Journal of California and Great Basin Anthropology
Vol. 16, No. 1, pp. 106-117 (1994).

A Descriptive Reanalysis of the Leporid Bones from Hogup Cave, Utah

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A total of 18,208 leporid bones from Hogup Cave was analyzed. Approximately 1% of the assemblage bore clear evidence of human modification (cut-marks and breakage patterns) while 8% showed clear evidence of nonhuman modification (digestive damage, presence in scat and pellet matter, and puncture marks). Raptors probably modified the majority of the latter group. The culturally modified bone pattern was consistent through time, suggesting a consistency of behavior throughout the occupation of the site, as predicted by the Desert Culture concept.

ARCHAEOLOGICAL excavations at Hogup Cave unearthed a host of artifact classes and thousands of animal bones (Aikens 1970). Of the estimated 3,440 individual animals recovered from the excavatons, 2,022 (59%) were leporids (cottontails [*Sylvilagus* sp.] and hares [*Lepus* sp.]) (Durrant 1970). Because Hogup Cave was excavated well before taphonomy began playing an important role in archaeofaunal analysis, initial interpretations about the aboriginal use of leporids near Hogup Cave were largely based on the association of bones with other artifacts such as netting fragments (Aikens 1970:97). Artifact and bone associations have continued to form the basis of interpretation of the Hogup leporid bones:

> From the dry cave sites have come abundant fragments of netting and netting twine made of twisted fibers of Indian hemp (*Apocynum*) and other plants. At Hogup Cave in particular, in the Wendover period deposits there was a strong correlation between the abundance of jackrabbit and cottontail bones and the abundance of netting and cordage fragments. In later periods, when the quantity of rabbit bones declined, so did the quantity of netting fragments. Thus the Wendover period people, like those of historic times in the same region, probably stretched long nets to form broad cul-de-sac traps into which numbers of rabbits could be driven, trapped, and killed during communal hunts [Aikens and Madsen 1986:155].

According to Aikens and Madsen (1986), prehistoric people hunted leporids more frequently during the Wendover Period and the first half of the Black Rock Period (before 3,250 years B.P.) than afterwards (Table 1).

With these previous interpretations in mind, this paper focuses on answering three questions about the Hogup Cave leporid bones: (1) were the bones deposited by human activity, or by nonhuman agents such as raptors, woodrats, and mammalian carnivores? (2) would reanalyzing the Hogup Cave leporid bones change current interpretations about the role these animals played in the prehistoric subsistence diet near Hogup Cave? and, relatedly, (3) is there good evidence that leporid hunting occurred much more frequently before 3,250 years B.P. than at any time thereafter, as Aikens (1970) and Aikens and Madsen (1986) have suggested?

SITE LOCATION AND STRATA

Hogup Cave is a limestone cavern located in the Hogup Mountains in the Great Salt Lake Desert, northwestern Utah. The cave rests approximately 1,432 meters (4,700 feet) above sea level, and was submerged underwater during high stands of Pleistocene Lake Bonneville (Benson et al. 1990; Dorn et al. 1990; Thompson 1990; O'Connor 1993). Aikens directed

Table 1
INITIAL INTERPRETATIONS OF THE FREQUENCY OF LEPORID HUNTING AT HOGUP CAVE IN RELATION TO THE 16 STRATA, THE FOUR SETTLEMENT UNITS DEFINED BY AIKENS (1970), AND THE FIVE PREHISTORIC PERIODS OUTLINED IN AIKENS AND MADSEN (1986)

Date (years B.P.)	Hogup Cave Strata	Hogup Cave Settlement Group	Prehistoric Period	Frequency of Leporid Hunting
150	|	|	|	|
650	15, 16	IV	Numic	|
1,000	|	|	|	|
	12, 13, 14	III	Fremont	|
2,000	|	|	|	|
3,000	9, 10, 11	II	|	declines
4,000	|	|	|	|
5,000	|	|	|	|
6,000	8	|	Black Rock	|
7,000	|	|	|	|
8,000	1, 2, 3, 4, 5, 6, 7	I	|	|
9,000	--	--	|	frequent
			Wendover	--
10,000	--	--	|	--
11,000	--	--	Bonneville	--

excavations in Hogup Cave during the summers of 1967 and 1968. Three-quarters of Hogup Cave's deep outer chamber and portions of a shallower inner chamber were systematically excavated during the two field seasons.

