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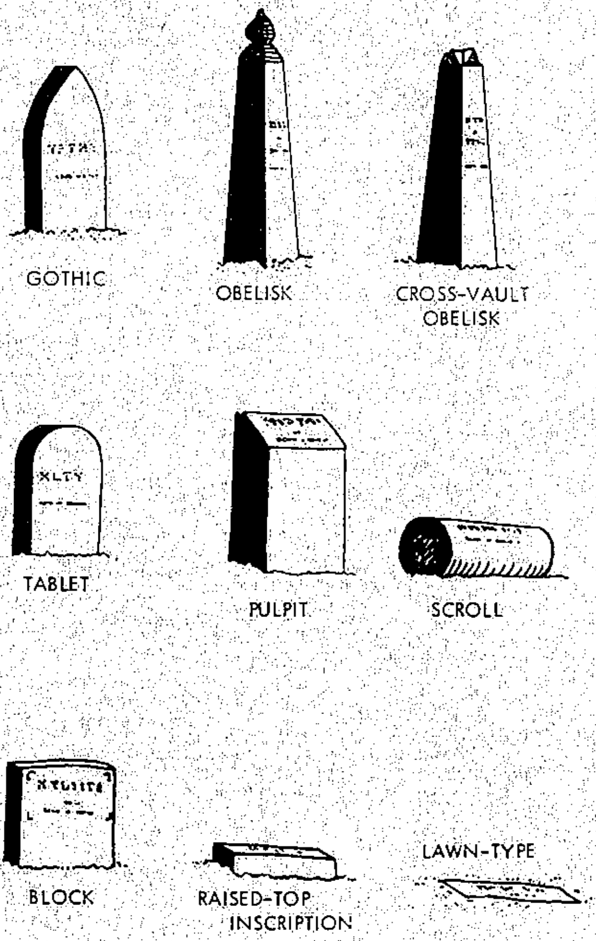

Traditional types of grave-markers (from Francaviglia 1971), (see article by Reno and Reno, page 14).

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EDITOR'S PAGE

The *Nevada Archeologist* (once again) must apologize to Thomas Stafford. In Volume 6, number 1, his name was left out of the acknowledgements in an article and in Volume 6, number 2, his name was misspelled due to a typographical error. In another printing error in the last issue, the scale bar was erased from the photograph on page 27.

This issue includes a diverse selection of papers covering prehistoric as well as historic archeology, and one article that discusses archeological method and interpretation. I hope to keep a balance in subject matter and I will be trying to find ways to improve our printing quality and the journal's overall attractiveness.

Special thanks go to Janis Klimowicz, editorial assistant, who singlehandedly creates the *Nevada Archeologist* by re-typing every submission in proper format, proofreading all pages, and ensuring that the illustrations, text, and tables are correctly arranged.

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Smith, G.H.
1943 The history of the Comstock Lode: 1850-1920. University of Nevada Bulletin 37(3). Geology and Mining Series No. 37.

Strangstad, L.
1988 A Graveyard Preservation Primer. American Association of State and Local History, in Cooperation with the Association for Gravestone Studies.

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THE CONCEPT OF "CARRYING RANGE": A METHOD FOR DETERMINING THE ROLE PLAYED BY WOODRATS IN CONTRIBUTING BONES TO ARCHEOLOGICAL SITES

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Abstract

Woodrats (also known as pack rats) may accumulate bones and artifacts in caves, rockshelters, or open-air sites, and may also move objects that were originally deposited by other processes, such as human behavior. This paper describes the concept of Carrying Range, an analytical tool that might discriminate between bones brought to a fossil site by woodrats and those brought by other agents such as humans.

Introduction

Woodrats are known for their ability to construct houses and nests (Finley 1958; Olsen 1973; Warren 1910). The principal material used in construction varies depending upon the debris available within the woodrats' foraging range (Ashley 1971; Linsdale and Trevis 1951). Large sticks, twigs, leaves, cactus joints, and bones are some of the common materials used in construction.

Archeologists and paleoecologists are aware that woodrats may accumulate bones as well as affect the distribution of bones in caves, rockshelters, and open-air sites (Emslie 1988; Heizer and Brooks 1965; Hoffman and Hays 1987; Mead and Philips 1981; Miller 1979). Faunal sites affected by woodrats may also contain bones and other artifacts left behind by prehistoric people.

