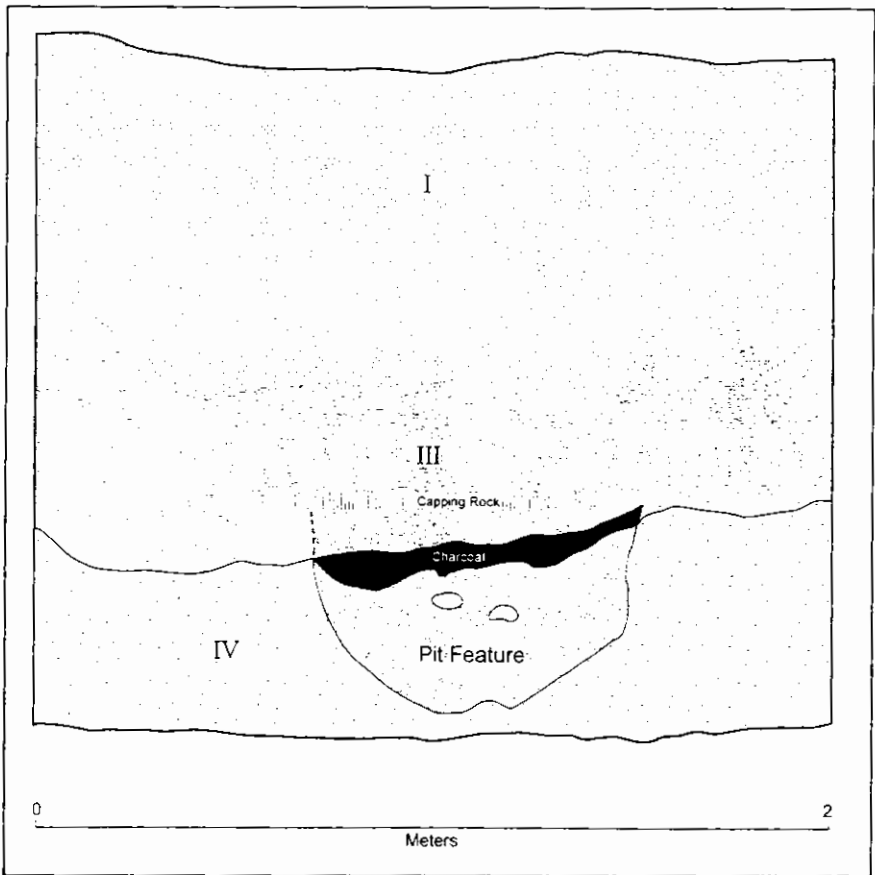


Figure 5. Profile of external storage pit feature, late component.

representing at least 11 genera, 12 fragments of piñon nut shell, and three unknown plant parts were recovered (possibly bulb fragments). Dominant among the seed assemblage are remains of Cyperaceae, most likely Bulrush (*Scirpus* sp.). Lesser amounts of Chenopodium-Amaranth (including *Chenopodium* sp.), Western Sea Purslane (*Sesuvium verrucosum*), Blazing star (*Mentzelia* sp.), Rice grass (*Achnatherum hymenoides*), Dock (*Rumex* sp.), Knotweed (*Polygonum* sp.), Ditch grass (*Ruppia* sp.), and Seepweed (*Suaeda* sp.) were also found. With the exception of purslane, all of these were eaten ethnographically (Fowler 1986; Steward 1933). Overall, the total number of seeds recovered is low compared to the volume of sediment analyzed. As well, the range of species represented is high, suggesting little specialization or focus on specific plants.

Six flotation samples comprising 10 liters were analyzed from the later component; one from HF3, two from a hearth lying on HF3, one from a pit associated with HF3, and two from hearths external to HF3. Five of the six samples (9 of the 10 liters) produced a total of 83 charred seeds, 13 fragments of piñon pine cone leaf bases, 3 fragments of plant leaves, and 14 unknown plant parts, some likely the remains of bulbs and tubers. The 83 seeds represent a minimum of 7 different genera including Saltbush (*Atriplex* sp.), Rush (*Juncus* sp.), Bulrush, Rice grass, a member of the Fabaceae family, a member of the Malvaceae family, and 10 seeds from a small-seeded grass. Again, the samples include a low density of seeds given the volume and context and represent a wide range of species. The final sample from the pit external to HF3, however, produced a much larger seed assemblage, including 6 *Scirpus* sp. seeds, 1 *Achnatherum* sp. seed, 5 *Chenopodium-Amaranth* seeds, and approximately 200–300 *Juncus* sp. seeds. The density of seeds in this feature suggests it served either as a storage facility or is a byproduct of *Juncus* seed processing. Perhaps it was excavated to hold a cooking basket or pot into which heated stones were placed and stirred. If the latter, it implies that seed processing was done outside the domicile, perhaps within the view of other community members.