Aikens (1970) divided the Hogup Cave sediments into 16 stratigraphic layers. He further subdivided these strata into four settlement units "characterized by a distinctive configuration of artifact types and frequencies and by a correlated and equally distinctive pattern of frequency distributions of plant and animal species" (Aikens 1970:187-188). The Hogup Cave deposits range in age from 8,500 years B.P. (Stratum 1) to 150 years B.P. (Stratum 16) (Table 1).

THE LEPORID BONES FROM HOGUP CAVE

Element Frequencies and Burning Patterns

The Number of Identified Specimens (NISP), Minimum Number of Elements (MNE), and the Minimum Animal Units (MAU) of all the leporid bones recovered from Hogup Cave are shown in Table 2. These data were derived by adding the NISP, MNE, and MAU values for each of the 16 strata defined in Hogup Cave (see Hockett 1993:147-162). Figure 1 graphically illustrates the MNE data presented in Table 2.

Table 2 reports that 18,208 identifiable leporid bones were recovered from Hogup Cave, excluding the unprovenienced bones. Of this total, 12,035 bones are from jackrabbits, 966 bones from cottontails, and 5,207 bones were identified only as leporid. These bones represent the remains of at least 1,402 individual animals.

Durrant (1970:243) estimated that 2,022 individual leporid animals (mimimum number of individuals, MNI) were deposited in Hogup Cave. The MNI estimate of 1,402 animals is substantially less than Durrant's estimate. Durrant's MNI estimate was apparently based

Table 2
NUMBER OF IDENTIFIED SPECIMENS (NISP), MINIMUM NUMBER OF ELEMENTS (MNE), AND MINIMUM ANIMAL UNITS (MAU) OF THE LEPORID BONES FROM HOGUP CAVE, UTAH

Taxon/ Element	Lepus			Sylvilagus			Unidentified Leporid
	NISP	MNE	MAU	NISP	MNE	MAU	
mandible	3,557	2,636	1318.0	210	133	66.5	--
maxilla	914	914	457.0	58	58	29.0	--
innominate	1,066	1,004	502.0	168	168	84.0	--
sacrum	58	58	58.0	25	25	25.0	--
femur	641	320	160.0	147	96	48.0	--
tibia	900	428	214.0	88	65	32.5	--
calcaneus	397	397	198.5	23	23	11.5	--
astragalus	77	77	38.5	1	1	0.5	--
scapula	2,021	1,518	759.0	54	43	21.5	--
humerus	1,342	985	492.5	127	102	51.0	--
radius	581	348	174.0	28	24	12.0	--
ulna	481	447	223.5	37	37	18.5	--
SUBTOTALS	12,035	9,132	1,318.0[a]	966	775	84.0[a]	--
skull	--	--	--	--	--	--	1,335
teeth	--	--	--	--	--	--	276
vertebra	--	--	--	--	--	--	1,620
rib	--	--	--	--	--	--	135
carpal/tarsal	--	--	--	--	--	--	224
metapodial	--	--	--	--	--	--	923
phalange	--	--	--	--	--	--	694
NISP SUBTOTAL	12,035			966			5,207
GRAND TOTAL NISP				18,208			

[a] greatest MAU value used as an estimate of minimum number of animals represented in the sample.

solely on the greater number of left versus right mandible portions per stratum. The 1,402 MNI figure was derived by dividing in half the number of complete mandibles plus the greater number of anterior versus posterior mandible fragments per stratum.

Figure 1 shows that the mandible was identified far more frequently than any other leporid element recovered from Hogup Cave. Scapulae and innominates were the only other bones that were consistently recovered in large numbers in the cave, but their MNE values were far less than that for the mandible.