Accurate interpretations of past human lifeways partially rests with our ability to differentiate between those bones utilized by humans from those bones accumulated by other agents. It is therefore imperative that woodrat bone-collecting behavior be understood in an archeological context.

The Study Area

Large bones collected from six nests of bushytail woodrat (Neotoma cinerea orolestes) (Durrant and Robinson 1962; Finley 1958) in the Gunnison Basin, west-central Colorado. One nest is located inside Haystack Cave, a late Pleistocene-Holocene locale, and the other five are located near the cave.

This paper reports on the bones of deer (Odocoileus hemionus), cottontail (Sylvilagus nuttali), and elk (Cervus canadensis) collected by bushytail woodrats for nest-building and gnawing purposes. Although rodent bones were also present in the nests, these bones were not part of this analysis as it is not possible to determine if they were brought to the nests by woodrats, or if the animals died in the nests.

The deer, cottontail, and elk bones were collected as part of a preliminary study of woodrat bone-collecting tendencies and capabilities in the Haystack Cave area. A more comprehensive study of the bones collected by bushytail woodrats is currently being conducted by the author.

Taphonomy

Forty-two bones other than rodent were collected in the six woodrat nests. Table 1 lists the location, element, element portion, generic identification, and marks on each bone collected.

Deer elements outnumber elements from cottontail and elk. Thirty-two of the thirty-seven identified elements are deer, or

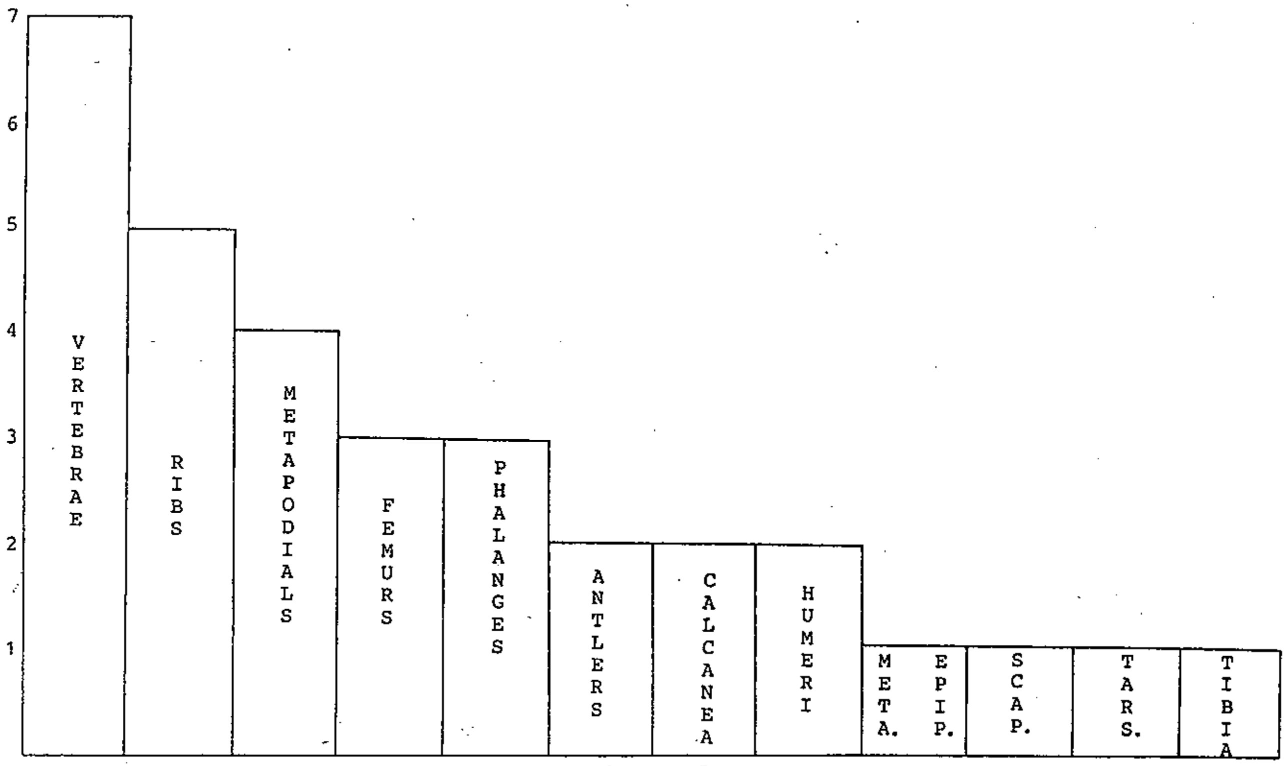

Figure 1
Number of Identified Deer Elements Collected from Six Bushytail Woodrat Nests in Gunnison County, Colorado