Comparison of the macrobotanical assemblages from the two components suggests little difference or change through time, with the exception of the aforementioned pit. The dominance of rush and bulrush, as well as the presence of ditch grass, dock, and seepweed, suggests an emphasis on gathering wetland seed resources in both temporal components. As well, the presence of piñon, which does not and did not grow near the site, indicates contact with nearby uplands and transportation of food to this base camp.

Despite sampling numerous locations, a low overall density of seeds was recovered. This does not suggest that seed processing activities were especially important during the Haiwee period. As well, seeds from a broad range of genera, nuts from piñon pine, and root and tuber remains suggests a generalized and rather broad diet. Most of these species are available in late spring to early fall. As well, the presence of seasonally-available waterfowl, substantial dwellings, and storage pits (at the later component), the macrobotanical assemblage suggests that the people inhabiting this site spent the vast majority, if not the entire year, at this location.

Obsidian Studies

A combination of visual inspection and Instrumental Neutron Activation Analysis (INAA) were carried out on the obsidian tools and debitage to learn more about the source provenance of these items. Visual sourcing has proven effective in past studies in the Owens Valley (e.g., Bettinger et al., 1984; Delacorte, 1999), attaining accuracy rates near 80–90%. The majority of the obsidian artifacts in this study were subjected to visual sourcing due to its low cost. However, 19 artifacts were submitted for INAA to cross-check the visual results and 8 additional visual

unknowns were also sourced by INAA to assign a source group. Of the 19 sourced by INAA, 18 had been correctly assigned by visual means, a success rate over 90%. A similar rate of success was obtained for a larger sample of 102 obsidian artifacts from sites nearby (but not reported here).

Together, the visual and INAA sourcing studies demonstrate that the overwhelming majority of obsidian at Sunga'va was derived from the nearby Coso Volcanic Fields, 60 km to the southeast. Of the 24 projectile points, 22 were assigned to Coso, with the remaining two sourced to Fish Springs, which is located some 100 km to the north. Similarly 121 out of 126 bifaces and over 99% of the debitage was assigned to Coso. Table 2 sums up the sourcing data by tool type and component. Clearly, there is little difference between the two components in terms of source diversity. These results complement the findings of Delacorte and McGuire (1993) who found that 91 of 94 artifacts from Sunga'va were attributable to Coso. Together, this information suggests that the inhabitants of Sunga'va were obtaining almost all of their toolstone from the closest source. These results are consistent with what we would expect of a sedentary population (Basgall, 1989; Cowan, 1999; Parry and Kelly, 1987). Notably, long-distance exchange (or procurement) of obsidian seems to have been negligible.

Flaked and Ground Stone Tool Technology

Flaked stone artifacts recovered from Sunga'va were numerous, including nearly 200 formal tools, over 200 casual flake tools, and nearly 10,000 waste flakes. The vast majority of these were fashioned from obsidian. As well, 16 unusual slate implements that were flaked around the edge to achieve an oval shape were recovered (see Avina, 2002 for similar artifacts collected on Owens Lake playa). Some are gently worn along their proximal or distal ends suggesting they may have been used to cut or process root stalks, tubers, or other large plant product. Notable among the flaked stone is an emphasis on the expedient use of

Table 2. Sourcing Data by Component and Tool Type, Comparing Coso (Local) vs. Non-Coso (Non-Local) Sources

	Projectile point		Biface		Waste flake	
	Coso	Non-Coso	Coso	Non-Coso	Coso	Non-Coso
Early component total	4	1	16	2	45	1
Later component total	19	1	105	3	96	0
Site total	23	2	121	5	141	1
	(92%)	(8%)	(96%)	(4%)	(99%)	(0.7%)

flakes and other materials in cutting and scraping activities. Such tool kits are indicative of more sedentary societies (Kelly, 1988; Parry and Kelly, 1987). Table 3 tabulates the various stone tools by component, breaking the later component down into house floor vs. non-house floor contexts.

