

CAVES, URSIDS, AND ARTIFACTS: A NATURAL-TRAP HYPOTHESIS

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ABSTRACT.—European cave deposits often contain the remains of extinct cave bears (*Ursus spelaeus* and *U. deningeri*) and artifacts or human remains. Two twentieth-century explanations for the apparent association of the remains and artifacts are: 1) late Pleistocene hominids preyed upon the bears; and 2) late Pleistocene hominids and bears occupied the caves at different times thus making the remains and artifacts appear behaviorally associated when they are not. The former option is dismissed in most cases based on taphonomic criteria and ursid mortality data. In caves with multiple entrances—particularly cases where at least one entrance is a vertical shaft comprising a natural trap—another option serves to better explain the presence of ursid remains and artifacts in the same deposits. Ursid-bone assemblages created by accidental entrapment of bears in vertical shafts result in a distinctive mortality pattern. This pattern reveals proportionally more prime adult individuals than expected in a living population. A consideration of North American black bear (*U. americanus*) physiology and behavior reveals that this distinctive mortality pattern should be *expected* from natural trap assemblages. Thus, in assemblages from caves with horizontal and vertical entrances, mortality data can be used to decipher whether ursids died from natural hibernation deaths, human predation, or accidental falls through vertical shafts.

Key words: ursids, mortality, natural trap, cave.

RESUMEN.—Los depósitos en las cuevas europeas frecuentemente contienen restos de osos extintos (*Ursus spelaeus* y *U. deningeri*) y artefactos. Dos explicaciones a la aparente asociación de restos y artefactos son: 1) que los osos fueron víctimas de los homínidos del pleistoceno tardío; y 2) que estas cuevas fueron ocupadas en diferentes momentos tanto por homínidos como por los osos; permitiendo que la presencia de artefactos y restos aparezcan como temporalmente asociados, cuando en realidad no lo están. Esta última situación, que ocurrió poco frecuentemente si en realidad ocurrió, puede ser abandonada en la mayoría de los casos empleando criterios de tafonomía y datos sobre mortalidad de los osos. En cuevas con múltiples entradas podemos encontrar otra explicación a la presencia de restos de osos y artefactos; particularmente en los casos donde una de las entradas es vertical y profunda en la cual el oso cae en una trampa natural. La contextualidad de los restos de oso representativos de este tipo de muerte accidental demuestran características muy distintivas. Considerando la fisiología y el comportamiento del oso negro de norte américa (*U. americanus*) este tipo de trampa revela patrones distintivos en la mortalidad de los osos. En este caso los datos de los restos encontrados en cuevas con entradas verticales y horizontales pueden ser empleados para decifrar si los osos murieron por hibernación natural, predación

humana, o por caídas accidentales en las entradas verticales y profundas de las cuevas.

RÉSUMÉ.—Les dépôts sédimentaires de cavernes européennes contiennent souvent des restes humains ou des objets façonnés associés à des restes osseux d'espèces éteintes d'ours des cavernes (*Ursus spelaeus* et *U. deningeri*). Il y a deux scénarios actuels pour expliquer cette apparente association de restes osseux et d'objets façonnés: 1) les hominidés de la fin du pléistocène chassaient les ours; et 2) les hominidés de la fin du pléistocène et les ours ont occupé les cavernes à des moments différents, donnant la fausse impression que les ossements et les objets façonnés sont associés culturellement. Dans la plupart des cas, le premier scénario, qui semble s'être réalisé rarement ou pas du tout, peut être rejeté en utilisant des critères taphonomiques et des données de mortalité ursidée. Pour les cavernes avec entrées multiples (particulièrement celles où au moins une entrée a des parois verticales constituant un piège naturel), un autre scénario explique mieux la présence dans les mêmes dépôts de restes ursidés et d'objets façonnés. Les assemblages d'ossements ursidés créés par la chute accidentelle des ours dans des entrées à parois verticales semblent présenter un profil de mortalité distinct. Ce profil révèle une proportion d'ours d'âge adulte plus importante que l'on pourrait le prévoir d'après une population vivante. Une revue de la physiologie et du comportement de l'ours noir nord américain (*U. americanus*) révèle que les pièges naturels *devraient* produire des profils de mortalité ursidée distincts. Pour les assemblages trouvés dans des cavernes avec entrées horizontales et verticales, les données de mortalité peuvent donc être utilisées pour déterminer si les ursidés sont morts naturellement pendant l'hibernation, suite à la prédation humaine, ou suite à une chute accidentelle dans une entrée à parois verticales.

INTRODUCTION

The co-occurrence of cave-bear (*Ursus spelaeus* and *U. deningeri*) remains and artifacts in European caves has been interpreted during the twentieth century to indicate that (1) humans hunted cave bears and deposited the ursid remains or (2) humans and cave bears occupied the same caves at different times—the bear remains were deposited via natural hibernation deaths (e.g., Gargett 1996) and the artifacts were deposited during unrelated use of the same caves (Kurtén 1976; Stiner 1998). Arguments that humans hunted cave bears [Abel and Kyrle 1931; Bächler 1940, 1957 (cited in Kurtén 1976, Stiner 1998)], though popular, have been dispelled by mortality and taphonomic data [Koby 1953 (cited in Kurtén 1976); Kurtén 1976; Stiner 1998; Webb 1988]]. The routine interpretation of apparently associated cave-bear and cultural remains is that humans and ursids used localities at different times, but another interpretation supported by a unique ursid mortality pattern merits consideration.

Taphonomic histories of cave assemblages are complex (Arsuaga et al. 1997; Oliver 1989; Stiner et al. 1996, 1998; Wolverton 1996), and though taphonomic and mortality data indicate that humans did not regularly hunt cave bears, another accumulation agent (other than alternate use of the caves by ursids and humans) might explain the co-occurrence of cave-bear and human remains in some European caves. In particular, caves that have or had in the past horizontal and vertical entrances may have served as shelter to humans and traps to cave bears.