TABLE 1
The Initial Data Recorded for Large Bones Collected from Six Bushytail Woodrat Nests in Gunnison County, Colorado

Location	Element	Element Portion	Genus	Attrition Marks
N1-1	vertebra		Odocoileus	poss. gnaw.
N1-2	metapodial		Odocoileus	poss. gnaw. at prox. end; transverse cuts
N1-3	metapodial	proximal	Odocoileus	gnaw.; puncture; spiral fract.
N1-4	rib		Odocoileus	rodent gnaw.?
N1-5	phalange		Odocoileus	poss. gnaw. at dist. end; split longitud.
N1-6	mandible		Sylvilagus	ramus broken/gnaw.*
N1-7	calcaneus		Odocoileus	undamaged**
N2-1	vertebra		Odocoileus	poss. gnaw.
N2-2	femur	proximal	Odocoileus	spiral fract.; head gnaw.; trochant. gnaw.
N2-3	scapula		Odocoileus	blade & glenoid area gnaw.
N2-4	tibia-phalange		Sylvilagus	metapod. & fibula broken; prox. tibia rodent gnaw.
N3-1	metapodial	proximal	Odocoileus	dry-bone break
N3-2	vertebra		Odocoileus	extensive gnaw.
N3-3	humerus	distal	Odocoileus	spiral fract.; gnaw.; rodent gnaw.
N3-4	antler		Odocoileus	poss. gnaw.
N3-5	vertebra		Odocoileus	undamaged
N3-6	rib		Odocoileus	ends broken/gnaw.
N4-1	vertebra			broken/gnaw.
N4-3	tarsal		Odocoileus	poss. gnaw.
N4-4	fragment			damaged
N4-5	femur	distal	Odocoileus	gnaw.; spiral fract.; rodent gnaw.
N4-6	vertebra		Odocoileus	extensive gnaw.; puncture
N4-7	vertebra		Odocoileus	gnaw.
N4-8	humerus	proximal	Odocoileus	dry-bone break; gnaw.
N5-1	vertebra		Cervus	probable gnaw.
N5-2	rib		Odocoileus	gnaw.; puncture; transverse cuts
N5-3	rib		Odocoileus	gnaw. & scoring
N5-4	rib		Cervus	gnaw.; scoring; pitting
N5-5	vertebrae		Sylvilagus	broken
N5-6	vertebra		Odocoileus	extensively gnaw.
N5-7	femur	distal	Odocoileus	gnaw.; furrowing, spiral fract.
N5-8	rib		Odocoileus	dry-bone break; gnaw. & punctures; transverse cuts
N5-9	calcaneus		Odocoileus	undamaged
N5-10	metapodial		Odocoileus	gnaw. at both ends
N5-11	tibia	distal	Odocoileus	spiral fract.; gnaw. & scoring; transverse cuts
N5-12	fragment			damaged
N5-13	antler		Odocoileus	undamaged
N5-14	metapodial epiphyses		Odocoileus	undamaged
N5-15	fragment			gnaw. on ends
N5-16	fragment			gnaw. on ends
N6-1	phalange		Odocoileus	extensive rodent gnaw.
N6-2	phalange		Odocoileus	extensive rodent gnaw.

*refers to a bone in which the agent that caused the damage is unclear
**refers to those bones that display no damage or strictly weathering damage

86.5% of the total identified. Figure 1 illustrates the deer elements collected by the woodrats, and the number of identified specimens per element. The axial skeleton is well represented by twelve (37.5%) of the thirty-two deer elements.

The deer elements collected by the woodrats are probably a reflection of several factors. The vertebrae and ribs may be common simply as a reflection of the fact that they are abundant elements in an ungulate carcass. Another potential reason for their abundance may be the biasing that results from carnivore scavenging of limb bones. The majority of the deer carcasses observed in the study area were represented by the complete pelvic girdle, vertebrae, and ribs, while the entire crania and all or most limb bones were typically absent from the main carcass scatter. If the ungulate death site is outside the woodrats' foraging range, carnivores such as coyote may carry limb elements within the woodrats' foraging range. Many ungulate limb bones were located near mesa bases directly underneath the woodrat nests.