As seen, for every projectile point there are 5 biface fragments, 5.1 expedient flake tools, and 342 obsidian flakes within the early component. By comparison, in the later component house floor contexts there are 5.1 bifaces, 6.6 casual flake tools, and 359 obsidian flakes for every projectile point. This implies an increased emphasis on casual tools, and perhaps cutting activities, through time. Table 3 also shows non-obsidian (primarily chert) to be uncommon comprising less than 2% of all tools and flakes in both components. A Chi-square comparison of obsidian to non-obsidian flakes between the two components is not significant ($p = .49$). Thus, in terms of raw material composition the flaked stone assemblage is very consistent between the two components, being composed almost exclusively of obsidian (98%).

An examination of the groundstone also suggests an increase in the importance of grinding implements in the local technology through time. Handstones and millstones are about two to four times more common in the later component, depending on the control used to compare the two assemblage (i.e., volume excavated, number of flaked tools, etc.). If groundstone is used in the processing of small seed resources, as is usually assumed, this suggests an elevated importance of seeds in the diet through time. Although this result was not evident in the flotation studies, recall that one of the pit features at the later component was full of small seeds. It is possible that grinding stones were used in greater amounts later in time to occasionally process such stores of small seeds. As well, it is possible that the groundstone at Sunga'va was used to process other plant resources such as roots and tubers.

SUMMARY

The presence of large domestic structures over 5 meters in diameter that had been partially excavated into the original site soil and constructed using large timbers implies substantial investment of time into the construction of houses during both temporal components at Sunga'va. In addition, the presence of several pits in the later component, presumably used for storage, also implies some degree of planning for an extended period of occupation. Such pits were not found in the earlier component, though it is possible that additional excavations would reveal them. Combined with the obsidian sourcing, seasonality data from macrobotanical and faunal assemblages, and flaked stone tool-kit, the data from Sunga'va are consistent indicating that residents practiced low residential mobility during both components.

Whether this settlement pattern is "fully sedentary" or only "semi-sedentary" is unclear, and perhaps a fruitless exercise in classification. Most likely, inhabitants

Table 3. Flaked and Ground Stone Tools Recovered at Sunga'va Listed by Component

Area of site	Projectile point	Biface	Drill	Expedient flake	Obsidian flake	Non-obsidian flake	Flaked slate	Milling stone	Hand-stone
Early component total	5	25	0	26	1711	32	2	3	4
Later component total	23	137	3	177	7812	161	14	11	20
Later component— house floor	7	36	0	46	2510	73	2	8	13
Later component— non-house	16	101	3	131	5302	88	12	3	7
Site total	27	162	3	203	9523	193	16	14	24

of Owens Valley adjusted their mobility strategies to constantly changing conditions, and undoubtedly there was variation among groups of individuals, some being more or less mobile than others (e.g., Bocek, 1991; Kelly, 1983, 1992:49). However, it is clear that the degree of residential mobility practiced by the residents of Sunga'va is significantly less than by those occupying sites that have been dated to earlier periods. In this respect, Sunga'va marks an important transition in settlement patterns in the region.

REGIONAL COMPARISON

This section compares the assemblage from the two Sunga'va components to similar well-dated contexts from the region, focusing on the immediately preceding Newberry and subsequent Marana periods. Due to the nature of previous investigations, which have focused largely on areas within the U.S. Highway 395 right-of-way, the majority of these sites lie along a linear corridor along the valley bottom.

Features

The houses at Sunga'va are substantial, and the density of artifacts on the floors is quite high. In these respects, the houses are more reminiscent of late Newberry period houses that are frequently over 4 m in diameter and contain large amounts of refuse on their surfaces. By comparison, most Marana period houses are smaller and relatively clean (e.g., Basgall and McGuire, 1988; Bettinger, 1989; Delacorte, 1999). Similar results were obtained at Eagle Valley Village near Carson City, where Newberry houses are larger than their Marana counterparts (Clay, 1996). An exception to this pattern seems to occur at high altitude sites in the White Mountains, where Marana houses are quite large and contain high densities of refuse, though they often also contain Haiwee materials (Bettinger, 1991). However, the extreme conditions in high altitude tundra environments may have fostered alternative adaptations that may account for this apparent discrepancy.