Vertical shafts comprising natural traps act as accumulation agents that produce mortality patterns distinguishable from ursid hibernation-death assemblages. In some cases—one of which is discussed here—the taphonomic histories of cave-bear/artifact assemblages should incorporate natural entrapment of ursids as a possible accumulation agent because cave structures change through time (e.g., Arsuaga et al. 1997)—entrances open and close.

Stiner (1998, see also Webb 1988) provides detailed discussion of expected mortality effects of hibernation deaths and human predation. Hibernation-death assemblages should produce mortality patterns that are biased toward young and old adults—U-shaped mortality—because those individuals are more susceptible to attritional death agents such as disease or starvation (Stiner 1998; see also Lyman 1994a). Human predation on hibernating bears, on the other hand should reflect L-shaped mortality or “affect prime adults, old adults, infants, and adolescents randomly, emulating their natural proportions in the living population sequestered in dens each year” (Stiner 1998:309; see also Lyman 1994a).

Natural traps attract young-adult bears; it follows that ursid mortality patterns from natural-trap deposits are biased toward high representation of young-adult remains compared to their representation in stable living populations. Two cave assemblages are discussed herein to demonstrate that this unique mortality pattern offers valuable taphonomic insight into the co-occurrence of cave-bear remains and artifacts/human remains in European caves with horizontal and vertical entrances. The first is a paleontological assemblage of North American black bear remains (*Ursus americanus*) from the Midwestern United States (central Missouri) that dates to the late Holocene (AA38931, 233 ± 39 ; AA38932, 207 ± 34 ; CAMS-27141, 170 ± 60 C14 yr B.P.). The second assemblage comprises cave-bear remains (*Ursus deningeri*) from Sima de los Huesos (Spain), a cave with a vertical shaft and possibly buried horizontal entrances, the deposit of which contained cave-bear and human remains (Arsuaga et al. 1997).

Lawson Cave.—Lawson Cave is located in central Missouri. The cave, in profile, is a bottle-shaped solution fissure formed through long-term dissolution of limestone parent material. The modern entrance is a 178 by 79 cm opening located along the top of a forested ridge (long axis oriented approximately east to west); this entrance drops $11\frac{1}{2}$ m straight to the cavern floor. The upper 3 m of the shaft are wet and mossy; the chimney opens into the southeastern portion of the cavern ceiling. The shaft widens as it extends down toward the cavern. A collapsed horizontal entrance conjoins the vertical shaft $4\frac{1}{2}$ m above the cave floor and runs west to east. When open the horizontal entrance would not have provided an exit from the trap because the lower cavern walls are steeply inverted. Lawson Cave's structure suggests it is unlikely that it served as a bear den.

Today the cave is moist with dripstone flowing from the ceiling. Portions of the cave floor were excavated during the 1950s, though the bedrock floor is covered with as much as 1 m of sediment; the identified mammalian remains recovered from the cave are listed in Table 1. Visibility of the modern cave entrance is poor; the opening cannot be seen by humans in daylight from outside of 5 m in all four cardinal directions (Wolverton 1996). Because the sample of bear remains is small (10 individuals), I postulate two explanations for the preponderance of

TABLE 1.—Taxonomic abundances at Lawson Cave.

Taxon	Abundance (NISP)
<i>Ursus americanus</i>	445
<i>Sylvilagus floridanus</i>	238
<i>Sus scrofa</i>	170
<i>Marmota monax</i>	66
<i>Canis</i> sp.	66
<i>Didelphis marsupialis</i>	42
<i>Neotoma</i> sp.	33
<i>Microtus ochrogaster</i>	19
<i>Peromyscus</i> sp.	18
<i>Mephitis mephitis</i>	12
<i>Sciurus</i> sp.	7
<i>Odocoileus virginianus</i>	5
<i>Scalopus aquaticus</i>	3
<i>Procyon lotor</i>	1
<i>Caster canadensis</i>	1
<i>Geomys bursarius</i>	1

young-adult bears: (1) the Lawson Cave mortality pattern is the result of random capture of black bears from the (historically extirpated) central Missouri living population or (2) the pattern is not the result of random capture, but young-adult bears are more susceptible to natural-trap mortality than bears of other ages. As demonstrated below, the mortality pattern appears unlikely to be the result of random accumulation of ursids in Lawson Cave.

Taphonomy of Lawson Cave.—Quantitative units used to discuss taphonomic variables include: number of identified specimens (NISP), minimum number of elements (MNE), and minimum animal units (MAU). NISP is the number of bone or tooth specimens (fragmentary and complete) identified to element and taxon. MNE is the "minimum number of complete skeletal elements necessary to account for observed specimens" (Lyman 1994b:290), or the number of elements represented by the identified complete and fragmentary specimens. MNEs are calculated by determining whether or not two or more specimens overlap; if two fragments overlap—e.g., one distal right humerus overlaps one complete right humerus—then the specimens must be from two separate bones, which equals an MNE of two. If the specimens do not overlap, then they could be fragments from the same element, hence the MNE would equal one. If two or more fragments (or unfused parts) refit, they equal an MNE of one. MAU is similar to MNE except it accounts for some elements occurring more or less frequently in one skeleton than others (e.g., one cranium vs twenty 1st phalanges in the same skeleton) by dividing MNE by the number of times the element occurs in the skeleton (Lyman 1994c).

Intensity of fragmentation, calculated as an NISP:MNE ratio, monitors how many fragments (NISP) occur per distinguishable element (MNE). If Lawson Cave served as a bear den, then high NISP:MNE is expected because trampling increases fragmentation intensity (Lyman 1994a; Stiner et al. 1995). NISP:MNE ratios are calculated for black bear (*U. americanus*) and cottontail (*Sylvilagus floridanus*) long-bone remains from Lawson Cave; the ratios incorporate only fragments

TABLE 2.—NISP:MNE and %Whole for black-bear and cottontail long bones.