It is impossible to state with certainty who or what deposited large numbers of leporid mandibles inside Hogup Cave. Human and nonhuman behaviors are both known to accumulate large numbers of leporid mandibles on the landscape. For example, leporid mandibles were abundant at site 26Ny3393, in southern Nevada (Hockett 1992), and at the Huffaker Hills and Vista sites near Reno, Nevada (Schmitt 1986; Dansie 1991). The leporid bones from 26Ny3393, the Huffaker Hills sites,

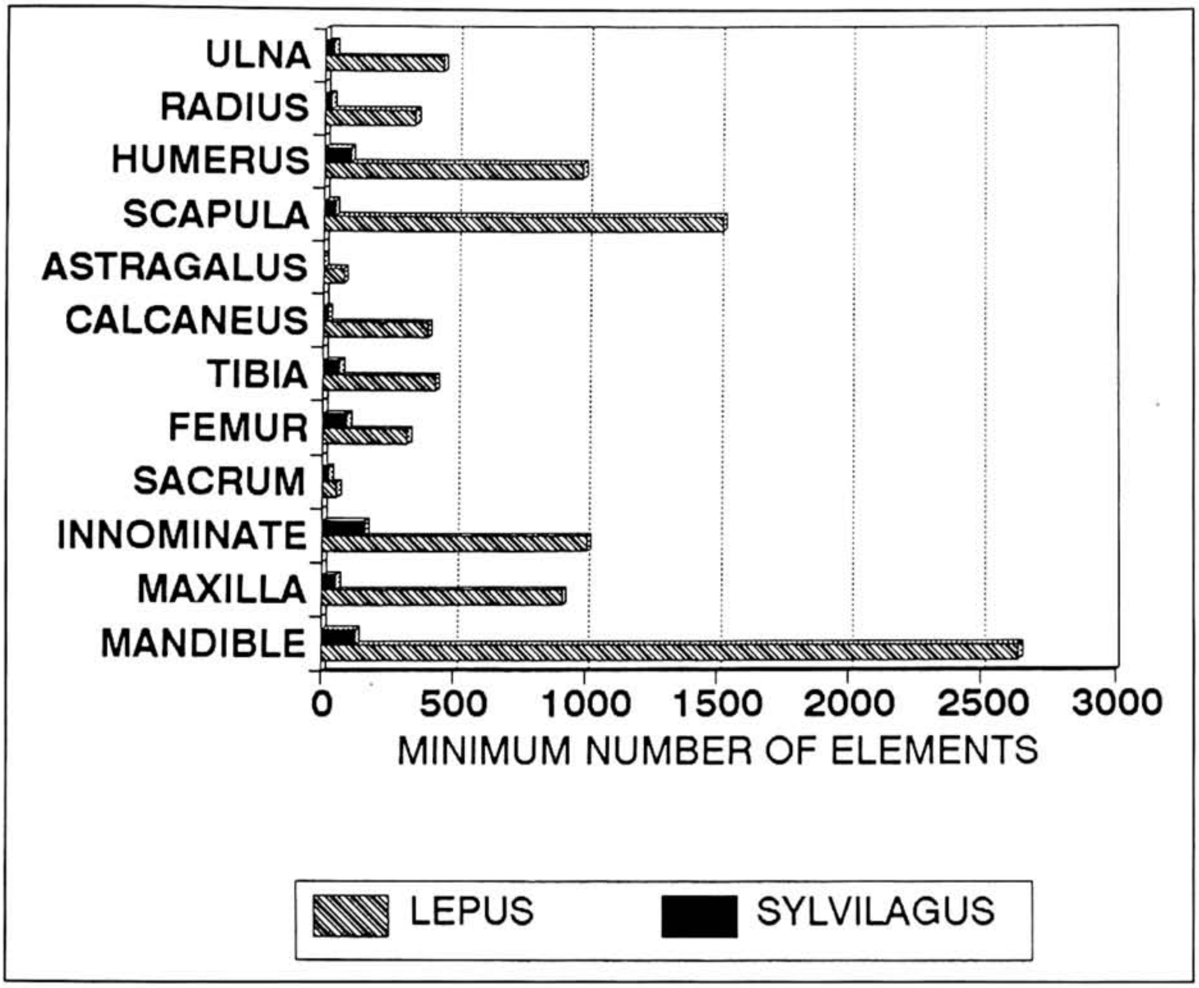

Fig. 1. Minimum Number of Leporid Elements recovered from Hogup Cave, Utah.

and the Vista site were recovered from open-air hearth and trash pit features. At these three sites, leporid mandibles were identified more frequently than many other leporid bones because humans had pounded the vertebrae, sacra, and the ends of long bones with milling stones (Schmitt 1986; Schmitt et al. 1986; Dansie 1991; Hockett 1992). This processing behavior removed many specimens of vertebrae, sacra, and long bones from the identifiable bone assemblages. Steward (1941:232, 1945:304, 364) ethnographically documented the differential destruction of small animal vertebrae and the ends of long bones by the Nevada Shoshoni, the Lemhi Shoshoni and Northern Paiute-speaking Bannock of Idaho, the Grouse Creek, Promontory Point, Cache Valley, and Skull Valley Shoshoni of Utah, and the Pahvant Ute of Utah.