Thus, in terms of house size and density of materials the Sunga'va structures are more like their earlier Newberry counterparts. This may indicate a continuance of the social composition of villages well into the middle of the Haiwee period (i.e., at least to 1160 BP). As well, it may also indicate greater site reoccupation rates or greater site permanence (i.e., sedentariness) during the late Newberry and early Haiwee periods than in the subsequent Marana period. Unfortunately, very few storage features and pits have been recorded from either Marana or Newberry contexts, and it is not possible to place the Sunga'va storage pits in a greater regional contexts. However, one external pit was recorded at nearby CA-INY-30 and radiocarbon dated to the Haiwee period (Basgall and McGuire, 1988). Thus, it is clear that storage was an important part of the cultural repertoire by at least the early Haiwee period.

Macrobotanical Remains

Table 4 lists the results of flotation analyses from other domestic contexts at Marana- and Newberry-aged sites in the region. The table indicates two important trends in regional seed use. First, although some Marana period contexts contain low numbers of seeds, all of the assemblages with high densities of seeds (i.e., greater than 50 seeds per liter) occur in this period. In other words, there is high variability but also a high average number of seeds in the Marana period. Perhaps significantly, all of these high-density assemblages date younger than 400 BP. On the other hand, Haiwee and Newberry period contexts are more consistent (i.e., less variable), but contain fewer seeds on average, typically between 10 and 20 per liter, with one Newberry house presenting an exception to this pattern. Second, diversity in the seed assemblage, as measured by the number of genera divided by the total number of seeds, is distinctively higher in Marana period assemblages. This indicates a real focus on particular species in the Marana. By contrast, Haiwee and Newberry period seed assemblages are much more diverse.

Table 4. Comparison of Flotation Samples from House Floors
in Southern Owens Valley

Period	Site	Context	¹⁴ C date (weighted)	Seeds/ liter	Genera/ seeds
Marana	Iny-30	Structure 9	180	3.4	3.4
	Iny-5207, Loc. 2	Structure 1	205	103	90.9
	Iny-3769, Loc. 13	Structure 1	293	2800	1000.0
	iny-30	Structure 10	360	63	71.4
	iny-30	Structure 8	370	4.3	4.6
	Iny-30	Structure 1	390	111	250.0
	Iny-30	Structure 5	410	19	6.3
	Iny-30	Structure 7	480	13	15.2
Haiwee	Iny-3769, Loc. 5	Structure 1	780	0.5	1.0
	Iny-3806	HF3	1160	10	8.2
	Iny-3806	HF1	1340	14	6.4
	Iny-3806	HF2	1445	21	5.8
	Iny-3812	Structure 1	1600	23	8.8
Newberry	Iny-30	Structure 11	1410	105	83.3
	Iny-30	Structure 15	1460	20	6.5
	Iny-30	Structure 12	1695	24	14.1
	Iny-30	Structure 14	1745	15	25.0

Notes: Data from Basgall and McGuire, 1988; Delacorte, 1999; Delacorte and McGuire, 1993; Eerkens, 1997; Gilreath, 1995.

Thus, the Sunga'va flotation assemblages are much more in line with Newberry patterns in terms of seed use. Although seeds are clearly being used, there does not yet appear to be any intensive seed use in the region at this time. If Marana period houses represent less permanent domiciles than their Haiwee and Newberry period counterparts, this pattern is particularly striking. That is, since they were occupied for a shorter period of time Marana houses would have had less time to accumulate seeds.

Obsidian Studies

Basgall (1989) discussed changes in obsidian use through time in the Inyo-Mono region and how these patterns reflected residential mobility strategies. He focused his analysis on the number of obsidian sources present, particularly as they relate to local (i.e., nearby) vs. non-local sources in both formal tool and debitage assemblages. His analyses clearly showed a change from relatively high source diversity during the Newberry and earlier periods, especially among formal tools such as bifaces and projectile points, to low source diversity during the Marana period among both artifact classes, with a focus on the most local source. For example, at CA-INY-30 non-local sources account for 42% ($n = 71$) of formal tools during the Newberry period, but only 17% ($n = 53$) of formal tools during the Marana period. Similarly, although the sample size is much smaller ($n = 24$) non-local sources account for 25% of formal tools in Haiwee-period assemblages from the site.