	Fragmentation intensity NISP:MNE	Extent of fragmentation % whole
<i>Sylvilagus floridanus</i>		
Humeri	10:8 = 1.25	15/23 = 65.2%
Ulnae	12:12 = 1.0	2/14 = 14.3%
Femora	21:14 = 1.50	11/25 = 44%
Tibiofibulae	35:22 = 1.59	12/34 = 32.3%
Total	78:56 = 1.39	40/96 = 41.7%
<i>Ursus americanus</i>		
Humeri	22:14 = 1.57	2/16 = 12.5%
Ulnae	14:12 = 1.17	1/13 = 7.7%
Femora	22:14 = 1.57	3/17 = 17.6%
Tibiae	10:8 = 1.25	5/13 = 38.5%
Total	68:48 = 1.42	11/59 = 18.6%

as the purpose of the ratio is to measure the degree of fracture of *broken* specimens (complete elements are unfractured). *Extent of fragmentation*—calculated as %Whole—incorporates fragmented and complete black bear and cottontail long bones. It measures what proportion of the bones (MNE) are complete (Lyman 1994b).

The Lawson Cave ursid and cottontail limb bones are extensively fragmented; the abundance of complete elements is low indicating most long-bones were fractured at least once (Table 2). Intensity of fragmentation for the rabbit and bear limb bones, however, is low (Table 2). Each broken identifiable ursid limb element is represented by 1.42 fragments; for cottontails the ratio is 1.39 NISP per MNE. An intensely fragmented assemblage results in several NISP per MNE (Lyman, 1994b:292); such is not the case here. Low intensity of fragmentation suggests that post-depositional processes (including carnivore damage and trampling) were limited likely because the deposit was well sheltered within the natural trap from weathering and other attritional agents. Extensive fragmentation—that is, the fact that most of the specimens are incomplete—suggests that individuals fell into the cave breaking their bones from the fall.

Evidence of carnivore damage is present on remains from Lawson Cave (Table 3); however, substantial gnawing results in density-mediated destruction of bone. The structure of low-density elements leads to their destruction by carnivores, thus low-density elements should be rare or absent in ravaged assemblages. Whether or not density-mediated destruction has occurred can be monitored by comparing the abundances of distal (dense) ends to those of the proximal (relatively less dense) ends of long bones (Binford 1981). Ratio values (RVs) between the abundance of high and low density ends are calculated by “determining the MNE for the proximal end and for the distal end of each bone, and then dividing all four values ([e.g.,] proximal humerus, distal humerus, proximal tibia, distal tibia) by the largest of the four values” (Lyman 1994a:400). Binford’s (1981) “zone of destruction” and “zone of no destruction” in Figure 1 are derived from empirical observation of carnivore ravaged and non-ravaged faunal assemblages (see

TABLE 3.—Carnivore damage on ursid remains.

Element	MNE	Carnivore gnawed
Zygomatics	12	0
Mandibles	17	0
Scapulae	14	3
Humeri	16	10
Ulnae	13	6
Radii	11	3
Innomimates	14	9
Femora	17	7
Tibiae	13	5
Total MNE	127	43 (33.9%)

Lyman 1994a:398–402). Carnivore ravaged assemblages produce RVs that fall within the zone of destruction.

Density mediated destruction of the Lawson Cave ursid and cottontail remains is monitored using tibia/tibiofibula and humerus RVs (Table 4). The resulting graph (Figure 1) illustrates that little or no density-mediated destruction has occurred; that is, low-density proximal tibiae and humeri occur at about the same frequency as high-density distal ends. Ursids undoubtedly temporarily sur-

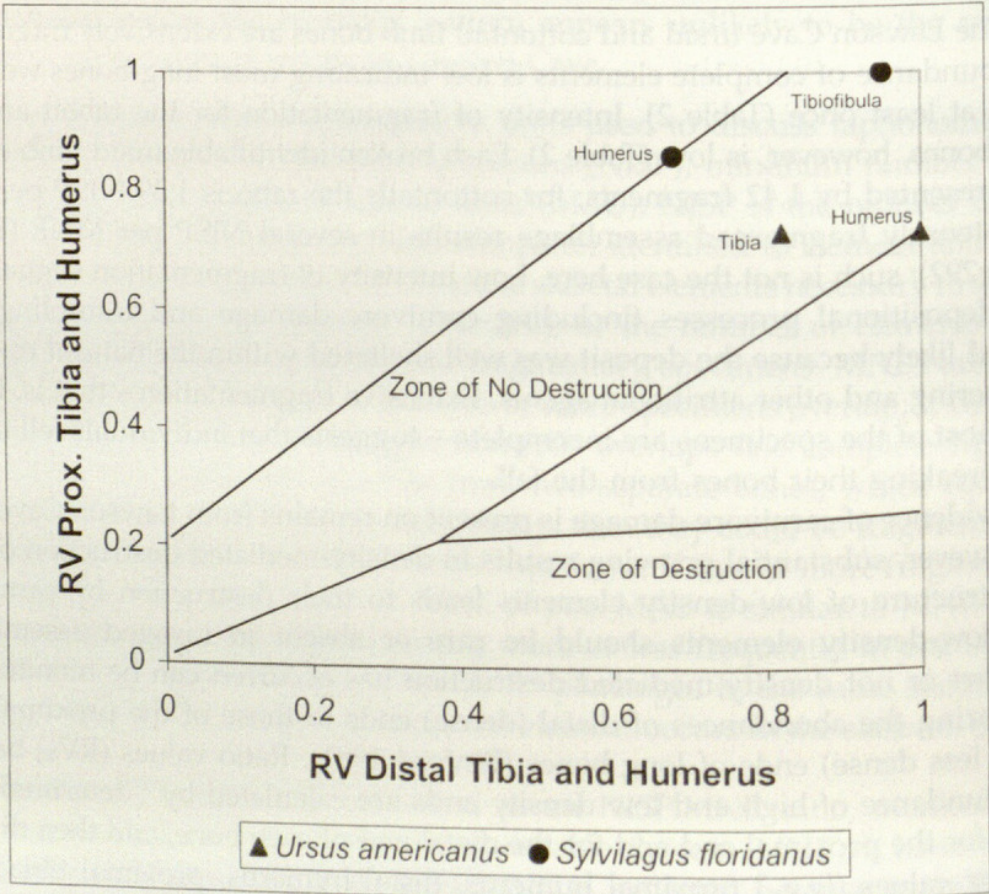


FIGURE 1.—Destruction graph: The ratio values of ursid and cottontail tibiae/tibiofibulae and humeri illustrate that low-density proximal ends occur in the sample. The RVs fall within or near Binford’s (1981) observed “zone of no destruction.”