Similarly, an assemblage of leporid bones created by raptors at Edwards Air Force Base, California, exhibited almost exclusively leporid mandibles and crania (Hockett 1989). This leporid bone assemblage was created below a feeding station frequented by raptors. The leporid carcasses were apparently beheaded at the feeding station, and the remains of the carcasses subsequently were carried off to another location.

If leporid mandibles were common at Hogup Cave because humans had differentially pounded the vertebrae, sacra, and the ends of long bones with milling stones, then many unidentifiable bones should have been recovered from the cave. For example, because humans pounded leporid bones with milling stones at 26Ny3393, over 2,000 small, unidentifiable bone fragments were recovered from the excavations. This figure represents 55% of the total number of identifiable and unidentifiable leporid-sized bone fragments recovered from the site. Additionally, approximately 60% of the unidentifiable bones were burned. Similar patterning has been observed at several archaeological sites located in western Nevada, except that the majority of these sites exhibited greater percentages of unidentifiable bones than did 26Ny3393 (Schmitt 1986, 1990a; Dansie 1991).

At Hogup Cave, only 510 (2.7%) unidentifiable leporid-sized bone fragments were recovered, and only 82 (16%) of these bones were burned. The small number of burned and unidentifiable leporid-sized bone fragments recovered from Hogup Cave could indicate that nonhuman agents deposited hundreds of leporid mandibles inside the site. The low number of unidentifiable fragments could also be due to the use of 1/4-in. screens during excavations in the cave since heavily fractured leporid-sized bones may easily pass through that screen size (Shaffer 1992; Hockett 1993). Aikens (1970:3), however, stated that screening experiments conducted during the excavation of Hogup Cave demonstrated that few bones were lost through the screens. Aikens (1970:3, emphasis added) also stated "All artifacts, however fragmentary, and *all bones except for small, unidentifiable scraps and splinters* (a small proportion of the total quantity) were collected."

Did humans process leporid carcasses with milling stones inside Hogup Cave, and did the majority of the unidentifiable bone fragments fall through the 1/4-in. screens? Did nonhuman agents such as raptors deposit large numbers of skulls and mandibles inside the cave? Unfortunately, these questions cannot be adequately addressed unless it is demonstrated that the frequencies of leporid specimens recovered from Hogup Cave were not adversely affected by the use of 1/4-in. screens.

A total of 803 (4.5%) of the 18,208 identifiable leporid bones was burned. Some of these bones may have been directly burned by humans roasting leporid carcasses inside the cave, but many were probably accidentally burned by either human or nonhuman set fires (Aikens 1970; Grayson 1988). Aikens (1970:25-26) stated that extensive portions of the Hogup Cave deposits were inadvertently burned by humans setting fires on unprepared surfaces in the cave. These fires undoubtedly burned leporid bones that were buried in deeper strata and not associated with roasting activities. For example, nine leporid bones that displayed carnivore tooth or raptor beak/talon puncture marks were also burned. For this reason, the number of bones burned by humans deliberately roasting leporid carcasses cannot be clearly defined at Hogup Cave.

Culturally Modified Leporid Bones from Hogup Cave

The large number of leporid mandibles, together with the presence of burned bones, may or may not indicate that humans deposited large numbers of leporid bones inside Hogup Cave. Three other taphonomic traces suggest, however, that humans probably did deposit hundreds of leporid bones inside the cave. First, Aikens (1970:95, Figs. 59c and 59d) illustrated two sets of leporid metapodials that were bound together with sagebrush bark. These 15 leporid bones were clearly artifactual. These bones may have been stored in the cave with the intent of manufacturing bone beads at a later date.