In this respect, the Sunga'va obsidian assemblages from both temporal components are more similar to Marana-period assemblages than earlier Newberry ones. However, the Sunga'va assemblages seem to take the use of the closest source to an extreme, where less than 4% of the formal tools comprise non-local sources. Delacorte and McGuire (1993) found a similar pattern of obsidian use at other Haiwee-period sites in the region. Thus, the focus on nearby and local obsidian appears to be a Haiwee phenomenon that carries over into later time periods and represents a marked departure from Newberry patterns. This may indicate smaller territories, shorter seasonal rounds, and/or reduced rates of exchange during the Haiwee period.

Flaked and Ground Stone Tool Technology

Table 5 compares flaked and ground stone tool assemblages associated with discrete radiocarbon-dated house floors in Owens Valley. Surprisingly, the table does not demonstrate a clear and significant increase in the importance of expedient versus formal flaked tools through time, as has been commonly assumed in the region (e.g., Basgall and McGuire, 1988; Delacorte, 1999). For example, the sixth column lists the ratio of expedient (utilized flakes) to formal (projectile points and bifaces) tools. From the table, it is not the case that all Marana assemblages contain higher frequencies of casual tools. Although the

Table 5. Flaked and Ground Stone Tools from Regional House Floor Assemblages

Site	Context	¹⁴ C date	Projectile point	Biface	Expedient/formal	Obsidian flake	Chert flakes	Groundstone
Iny-30	Structure 9	180	3	5	1.1	114	4.7%	0
Iny-5207, Loc. 2	Structure 1	205	8	25	0.4	1515	5.0%	3
Iny-3769, Loc. 13	Structure 1	293	1	6	0.3	137	27.4%	34
Iny-30	Structure 10	360	1	6	1.0	378	1.8%	3
Iny-30	Structure 8	370	1	0	14.0	168	5.7%	0
Iny-30	Structure 1	390	1	7	0.3	426	2.9%	5
Iny-30	Structure 5	410	1	6	0.4	212	6.1%	0
Iny-30	Structure 7	480	3	7	1.5	348	6.9%	3
Iny-30	Structure 13	710	8	36	1.3	1773	0.9%	3
Iny-3769, Loc. 5	Structure 1	780	1	0	2.0	61	16.1%	2
Iny-3806	HF3	1160	7	36	1.1	2510	5.9%	7
Iny-3806	HF1	1340	5	22	0.7	1464	1.7%	3
Iny-3806	HF2	1445	0	3	2.0	247	2.4%	4
Iny-3812	Structure 1	1600	5	27	2.5	2887	0.1%	0
Iny-30	Structure 11	1410	8	30	0.2	1125	0.2%	3
Iny-30	Structure 15	1460	5	29	0.5	498	0.8%	5
Iny-30	Structure 12	1695	4	75	1.1	4765	0.7%	13
Iny-30	Structure 14	1745	12	57	0.5	1865	0.5%	8

Notes: Expedient/Formal = Ratio of Expedient flake tools to formal bifacially flaked tools; Groundstone = sum of handstone and millingsstone fragments.

average is higher in the Marana period, there are many exceptions, highlighted by a single Marana floor that contains over ten times the number of flake tools as others. Part of the divergence from accepted notions about the importance of expedient tools later in time may relate to the context examined here, namely domestic ones. It is likely that houses would have been routinely cleaned of larger debris. Moreover, the hide-scraping and other cutting activities performed with expedient tools may not have been performed within houses. Indeed, if we examine the density of casual flaked tools in the later component at Sunga'va (Table 3), there is a higher density of expedient tools outside of the house than within it. On the other hand, in a broader comparison of assemblages from the Owens Valley region, Bettinger (1999b:44) found that casual flake tools are significantly less common in later (comprising both Haiwee and Marana) than in earlier (Newberry and pre-Newberry) contexts. Thus, the lack of low numbers of casual tools in Marana houses documented in Table 5 may be part of a larger regional pattern.

A second clearer trend is the increased importance of chert in the Marana period. Table 5 shows the percentage of chert flakes among debitage assemblages. Clear from the table is an increase from Newberry period assemblages, where chert comprises less than 1% of all flakes, to the Marana period where chert typically comprises between 2% and 7%. In terms of chert, the Sunga'va assemblages are much more in line with the later Marana than the earlier Newberry assemblages. The two earlier structures contain lower percentages (ca. 2% each) than the later floor (ca. 6%). This suggests that the rate of chert use may have increased gradually from the Newberry period, where less than 1% of flaking debris is of this material, to early Haiwee, where the amount doubled to 2%, to the middle Haiwee and onwards, where up to 6% was chert. Increasing use of chert may be related to decreased access to obsidian sources and/or changes in the direction and intensity of toolstone exchange relations.