TABLE 4.—Ratio-value data for ursid and cottontail humeri and tibiae/tibiofibulae.

	MNE	Ratio value
<i>Ursus americanus</i>		
Distal tibia	9	0.82
Proximal tibia	8	0.73
Distal humerus	11	1.0
Proximal humerus	8	0.73
<i>Sylvilagus floridanus</i>		
Distal tibiofibulae	21	0.95
Proximal tibiofibulae	22	1.0
Distal humeri	15	0.68
Proximal humeri	19	0.86

vived falls into Lawson Cave as indicated by the presence of large carnivore gnaw marks on many specimens (Table 3); however, the RV plot indicates that any density-mediated destruction of ursid and cottontail elements by fall survivors was minimal. Taphonomic assessment of the assemblage reveals that fragmentation damage, though extensive, was not intense; further, carnivore damage was limited during the cave's accumulation history indicating the cave was not a den but a natural trap.

Sima de los Huesos.—Sima de los Huesos is a natural trap located within the Sierra de Atapuerca karst system in north-central Spain. The cave deposits date to the middle Pleistocene (roughly 200 to 300 kya), and the remains of cave bears (*U. deningeri*), humans (*Homo* sp.), and numerous carnivore taxa co-occur in the deposit (Arsuaga et al. 1997). The modern entrance is a 13 m vertical chimney connecting to the cave system. The presence of tooth marks on ursid and human remains as well as cave-bear claw marks on the chimney walls indicate that bears (and possibly other carnivores) survived falling into the cave but were trapped at the base of the chimney.

The cave system above Sima de los Huesos contains dens and complete skeletons of cave bears; it is likely that cave bears used the karst system for hibernation. Arsuaga et al. (1997; see also Garcia et al. 1997) interpret the high abundance of carnivore remains (particularly those of cave bears) and the absence of herbivore remains in the pit to mean that Sima de los Huesos never served as a den; rather, they postulate that bears and other carnivores were attracted to the vertical shaft because of carrion at the base of the chimney (Arsuaga et al. 1997; Garcia et al. 1997). Arsuaga et al. (1997) base their interpretation on taphonomic evidence; however, they also hypothesize that a closed horizontal entrance might have existed for Sima de los Huesos at some period in the past—perhaps accounting for the presence of human remains in the cave. Cave-bear mortality data suggest that ursids entered Sima de los Huesos via the vertical shaft not horizontal entrances.

THE AGE SCORING TECHNIQUE

Bear teeth have attracted considerable attention among researchers for the last few decades (e.g., Gordon 1977, 1986; Gordon and Morejohn 1975; Graham 1991;

Grandal-D'Anglade and Vidal-Romaní 1996; Marks and Erickson 1966; Rausch 1961; Smith et al. 1994; Stiner et al. 1996, 1998; Tucker 1984; Wolverton and Lyman 1998). This is so for two reasons; first, relative ontogenetic ages of bears can be determined from their teeth, and second, teeth are often the only preserved skeletal remains in paleontological and zooarchaeological assemblages. Zooarchaeologists and paleontologists find that dental wear exhibited by bear teeth diagnoses age fairly well (Kurtén 1958; Rausch 1961), and the techniques used to assess wear are nondestructive.

The age-scoring technique proposed by Stiner (1998) allows analysts to order isolated teeth, mandibles, and/or maxillae by age-at-death relative to teeth of other individual bears. Within a given cohort—a group of individuals born within the same limited time period (Begon et al. 1995; Lyman 1987, 1994a)—tooth wear is variable and depends largely on the amount of abrasive food in the diet of bears (Rausch 1961). Stiner's (1998) technique assigns bear teeth to one of nine cohorts; those cohorts are collapsed to three life history phases of unequal duration that correspond to physiological changes in female mammals—juveniles, prime adults, and old adults (Stiner 1990, 1994, 1998). It is *because* Stiner's units are theoretically informed, ecologically warranted, and suitable for small samples that her system is applied to the Lawson Cave ursid remains in this analysis.

Although Stiner's (1998) age-scoring technique is designed for European cave bears (*U. deningeri*), the technique can be used on other members of the genus *Ursus* (except polar bears, *U. maritimus*). It is widely believed that cave bears consumed diets higher in gritty material than modern members of *Ursus* resulting in more rapid rates of tooth wear (e.g., Kurtén 1976). Stable-isotope data indicate that European cave bears and modern black and brown bears have similar hibernation metabolisms (Nelson et al. 1998), though the dentition of cave bears suggests pronounced herbivorous specialization (Kurtén 1958, 1976). Bocherens et al. (1994) report, based on analyses of carbon and nitrogen stable isotopes, that most ursids are predominately herbivorous. The stable isotope evidence indicates that cave bears (*U. spelaeus*) were more herbivorous than modern bears (Bocherens et al. 1994). Stiner's tooth-wear phases are applicable to the Lawson Cave black-bear teeth despite differences in diet among different species of *Ursus* because the phases are ordinal scale and calibrated to fundamental life-history periods.

METHODS AND MATERIALS

Isolated and inset mandibular and maxillary molars (MNE = 60) from Lawson Cave were age-scored using Stiner's wear-chart illustrations (1998:312–313, figures 2 and 3) and assigned to one of nine age cohorts (Table 5). Following Stiner, cohorts 1 to 3 were grouped as the juvenile phase, 4 to 7 were grouped as the prime-adult phase, and 8 and 9 were grouped as the old-adult phase. Lower and upper fourth premolars (MNE = 2 left upper, 2 right upper, 4 left lower, 4 right lower) were excluded because of their low abundance in the collection; this includes a mandible with an erupting permanent, lower-fourth premolar. Similar mortality patterns should emerge from each type of molar based on Stiner's (1998) research.