Second, 15 of the Hogup leporid bones were cut by stone tools. Eight bones exhibited butchery or skinning marks (Fig. 2a, b), and

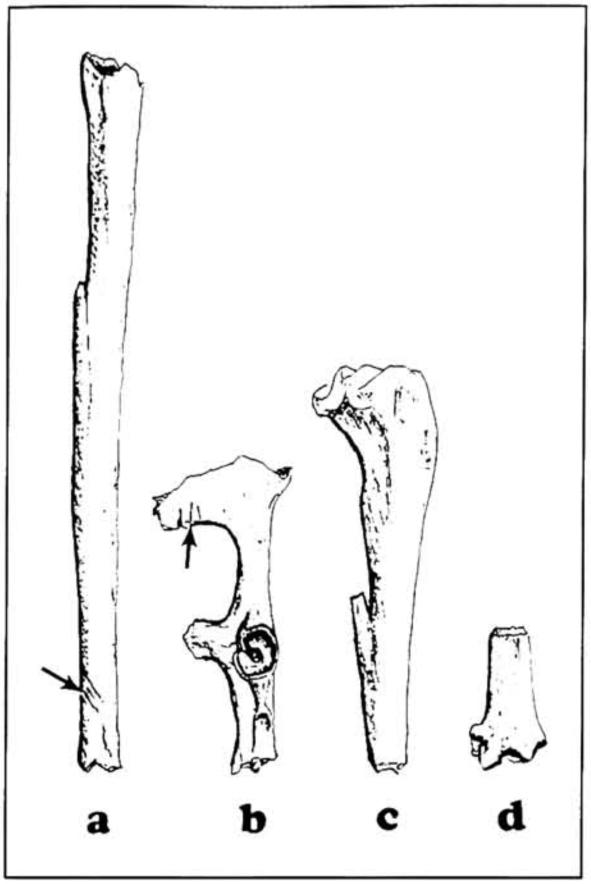

Fig. 2. Cut leporid bones from Hogup Cave: (a) *Lepus* tibia diaphysis cylinder with butchering marks from Stratum 5; (b) *Lepus* innominate with butchering marks from Stratum 4; (c) bone bead manufacturing waste tube from Stratum 6; (d) bone bead manufacturing waste tube from Stratum 3.

seven bones were cut during the manufacturing of bone beads (Fig. 2c, d; see also Aikens 1970:93, Fig. 52f). The recovery of only eight bones that displayed butchery marks corroborates previous research that suggests few bones are cut during the butchery of small to medium-sized fauna (Jones 1983; Simonetti and Cornejo 1991). Additionally, smaller carcasses generally are not cut up as frequently during processing as are larger carcasses (Lyman 1992). The seven waste tubes suggest that the occupants of Hogup Cave utilized the groove-and-snap technique to manufacture bone beads from leporid bones.

Third, 211 adult *Lepus* tibia diaphysis cylinders (LTDCs) were recovered from Hogup Cave (see Fig. 3 for examples). Of these, three were waste tubes from the manufacturing of bone beads (see Fig. 2c, d), and 12 were recovered from unprovenienced strata. A total of 196 provenienced LTDCs was therefore recovered from the cave, excluding the waste tubes.

Humans probably deposited the majority of the LTDCs in Hogup Cave because these bones were four times as common in the cave as they were in recently analyzed leporid bone assemblages created by raptors and woodrats (Hockett 1989, 1991, 1993). Nearly 2% of the 12,035 provenienced *Lepus* bones from Hogup Cave were LTDCs. In contrast, LTDCs constituted less than one-half of one percent of the identifiable leporid bones recovered from raptor pellets, raptor nests, and woodrat nests (Hockett 1991, 1993). Additionally, five of the eight leporid bones that showed butchery or skinning marks were LTDCs. The occupants of Hogup Cave, therefore, often obtained bone marrow from the medullary cavity of *Lepus* tibiae by snapping the proximal and distal ends off these bones. Once the marrow was extracted, a few LTDCs probably were utilized in the manufacture of beads (see Schmitt 1990b).

Nonculturally Modified Leporid Bones from Hogup Cave

Five taphonomic traces indicate that nonhuman agents deposited leporid bones inside Hogup Cave. First, each leporid bone was examined for corrosive damage caused by the gastric digestive fluids of carnivores and raptors (Mayhew 1977; Andrews and Evans 1983; Andrews 1990; Fernandez-Jalvo and Andrews 1992; Schmitt and Juell 1994), and for scat/pellet matter that may have adhered to notches or cavities in the bone. A total of 1,052 bones (6%) had corrosive damage or scat/pellet matter adhering to them (Table 3).