Finally, as shown in Table 5, there is no clear increase in the density of groundstone through time. Thus, relative to other artifact categories, Newberry, Haiwee, and Marana houses contain approximately equal numbers of millings and handstones. This result is also not in line with what is generally known in Owens Valley, where seed consumption and grinding activities are perceived to have increased after the Newberry period. However, like with casual flaked stone tools, this may have more to do with the spatial context of this analysis than overall changes in milling behaviors. In other words, grinding tools may not have been kept inside the house, were disposed of outside it, or much of the grinding of foods may have taken place outside. In this respect, the three Sunga'va houses do not have particularly high or low numbers of groundstone artifacts relative to other time periods.

DISCUSSION AND CONCLUSIONS

Sunga'va is an important site because it fills a major temporal gap in our understanding of Owens Valley and regional prehistory. The site contains two spatially-discrete temporal components dating to the Haiwee period (ca. 1350–650 BP). Prior to excavation at this site, it was clear that there were major changes in settlement, subsistence, and material technology from the preceding Newberry period (ca. 3500–1350 BP) to the succeeding Marana period (ca. 650–150 BP). However, it was unclear what exactly happened within the intervening Haiwee period. For example, were these changes part of a single broad-sweeping cultural overhaul or did particular elements change independently of others. If we combine the findings at Sunga'va with those of other domestic contexts in the region and assume they are representative of regional trends, several interesting patterns emerge.

First, analysis of the artifact assemblage at Sunga'va suggests that the residents of southern Owens Valley were relatively sedentary (residentially) during the early part of the Haiwee period. The effort expended on the construction of large and semi-subterranean houses in both temporal components implies that residents intended to spend a long period of time in this location (e.g., Gilman, 1987; Kent, 1991, 1992; see also Panja, 2003; Smith, 2003). As well, the distribution of flaked stone raw materials suggests nearly exclusive use of local materials, as would be expected of more sedentary groups. Finally, seasonality data from the charred seeds and faunal assemblage (currently under analysis by Stephanie Livingston) suggest that residents were living at this location from at least spring through late fall. Given the dearth of winter indicators in the region and evidence for storage facilities at the site, year-round occupation seems likely. This sedentary pattern is a departure from Newberry strategies and seems to carry over into the Marana period. In fact, there are some indications that the degree of sedentism during the Haiwee period was even greater than the ensuing Marana period.

Second, the intensive harvesting of small seeds witnessed during the Marana period was not yet in place when Sunga'va was occupied. Despite analysis of multiple flotation samples from a range of contexts, only one sample from a pit feature contained charred seeds in comparable densities to that typically seen later in time. In this respect, the site appears much like Newberry sites from the region. Overall, the charred seed assemblage from Sunga'va reflects a more generalized and low intensity plant collection strategy. This strategy appears to have included root and tuber harvesting. All of this suggests that sedentism was not a response to an increase in the use of seed resources, for example, to maintain territorial control over productive seed patches (e.g., Henry, 1989:35). That sedentism precedes plant intensification is very much in line with the conclusions reached by Rafferty (1985) on the Columbia Plateau and Green (1993) in the northeast corner of the Great Basin (i.e., southern Idaho). Yet, it is unlike those reached by Basgall (1987) for acorn intensification in northern California and incipient agriculture in the

Southwest which precede sedentism (e.g., Gilman, 1987; Powell, 1983; Stokes and Roth, 1999; Wills, 1988). These factors suggest that reasons behind the transition to more sedentary lifestyles were quite different in the Great Basin than in California and the Southwest.

Third, while the faunal analyses are not yet complete, they appear to reflect an intensive focus on water fowl, with little emphasis on large game. If true, such a pattern would be unlike Newberry sites, which typically contain ample large game (Hildebrandt and McGuire, 2002). At the same time, this pattern is also unlike the succeeding Marana period, where sites typically have more small mammal bone. From this we can conclude that Haiwee hunting patterns shifted away from large game and moved towards smaller animals, a pattern that continued into the Marana period though it focused on different animals. This shift is likely a result of the introduction of the bow and arrow, which as Bettinger (1999a) has recently argued is more conducive to individual hunting. Individual hunting of smaller animals may have been an attempt to move away from resources that were subject to automatic sharing such as large game (Bettinger, 1999a).