Garcia et al. (1997) use four *stages* of tooth development and wear in their

TABLE 5.—Frequencies (MNE) of each tooth type aged to age cohorts and life-history phases.

Age cohort	Left M ¹	Left M ^{2*}	Left M ₁	Left M ₂	Left M ₃	Right M ¹	Right M ^{2*}	Right M ₁	Right M ₂	Right M ₃
1 Juv.	—	—	—	—	—	—	—	—	—	—
2 Juv.	—	—	—	—	—	—	—	—	—	—
3 Juv.	1	1	—	—	—	1	—	1	—	—
4 Prime	—	2	1	1	—	1	2	1	1	1
5 Prime	3	3	2	2	1	3	2	2	2	2
6 Prime	1	—	1	1	1	—	—	1	—	1
7 Prime	1	1	1	1	1	1	—	1	1	1
8 Old	—	—	1	1	1	1	1	—	1	—
9 Old	—	—	—	1	1	—	—	—	—	—

* The M² is highlighted here because it is the tooth used by Garcia et al. (1997).

analysis of the Sima de los Huesos cave-bear remains (Table 6). For the Sima de los Huesos assemblage, Garcia et al. (1997) add the deciduous stage (d3) shown in Figure 2A. Note that the word "phase" is used here to refer to life-history periods derived from Stiner's age-scoring technique, the word "stage" is used in discussion of Garcia et al.'s (1997) units, which were derived from Kurtén's (1958) earlier work, and the word "cohort" refers to one of Stiner's original nine age-scoring units later collapsed to three life-history phases.

No attempt was made to convert the Sima de los Huesos mortality data to the form recommended by Stiner (1990, 1994, 1998)—conversion would require access to the collection. Similarly, the Lawson Cave data were not assessed using Garcia et al.'s (1997) stages. The three-phase scheme is clearly the most appropriate for the small assemblage from Lawson Cave. Although Kurtén (1958) *estimated* actual ages based on his original wear stages, I treat Garcia et al.'s stages as ordinal scale though they are derived from Kurtén's scheme. Stiner's and Kurtén's/Garcia et al.'s aging techniques, thus, use different numbers of age units to measure life span—three units are used in Stiner's scheme and four units are used by Garcia et al. There exists no lowest common denominator between the two scales, thus data from the natural traps cannot be directly compared. Nevertheless, indirect visual comparison of the graphs is possible and is pertinent to the argument made here.

For comparative purposes, I include mortality data from three cave-bear assemblages thought to have been accumulated by hibernation deaths based on U-shaped mortality patterns. The Yarimburgaz (Turkey) cave-bear (*U. deningeri*) mortality data are available in the three-phase format of Stiner (1998). Lawson

TABLE 6.—M² wear stages used by Garcia et al. (1997).

Wear stage	Description
I	open roots at the apices, walls forming, unworn crowns
II	roots closed, cusps clearly visible, crowns polished, narrow attrition facet along the internal ridge
III	attrition facet enlarged, loss of large parts of enamel
IV	facet more enlarged, enamel disappeared, cementum eroded