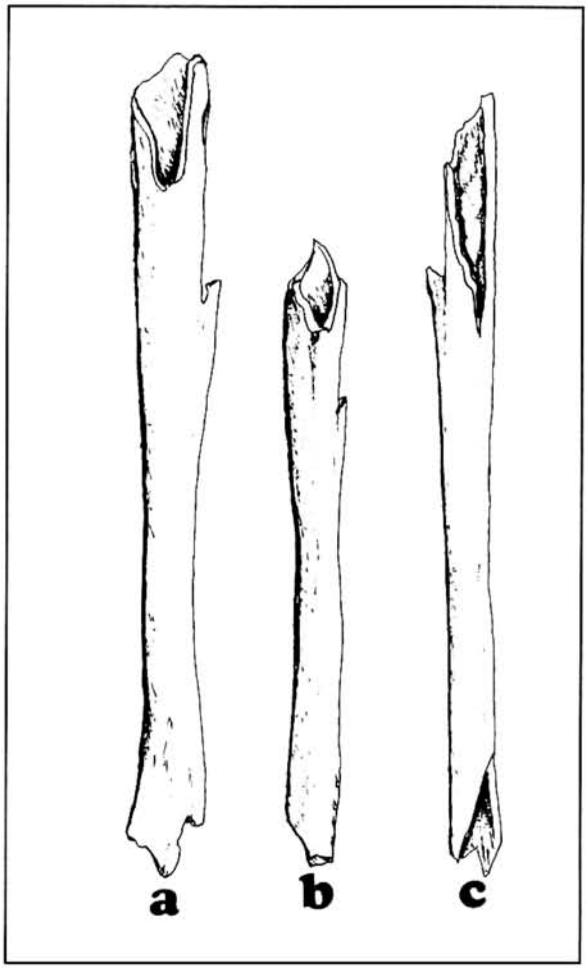

Fig. 3. *Lepus* tibia diaphysis cylinders from Hogup Cave: (a) Stratum 2; (b) Stratum 10; (c) Stratum 14.

Corrosive damage was most often recognized on calcanei and proximal ulnae. Scat/pellet matter was frequently found packed in the medullary cavity of broken limb bones, in the body canals of vertebrae, in the acetabular fossa of innominates, and in the distal ends of humeri. Unfortunately, the Hogup Cave leporid bones had been washed in the laboratory, and this may have removed all traces of scat/pellet matter from some of them. Nevertheless, the bones that still had scat/pellet matter adhering to them add to the total number of leporid bones that were assigned to a nonhuman component.

The majority of leporid bones that had scat/pellet matter adhering to them measured greater than 2 to 3 cm. in length, and they generally showed minimal signs of corrosive damage. These taphonomic traces are characteristic of leporid bones that have been regurgitated by owls. Although similar bones have been found in carnivore scats, they are relatively rare compared to the number of large, minimally corroded bones typically found in owl pellets (Andrews 1990; Kusmer 1990; Hockett 1991).

Second, 323 (2%) leporid bones were punctured by carnivore teeth or by the piercing action of raptor beaks or talons (Table 3 and Fig. 4). This figure compares favorably with the percentage (approximately 2%) of leporid bones that were found to be punctured in several samples of raptor pellets and raptor nests that have been examined (Hockett 1991, 1993). Additionally, approximately 40% of the 323 punctured bones were innominates, and almost 90% of these bones were punctured behind the acetabular fossa (see Fig. 4b). Given the frequency of punctured innominates and mark locations, raptors probably punctured the majority of these specimens (see Hockett 1991, 1993).

Third, raptors may cause scissoring-like damage to leporid bones, and in particular to innominates and proximal femora. Twelve leporid innominates from Hogup Cave displayed scissoring-like damage (Fig. 4d).

Fourth, raptors sometimes damage the greater trochanter of femora (Hockett 1989, 1991, 1993). During carcass dismemberment, raptors sometimes "shear" off the greater trochanter, creating a scissoring-like damage pattern on the bone. The greater trochanters of 31 femora from Hogup Cave were damaged in this manner.