Fourth, the presence of at least three pits at Sunga'va, all associated with the later component, suggests that storage was an important component of prehistoric living by at least the middle of the Haiwee period. Unfortunately, such features have only rarely been recorded at sites in the valley and it is not possible to state whether the frequency and/or intensity of storage increased or decreased through time. The lack of storage facilities in the earlier component at Sunga'va hints that sedentism may have developed slightly before storage became important. This also suggests that storage preceded seed intensification. Of some interest is that two of the three storage pits were constructed out in the open where they may have been accessible to all members of the village. In other words, they and their contents may have been publicly rather than privately owned. Thus, although small game may have been privatized by use of the bow and arrow (Bettinger, 1999a), not all resources may have been similarly treated. An interesting line for future research would be to take a broader regional perspective and examine the spatial context of storage features through time to see if there is a consistent shift in the location of such features from public to more private (i.e., within houses) contexts. Given the small number of storage features that have been excavated to date, the notion of public versus private resource ownership must remain speculative.

Fifth, although the site has less to say about the shift from formal to expedient stone tools, it appears that the transition to increased use of chert probably took place during the middle of the Haiwee period. That is, while the earlier component at Sunga'va had little chert, the later component had a higher percentage, similar to other Marana assemblages. As well, there is little evidence for long distance exchange at either of the Sunga'va components. Outside of a very small number of exotic obsidian projectile points and a handful of marine-shell beads, there are few items within the artifact assemblage that were traded into the valley from

outside it. This contrasts with many later Marana assemblages (e.g., Basgall and McGuire, 1988) that often have large numbers of marine shell and steatite beads, among other exotic goods. All of this suggests that sedentism probably developed before the development and stabilization of long-distance exchange networks. This does not provide support for some of the social models that have been advanced to explain the development of sedentism in other areas (e.g., Bender, 1985; Kaufman, 1992; Lourandos, 1985).

In the last analysis, the excavations at Sunga'va and comparison to other well-dated sites in the region suggest that late prehistoric culture change in the Owens Valley took place in a piecemeal fashion. There was not a single shift encompassing settlement, subsistence, storage, exchange, and technological transformation around 1500 BP. Instead, these changes seem to have taken place one or two at a time over the course of nearly a millennium, perhaps in response to one another. It appears that significant reductions in residential mobility came to pass first. This change appears to have been coeval with the introduction of bow and arrow technology and a focus on small game in hunting activities. This was followed by the development of storage, which was often out in the open. Finally, an intensification on small seeds (and by extension, proto-agriculture) and the development of long-distance exchange networks (and by extension, social inequality) came about long after these earlier changes. Seed intensification seems to have been accompanied by a marked increase in pottery use and the privatization of gathered resources (Eerkens, 2001).

One factor that is an important component of most models explaining the development of sedentism is population pressure. In fact, some (e.g., Rosenberg, 1998) see population pressure as the single most important factor behind sedentism, and it has been used much in Owens Valley to explain culture change (e.g., Bettinger, 1978, 1982; Bouey, 1979; Delacorte, 1999, though see Bettinger, 1999a). Unfortunately, it is difficult to measure population pressure, particularly from the remains of a single site. Presently, it is unclear if the population-resource balance significantly decreased (either through population increase or resource abundance decrease), prior to the Haiwee period or after it, or whether it was constantly decreasing throughout all of prehistory. Thus, I am unable to directly evaluate the role of this factor in the development of sedentism. However, the lack of appreciable numbers of sites dating to the early Haiwee period and the absence of any apparently significant climatic change around 1500 BP does not suggest that the population-resource base deteriorated at the time sedentism developed.

Clearly, Sunga'va is just one site that represents a fraction of the total archaeological record. Indeed, all the sites excavated to date probably still represent just a fraction of this record. However, there is enough consistency in the sites that have been excavated to begin painting larger regional pictures about change in prehistory. The sequence of developments in Owens Valley suggests that some models are more inappropriate for explaining the shift to

sedentism and intensive seed processing. Additional excavations and analyses in the region will help to evaluate other factors that I could not, such as population pressure, and to fill in additional details about prehistoric cultural evolution in the region.

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