Support for the proposition that carnivore behavior must be understood to understand woodrat bone-collecting behavior comes from the fact that 51.3% of the nonrodent bones collected by the woodrats specifically displays signs of carnivore damage. In addition, nearly all deer limb elements show positive signs of carnivore damage.

Another factor affecting element composition may be the dimensions and weight of particular elements. This will be discussed in the next section.

Woodrats also collect coyote scats for nest-building material. A total of three coyote scats were collected in two of the six nests. Bushytail woodrats in the study area are potential contributors of scats (and thus the microfaunal remains found within these scats) to archeological sites (see Hockett 1988 for further details regarding the scat bones).

Few bones had been gnawed by the woodrats. Although signs of gnawing on bones have been considered in the literature to be a clear indication of the relative contribution that porcupines made to fossil bone assemblages (Binford 1984; Brain 1981; Hendy and Singer 1965), it does not appear that gnawing is as diagnostic a characteristic for woodrats.

The weathering stages of the bones (Behrensmeyer 1978) ranged from Stage 1 (degreased but still fairly fresh) to Stage 4 (extreme weathering). The condition of the bones at the time woodrats first collected them is unknown.

Woodrat bone-collecting behavior is a complex process. For example, both direct and indirect interactions between woodrats and coyotes may accumulate bones in archeological sites. The direct interactions include coyotes feeding on woodrats and defecating microfaunal woodrat remains in archeological assemblages. The indirect interactions include woodrats exploiting bones damaged by carnivores and the scats of coyotes for nest-building material. Coyotes may also utilize archeological sites to feed on rabbit, deer, and elk remains. Therefore, coyotes directly contribute similar bones indirectly collected by woodrats for nest-building and gnawing purposes.

Table 2
Individual CR Measurements for Large Bones Collected from Six Bushytail Woodrat Nests in Gunnison County, Colorado

Location	Minimum Width	Weight	Length
N1-1	2 mm	5.4g	40 mm
N1-2	11 mm	37.6g	176 mm
N1-3	2 mm	23.9g	163 mm
N1-4	4 mm	2.3g	84 mm
N1-5	1 mm	2.9g	41 mm
N1-6	1 mm	1.1g	37 mm
N1-7	5 mm	27.8g	94 mm
N2-1	2 mm	10.4g	53 mm
N2-2	3 mm	18.8g	123 mm
N2-3	.5 mm	17.8g	128 mm
N2-4	3 mm	4.1g	101 mm
N3-1	2 mm	14.2g	59 mm
N3-2	2 mm	6.5g	34 mm
N3-3	3 mm	17.7g	80 mm
N4-1	2 mm	1.4g	37 mm
N4-3	5 mm	3.8g	18 mm
N4-4	4 mm	.9g	20 mm
N4-5	3 mm	54.5g	95 mm
N4-6	3 mm	22.6g	95 mm
N4-7	3 mm	8.9g	44 mm
N4-8	3 mm	49.2g	181 mm
N5-1	5 mm	27.7g	107 mm
N5-2	2 mm	18.1g	295 mm
N5-3	2 mm	7.8g	153 mm
N5-4	2 mm	31.8g	199 mm
N5-5	3 mm	3.6g	117 mm
N5-6	2 mm	2.5g	65 mm
N5-7	3 mm	19.1g	70 mm
N5-8	1 mm	8.0g	182 mm
N5-9	5 mm	27.1g	91 mm
N5-10	7 mm	36.8g	180 mm
N5-11	3 mm	51.1g	179 mm
N5-12	3 mm	12.1g	99 mm
N5-13	3 mm	33.2g	86 mm
N5-14	8 mm	2.7g	20 mm
N5-15	2 mm	7.8g	103 mm
N5-16	2 mm	14.9g	85 mm
N6-1	8 mm	4.9g	30 mm
N6-2	6 mm	8.7g	49 mm

Put another way, woodrat and coyote utilization of a cave or rockshelter may contribute similar faunal remains with few apparent diagnostic attributes to distinguish between them. Nevertheless, deciphering the agents and events responsible for the deposition of all bones at archeological sites is crucial to accurate interpretations.

Development of the Carrying Range

How can archeologists distinguish between bones brought to a site by woodrats from those brought to a site by other agents (including humans)? A Carrying Range (CR) is proposed as an initial step toward answering this question.

The rationale for establishing a CR is that there must be a fixed range to the width, weight, and length of a bone which a woodrat can clasp and carry or drag into archeological sites. These ranges are expected to be much less for woodrats than for coyotes and many other carnivores and humans.