Fifth, raptors and woodrats may damage proximal tuberosities of tibiae. Raptors sometimes break or shear off proximal tuberosities of leporid tibiae during carcass

Table 3
DAMAGED LEPORID BONES FROM HOGUP CAVE, UTAH

Strata	Total NISP[a]	No. LTDC[b]	No. cut[c]	No. pellet/scat	No. punctured
15-16	303	2	0	10	4
12-14	2,146	30	3	42	23
9-11	1,139	15	2	77	20
1-8	14,620	149	9	923	276
Totals	18,208	196	14	1,052	323

[a]number of identified specimens
[b]*Lepus* tibia diaphysis cylinders; 15 LTDCs recovered from unprovenienced strata not included
[c]one cut bone recovered from an unprovenienced context not included

dismemberment. Woodrats create a similar damage pattern by gnawing on proximal tibiae (Hockett 1993), but unlike raptors they leave tooth markings on the bone. Five proximal tibial tuberosities that did not display tooth markings were damaged at Hogup Cave. These data strengthen the interpretation that raptors played a prominent role in the deposition of the Hogup Cave leporid bones.

DISCUSSION

The three questions posed at the beginning of this paper are discussed below. First, were the majority of leporid bones deposited in Hogup Cave by humans or nonhuman agents? A total of 1,664 (9.1%) of the 18,208 provenienced leporid bones recovered from Hogup Cave was assigned to either a human or a nonhuman component. Based on the above analysis, humans and raptors were both major contributors of leporid bones inside Hogup Cave.

Three taphonomic traces indicate that humans deposited at least 241 (1.3%) of the 18,208 leporid bones identified from Hogup Cave. Fifteen unmodified leporid metapodials were bound together with sagebrush bark, 15 bones were cut by stone tools, and 211 LTDCs were recovered.

A total of 1,423 (7.8%) leporid bones displayed taphonomic traces that indicate they were deposited in Hogup Cave by nonhuman agents. Of these, 1,052 (74%) showed corrosive damage or had pellet/scat matter adhering to them, 323 (23%) had puncture marks on them, the greater trochanter of 31 femora (2%) were damaged, 12 bones (1%) displayed scissoring-like damage, and five proximal tibial tuberosities (0.07%) were damaged.

As mentioned above, raptors probably deposited the majority of these bones inside Hogup Cave. It may also be noted that Hogup Cave continues to serve as a roosting site for raptors. I visited the cave in early April, 1991. During my visit, I frightened two prairie falcons (*Falco mexicanus*) from a large nest located near the entrance to the cave. Later that month, Brooke Arkush of Weber State University discovered two great-horned owls (*Bubo virginianus*) nesting in the back portion of Hogup Cave (B. Arkush, personal communication 1993).

Second, would reanalyzing the Hogup Cave leporid bones change previous interpretations about the role these animals played in the aboriginal diet, and third, did leporid hunting occur more frequently before 3,250 years B.P.

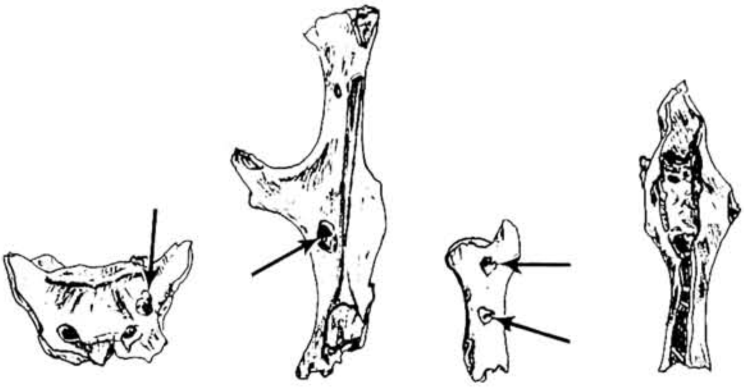

Fig. 4. Hogup Cave leporid bones damaged by nonhuman agents: (a) *Lepus* sacrum with puncture mark from Stratum 4; (b) *Lepus* innominate with puncture mark from Stratum 12; (c) *Lepus* scapula with puncture marks from Stratum 6; (d) *Lepus* innominate with shearing damage from Stratum 6.

than afterwards? Aikens (1970) and Aikens and Madsen (1986) concluded that humans had hunted leporids near Hogup Cave for a very long time, perhaps as early as 8,500 years ago. They are most likely correct. The 15 cut leporid bones and the 211 LTDCs were recovered from the earliest to the latest strata identified in Hogup Cave (Table 3). This suggests that the human occupants of Hogup Cave butchered leporid carcasses, created bone beads from leporid bones, and broke the proximal and distal ends from *Lepus* tibiae in order to obtain bone marrow for at least the past 8,000 years.