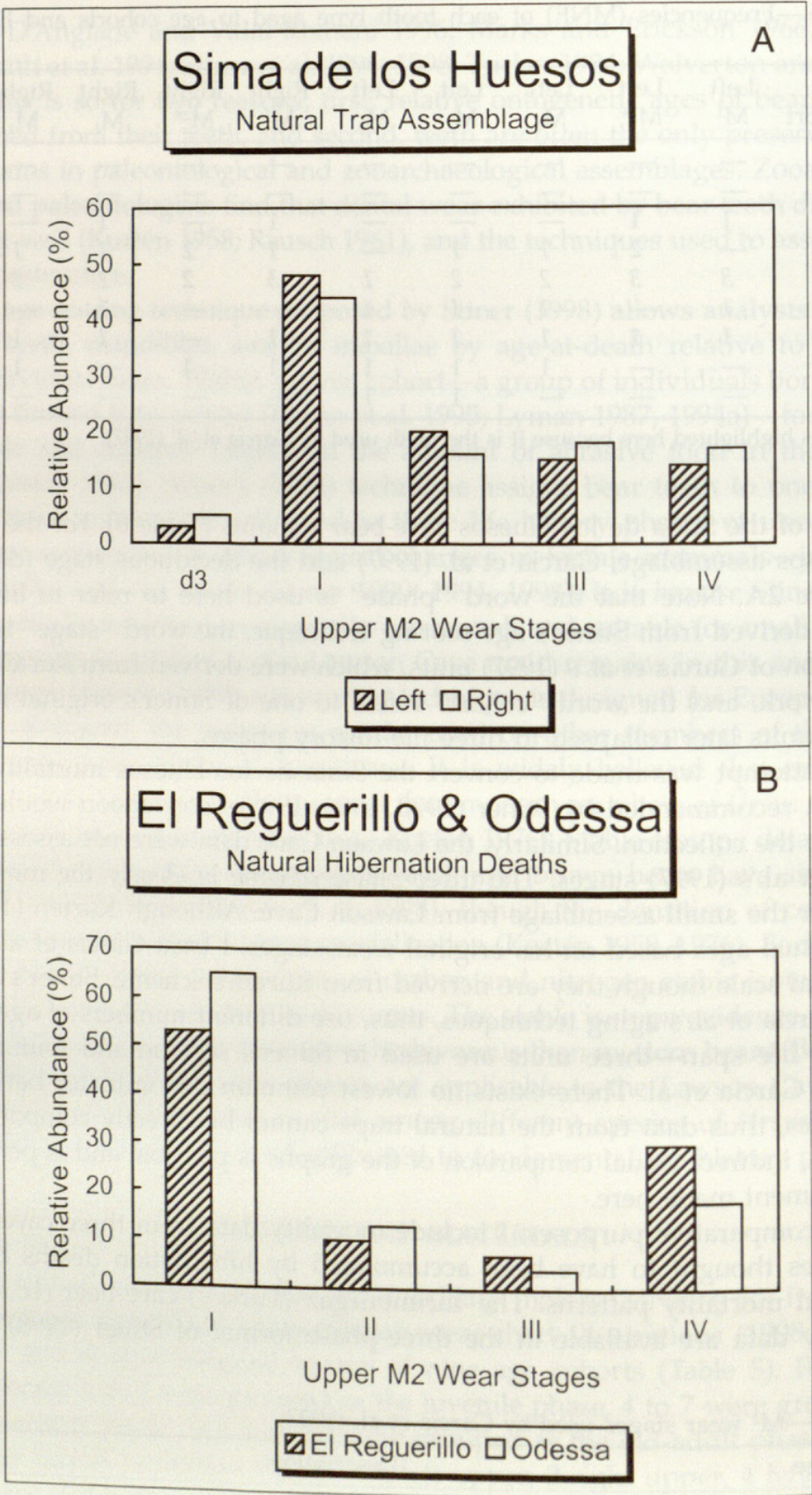


FIGURE 2.—Cave-bear mortality profiles from Sima de los Huesos (*U. deningeri*), El Reguerillo (*U. spelaeus*), and Odessa (*U. spelaeus*) (after Garcia et al., 1997, figs. 6, 7, & 8: 167–168).

Cave and Yarimburgaz Cave ursid mortality patterns are, thus, directly comparable. The El Reguerillo (Spain) and Kurtén's (1958) Odessa cave-bear (*U. spelaeus*) mortality patterns are presented by Garcia et al. (1997) in four-stage format and are compared to the Sima de los Huesos assemblage. Both El Reguerillo and Odessa are thought to be natural, hibernation-death assemblages (based on mortality criteria discussed above).

In order to evaluate the Lawson Cave ursid mortality pattern, three populations were modeled (Figure 3). Each population comprises 100 individuals; all three are variations of the "idealized stable structure" (L-shaped) living population discussed by Stiner (1990:308–309; Lyman 1987). The percentage of prime-adults differs for each population. Fifty samples of 10 individuals each were drawn from each modeled population to determine the likelihood that the prime-dominated pattern—comprising a higher proportion of prime adults than expected in a living population—from Lawson Cave is the result of random capture of prime adults.

RESULTS

The natural-trap assemblages—Sima de los Huesos and Lawson Cave—exhibit proportionally more prime adults than expected in a living population, which should approximate an L-shaped profile (Lyman 1987, 1994a; Stiner 1990). This pattern is visible in both assemblages despite the use of different aging formats. The Sima de los Huesos assemblage noticeably boasts more subadults and young adults (Figure 2A) than assemblages thought to be deposited via hibernation deaths, such as those from El Reguerillo and Odessa (Figure 2B). Further, the Sima de los Huesos pattern is not L-shaped.

The mortality pattern from Lawson Cave is heavily prime dominated [$> 80\%$ of molar specimens are prime aged (Figure 4)]. Following Garcia et al. (1997), 83% of the M²s (MNE = 12) are from prime adults (Table 5). Graphic comparison to the presumed hibernation-death pattern from Yarimburgaz Cave (Stiner 1998) highlights the distinctiveness of the Lawson Cave pattern (Figure 4).

Validity of the Lawson Cave Ursid Mortality Pattern.—Samples of the model populations yield no mortality patterns as prime-dominated as that from Lawson Cave (Table 7). Eight of the fifty samples drawn from Population A were prime-dominated (the samples contain more prime adults than expected from the modeled population); two of those samples included 60% prime adults. The fifty samples from Population B, which consisted of more prime adults than A, included seven prime-dominated samples. Two of those samples comprised 60% prime adults, and one consisted of 70% prime adults. The fifty Population C samples included thirteen prime-dominated samples. One of those contained 60% prime adults and another contained 70% prime adults. Based on the samples drawn from these model populations it is reasonable to conclude that prime-dominated assemblages can be produced randomly from stable-age structure living populations. However, it appears unlikely that assemblages as heavily prime-dominated as that from Lawson Cave regularly result from random sampling of stable living populations. Given these results it is more reasonable to conclude that the prime-dominated