The CR was developed by taking three measurements on each bone collected from the six bushytail woodrat nests. The minimum width of each bone was measured to the nearest millimeter. The minimum width measures how wide a woodrat must have opened its jaws to clasp onto the thinnest portion of each bone. The weight of each bone was recorded to the nearest tenth of a gram. Finally, the length of each bone was measured to the nearest millimeter.

The results of the three measurements taken on each bone are displayed in Table 2. Bones N3-4 through N3-6 were not included since they were not physically in the woodrat nest, but were found on a slope leading up to the nest.

The greatest minimum width of any of the bones is eleven millimeters, measured on a deer metapodial collected from Nest 1. The heaviest bone is a deer femur weighing 54.5 grams. The longest bone is a deer rib which measures 295 millimeters in length. These three measurements may be viewed as individual ranges which comprise a more general Carrying Range. These individual ranges are a maximum minimum width range (MMW), a maximum weight range (MXW), and a maximum length range (MXL). The combination of the three ranges form the CR. The Neotoma cinerea orolestes CR is established at 11mm, 54.5g, 295mm.

It may be that a woodrat cannot carry or drag a bone which has the dimensions and weight equal to the CR into archeological sites. This will be determined as more bones are collected from woodrat nests and measured. Nevertheless, it is proposed that the CR may be a useful tool to separate assemblages in terms of site-formation agents. It is suggested that each bone recovered from archeological sites of known woodrat activity be measured for MMW, MXW, and MXL. If none of the three individual ranges exceed their CR counterpart (11mm for MMW, 54.5g for MXW, 295mm for MXL), then the bone in question may have been deposited at the site by woodrats. Bones whose individual range(s) exceed their CR counterpart were probably deposited at the site by agents other than woodrats.

It is understood that variation between woodrat species and among members of the same species will have an affect on the bones each individual is capable of dragging or carrying. Therefore, a different CR may be needed for each species of woodrat.

The difference between ground-level sites and those sites that require vertical climbing to access them will also affect the CR. The deer metapodial which measured 11mm for MMW was carried or dragged 2.4 meters up a nearly vertical slope into its nest. The deer femur which weighed 54.5g for MXW was carried or dragged 3.5 meters up a nearly vertical slope into its nest. The deer rib which measured 295mm for MXL was carried or dragged 2.8 meters up a nearly vertical slope into its nest. More quantification data are needed to establish if different Carrying Ranges are necessary for variation in vertical access to sites.

The CR must be used with other types of data and an appreciation for all current taphonomic knowledge. For example, the percentage of articular ends present on ungulate limb bones, charring patterns, cut mark data, and the presence of hearths may all be combined to suggest human modification to relatively unambiguous faunal remains. The CR's value lies with bones in deposits whose origins are ambiguous. It is philosophically preferable to discount certain bones as potentially brought to a site by woodrats than to assume they were brought to a site by humans. Finally, one of the CR's greatest assets is that it is not affected by disturbance. Many North American archeological sites have been heavily disturbed, yet disturbance has no affect upon woodrat CRs.

Conclusion

Archeologists are growing more sensitive to the role natural agents play in bone accumulation. Yet, often conclusions about the role of human behavior in depositing bones are drawn based upon spatial associations between bones and artifacts alone. The presence of human artifacts or bones modified by humans does not unequivocally mean that all of the associated bones were deposited by humans as well. Wherever woodrat activity is found, woodrat bone-collecting behavior must be considered.

It is conceivable that woodrats exploited bones from culturally modified carcasses in the past. Sticks and twigs make up the bulk of woodrat nest-building material, and it is possible that woodrats could have brought arrow and spear shafts into archeological sites. Stone artifacts and human feces may also be collected by woodrats. Understanding all facets of woodrat collecting behavior is vital. Woodrat Carrying Ranges may play a role in increasing the accuracy of archeological interpretations of past human lifeways.

Acknowledgements

Gary Haynes made helpful comments and suggestions on an earlier draft of this paper.

This report stems from a thesis completed at San Diego State University. I thank my committee members - Lois Lippold, Larry Leach, and Thomas Rockwell - for their interest and helpful comments. Lois Lippold and Richard Cerutti of the San Diego Natural History Museum helped in identifying the bones.

I am indebted to David Nash for including me in the Haystack Cave field crew. Arden Anderson and all the Park Rangers and government personnel working in and around Gunnison have been more than supportive.

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