Aikens and Madsen (1986) also suggested that humans had deposited more leporid bones inside Hogup Cave during the Wendover Period and the early stages of the Black Rock Period (before approximately 3,250 years B.P.) than any time thereafter. Unfortunately, this interpretation cannot be tested with confidence. The only data that might address this interpretation are the number of *Lepus* tibia diaphysis cylinders (LTDCs) deposited through time in the cave. It is unclear, however, whether the number of LTDCs deposited in Hogup Cave accurately reflect the frequency of leporid carcass processing that occurred through time.

It may be noted, however, that LTDCs were deposited about as frequently during the Fremont occupation of Hogup Cave as during the previous 6,500 years of occupation in the cave (see Hockett 1993:196, Table 7.36). People who included domesticated crops in their diet, therefore, deposited LTDCs in Hogup Cave as frequently as did the strictly hunter-gatherer populations that occupied the cave during earlier time periods.

Leporid bones that displayed one or more of the taphonomic traces created by nonhuman agents, however, were more numerous and were deposited in greater frequency in strata that dated before 3,250 years B.P. than in strata that dated after 3,250 years B.P. (Table 3; also see Hockett 1993:201, Table 7.37). These data corroborate Harper and Alder's (1970) interpretation that fewer nonhuman animals utilized the cave and surrounding habitats after 3,250 years B.P. due to environmental deterioration. Mehringer (1986) attributed this environmental deterioration to rising lake levels which inundated freshwater springs and destroyed marshland habitat near the cave. Thus, there simply may have been fewer leporids available near Hogup Cave for humans and other animals to hunt after 3,250 years B.P.

CONCLUSION

This taphonomic analysis made it possible to discern that humans deposited at least 241 leporid bones inside Hogup Cave. Nonhuman agents deposited at least 1,423 leporid bones inside the cave. These data are important, but approximately 91% of the leporid bones recovered from Hogup Cave could not be assigned to either a human or a nonhuman component.

Compared to Hogup Cave, leporid bones recovered in strong cultural context, such as those from open-air hearth and trash pit features, would offer more details of prehistoric human ecology. For example, an analysis of nearly 4,000 leporid bones recovered from an open-air hearth/trash pit at site 26Ny3393, in southern Nevada, revealed that the site was probably occupied during the late fall or winter months, and the axial skeleton minus the skull was differentially destroyed during processing of the carcasses. Because the inhabitants of the site did not utilize all the nutrients that could have been extracted from the leporid carcasses, it was suggested that the site may have been occupied during mild winter conditions, or perhaps population size and density were not critical factors in shaping the intensity of resource use at the time the site was occupied (Hockett 1992). These types of interpretations simply cannot be offered for Hogup Cave due to the large number of predators and collectors that called the cave home.

Issues such as the continuity or variability in the treatment of leporid bones and carcasses through time at Hogup Cave can therefore only be addressed in a general way. There was, however, a consistent pattern in the prehistoric human use of leporids through time at Hogup Cave. The patterns of hunting leporids, creating adult LTDCs to extract bone marrow and perhaps to create bone bead blanks, and utilizing the groove-and-snap technique on leporid bones to manufacture bone beads, occurred at Hogup Cave for at least the past 8,000 years.

This continuity in behavior patterning transcended major changes in technology. Humans wielding spear points and atlatl darts preceded those that included the bow and arrow in their tool kits. Humans that relied solely on the hunting and gathering of wild foodstuffs both preceded and succeeded those that included domesticated crops in their diet (the Fremont). Yet there was a general similarity in the human treatment of leporid bones and carcasses throughout the depositional history of Hogup Cave. In this way, the behavior of the people that occupied Hogup Cave was as the original Desert Culture concept (Jennings 1957) would predict.

ACKNOWLEDGEMENTS

This paper is a revised version of chapters 7 and 8 of my doctoral dissertation. The support and comments of Gary Haynes, Mel Aikens, Don Fowler, Don Hardesty, Peter Wigand, and Ken Fliess are greatly appreciated. I also thank Anne Hannibal of the Natural History Museum at the University of Utah for her support. Dave Madsen, Dave Schmitt, and an anonymous reviewer provided additional comments that greatly improved the manuscript. The drawings are by Anna K. Lawton-Creger. Any errors or shortcomings in this report are mine alone.

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