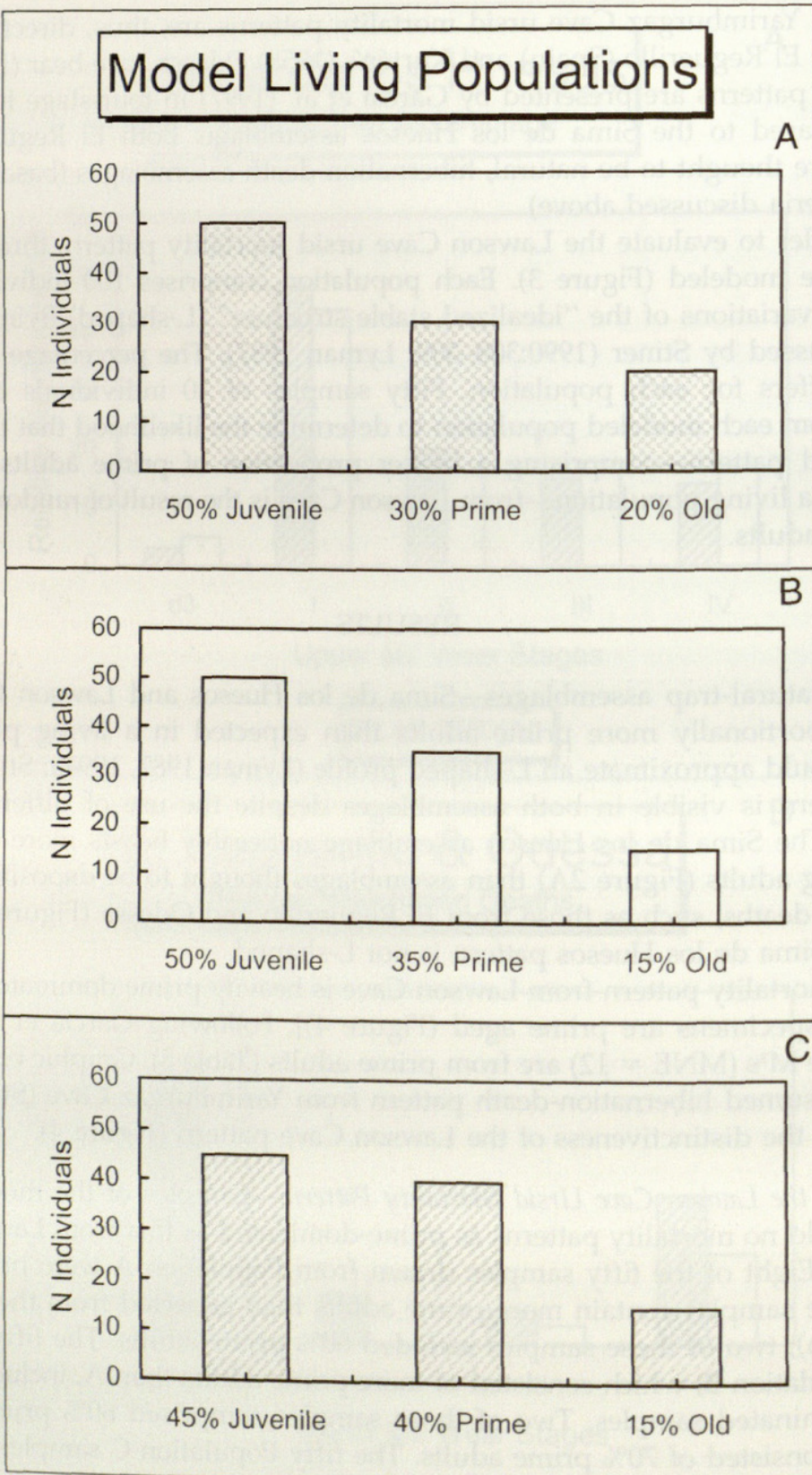


FIGURE 3.—Age structures of modeled living-structure populations.

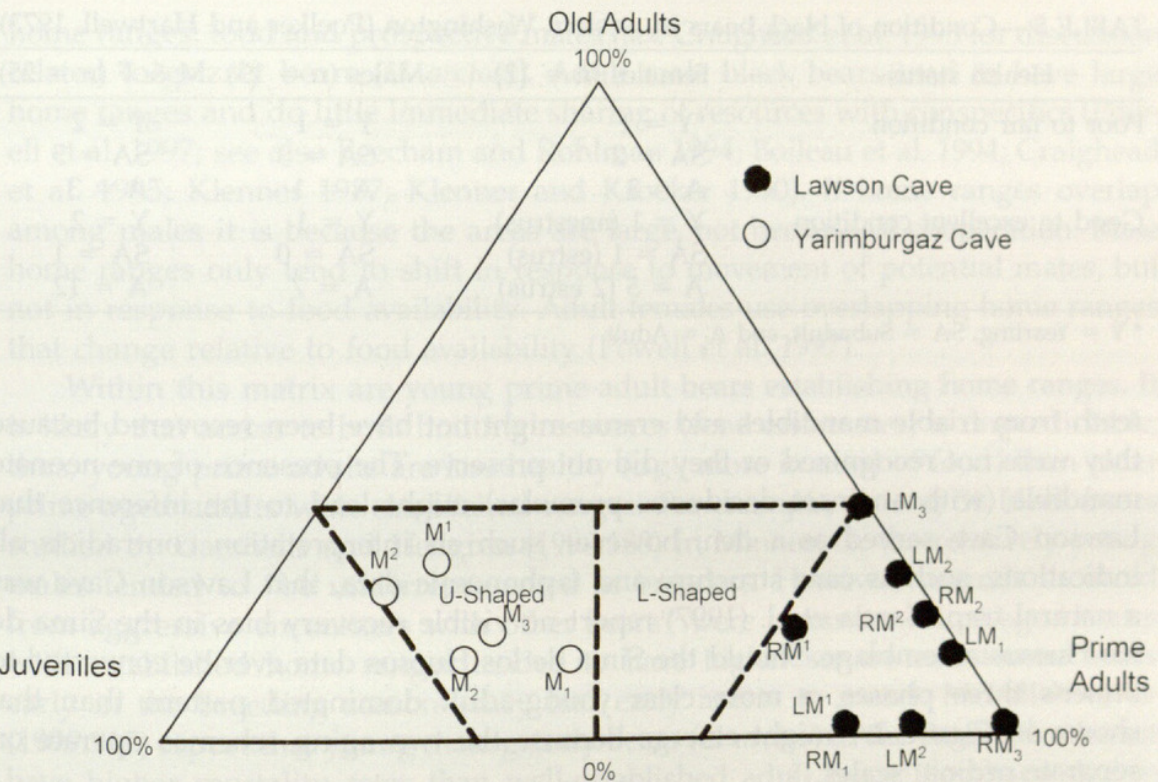


FIGURE 4.—Three-pole graph illustrating ursid mortality patterns from Yarimburgaz Cave (*U. deningeri*) and Lawson Cave (*U. americanus*).

pattern at Lawson Cave is the result of physiological and related behavioral characteristics of young prime-adult bears.

DISCUSSION

One can argue that Lawson Cave and Sima de los Huesos acted as similar faunal accumulation agents based on cave structure alone; Lawson Cave is 11.5 m deep and Sima de los Huesos is 13 m deep (Arsuaga et al. 1997). The mortality patterns of these two assemblages are likely more similar than appears because of a minor recovery bias at Lawson Cave; smaller elements occur in lower than expected frequencies in the collection (Wolverton 1996). Neonate and juvenile

TABLE 7.—Results of model-population random sampling.

	Population A	Population B	Population C
50 samples (n = 10) drawn per population			
% prime-dominated samples drawn at random	16%	14%	26%
Number of samples containing 60% prime adults	n = 2 (4%)	n = 2 (4%)	n = 1 (2%)
Number of samples containing 70% prime adults	n = 0	n = 1 (2%)	n = 1 (2%)
Number of samples containing 80% prime adults	n = 0	n = 0	n = 0

TABLE 8.—Condition of black bears in western Washington (Poelker and Hartwell, 1973).

Health status	Females (n = 12)	Males (n = 13)	M & F (n = 25)
Poor to fair condition	*Y = 1	Y = 1	Y = 2
	SA = 2	SA = 3	SA = 5
	A = 2	A = 1	A = 3
Good to excellent condition	Y = 1 (anestrus)	Y = 1	Y = 2
	SA = 1 (estrus)	SA = 0	SA = 1
	A = 5 (2 estrus)	A = 7	A = 12

* Y = Yearling, SA = Subadult, and A = Adult.

teeth from friable mandibles and crania might not have been recovered because they were not recognized or they did not preserve. The presence of one neonate mandible (with an inset deciduous premolar) might lead to the inference that Lawson Cave served as a den; however, such an interpretation contradicts all indications, such as cave structure and taphonomic data, that Lawson Cave was a natural trap. Garcia et al. (1997) report no visible recovery bias in the Sima de los Huesos assemblage. Should the Sima de los Huesos data ever be converted to Stiner's three phases, a more clear young-adult dominated pattern than that shown in Figure 2A might emerge because the two aging schemes operate on separate ordinal scales.

As stated by Garcia et al. (1997:172) "the most likely scenario compatible with the structure of the Sima de los Huesos carnivore assemblage is a natural trap (very likely the current pitfall) attracting carnivores to accidental deaths." A simple physiological analogy—implicating a carrion attractant—is useful to understand the proximate reason that ursids, given their keen senses of smell (Brown 1993; Schullery 1992), were attracted to both pits. Modern bear-bait trapping utilizes meat or carrion to draw ursids into barrels or other enclosures (Conover 1983; Craighead et al. 1995; McLaughlin and Smith 1990; Oliver 1995). Clearly U-shaped mortality patterns cannot be expected in natural-trap ursid assemblages. Why, then, do there appear to be proportionally more prime adults in the Lawson Cave and Sima de los Huesos assemblages than might be expected in a stable living population? Why wouldn't bears of all ages be equally susceptible to natural-trap deaths, which would result in L-shaped mortality patterns?

Again, a modern analogy provides a plausible answer. There appear to be high relative abundances of *young* prime adults in the Lawson Cave assemblage; the same can be argued for Sima de los Huesos based on the proportion of individuals in stages I and II. Most of the prime-adult-phase molars from Lawson Cave fall in the two early, prime-adult cohorts (4 and 5). Sixty percent of the left molars and seventy-four percent of the right molars were aged to cohorts four and five within the prime-adult phase (Table 5). It is arguable, then, that these molars represent old sub-adults or young adults within the prime-adult phase.

Poelker and Hartwell (1973:121) demonstrate that Washington-state subadult black bears—those individuals no longer with their mother and in the process of establishing home ranges (Powell et al. 1997)—are the least healthy of all age classes (Table 8). Health was gauged in terms of disease and parasite loads and general hematology; only one subadult was considered healthy (Poelker and Hartwell 1973). Powell et al. (1997) discuss two limiting resources that shape bear

home ranges: food and prospective mates [see Craighead et al. 1995 for discussion related to grizzly bears (*U. arctos*)]. Adult male black bears tend to have large home ranges and do little immediate sharing of resources with conspecifics (Powell et al. 1997; see also Beecham and Rohlman 1994; Boileau et al. 1994; Craighead et al. 1995; Klenner 1987; Klenner and Kroeker 1990). If home ranges overlap among males it is because the areas are large, not because of cooperation. Male home ranges only tend to shift in response to movement of potential mates, but not in response to food availability. Adult females use overlapping home ranges that change relative to food availability (Powell et al. 1997).

Within this matrix are young prime-adult bears establishing home ranges. It is likely that access to both limiting resources (food and mates) is unpredictable; thus, young prime adults are less healthy (e.g., more in need of food) than older prime-aged adults with established ranges. For example, among 56 black bears studied by Garshelis and Hellgren (1994:180) in Minnesota, the relatively young males tended to "be underrepresented as breeders. However, wounds incurred from aggressive encounters with other bears" were common. Prime-aged males with established home ranges tended to have higher serum-testosterone levels early in the breeding season—they had early access to mates. McLellan et al. (1999:917) report that young male grizzly bears (*U. arctos*) in the Pacific Northwest have higher mortality rates than well-established adult bears; "perhaps due to their large ranges and inexperience, young males are more prone to encounter human attractants and be killed as problem bears than [members of] other sex-age classes." Adult males and females with established home ranges have better access to preferred food resources and mates; as a result they have lower mortality rates.

Given the argument presented here, subadult and young adult black bears are under greater nutritional stress than adult bears; they lack access to limiting resources (food and mates). It follows that subadult and young adult bears are susceptible to carrion attractants in natural traps. The apparent preponderance of young prime-adults in the Lawson Cave assemblage supports this notion because young-adult bears undergo considerable stress during their attempts to establish home ranges (Garshelis and Hellgren 1994; McLellan et al. 1999; Powell et al. 1997).

CONCLUSIONS

As the title to this paper suggests, the results here are best cast in the form of a natural-trap hypothesis regarding ursid mortality. This is so for two reasons: 1) only two natural-trap assemblages are examined here using different aging methods, and 2) one of those assemblages (Lawson Cave) is small. Nevertheless, the high proportional abundance of young adult ursids in these two natural trap assemblages is markedly distinct from their low proportional abundance in winter-death, U-shaped mortality profiles. Further, the documented natural-trap mortality patterns contrast with those expected to result from human predation on vulnerable, hibernating bears. There is a physiological/behavioral reason that ursids are attracted to natural traps; in particular young-adult ursids are most susceptible to death in natural traps.

Ursid mortality data from sites such as Sima de los Huesos provide another line of evidence with which to understand accumulation histories of palimpsest assemblages, such as those from caves—whether archaeological, paleontological, or mixed. An important component of the argument presented here is that the Lawson Cave assemblage is a non-cultural assemblage; it can be used to ferret out expected characteristics of remains deposited via natural entrapment. In particular, mortality data can be useful for understanding accumulation histories of assemblages that contain artifacts/human remains and ursid remains. This is particularly relevant for faunal assemblages from caves with multiple entrances.

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