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Scavenger scattering at two contemporary open air sites in Hungary

Dispersión de carroñeros en dos yacimientos contemporáneos al aire libre en Hungría

KEY WORDS: scavenger transport, scattering, open-air sites, taphonomic experiment.
PALABRAS CLAVE: transporte de los carroñeros, dispersión, yacimientos al aire libre, experimento tafonómico.

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ABSTRACT

A major cause of taphonomic loss is bone destruction by scavengers. Having monitored nine sheep bone scatters and two modern sheep carcasses near a farmstead and in a nearby forest clearing, it was hypothesized that the proximity of the settlement influenced multiple non-human bone modificator activities. This observation was tested by an experiment in which the rate of transport was measured in two deposits of standard slaughter house refuse bones at the two sites. Access by scavengers (wild pig vs. canids) differed at the two loci, with the intensity of scavenging higher near the farmstead. It seems that human proximity modified the composition of scavengers by scaring away wild competitors to dogs.

RESUMEN

Una de las causas principales de la pérdida tafonómica es la destrucción ósea provocada por los carroñeros. Tras haber controlado la dispersión de los huesos de nueve ovejas y de los cadáveres de dos ovejas modernas cerca de las instalaciones de una granja y en un claro de un bosque cercano, se estableció la hipótesis de que la proximidad del asentamiento influía en múltiples actividades no humanas que provocaban modificaciones en los huesos. Se llevó a cabo un experimento para evaluar esta observación en el que se medía el ritmo de transporte en dos depósitos de restos óseos normales de matadero en ambos yacimientos. El acceso de los carroñeros (jabalíes frente a cánidos) difería entre ambos grupos, siendo mayor la intensidad cerca de las instalaciones de la granja. Parece demostrarse que la proximidad de los seres humanos modificaba la composición de los carroñeros al asustar y así alejar a los competidores salvajes de los perros.

LABURPENA

Galera tafonomikoaren arrazoirik nagusienetakoa sarraskijaleen ondorioz hezur-aztarnetan gertatzen den galera da. Granja batean eta inguruko baso bateko argigunean utzitako bederatzi ardiren hezurretan eta bi ardiren gorpuetan sarraskijaleen eraginak kontrolatu ondoren, hipotesi bat egin zen: sarraskijaleen kokagune bat hurbil egoteak eragin handia du hezur-hodakinek erakusten dituzten aldaketetan, eta horiek ez dira gizakiak eragindakoak izaten. Teoria hori esperimentu batekin ebaluatu zen: bi aztarnategietan hiltegitik ateratako hezur-hondakin batzuk utzi eta horien garraioaren erritmoa neurtu zen. Sarraskijaleek (basurdeak kanidoak baino) neurri ezberdinez iristen ziren batera edo bestera; gehiago ziren granjatik gertu lekututako sarraskijaleen etorrerak. Badirudi, gizakia hurbil egoteak sarraskijaleen osaera aldatu egin zuela txakur basati lehiakideak urrutiraraziz.

1. INTRODUCTION

Scavenging has attracted the attention of archaeologists long before the concept of taphonomy was introduced in paleontology (EFREMOV 1940). In an early piece of processual reasoning, BUCKLAND (1823) studied similarities between gnaw marks on ancient bone and those left on a cattle tibia demolished by a captive hyena: as the phenomenon was replicated, the process could be reconstructed with regard to the agent.

While the notation and analysis of gnawing marks has become standard practice in the analysis of archaeological sites (e. g. ENLOE *et al.* 2000), reconstructions of this form of bone loss have received relatively little attention in later periods such as the Middle Ages. Little in the way of measurement has been carried out concerning various aspects of scavenging, including transport and scattering. These two biostratonomic parameters influence bone deposition at archaeological sites.

2. HYPOTHESIS AND TEST IMPLICATIONS

The term scattering refers to an increase in dispersion of skeletal parts (HILL 1979: 269). In theory, it is analogous to an increase in entropy, the statistical measure of disorder in a closed system. In practice, however, the systems studied here are admittedly open: scavengers had free access to the bones whose complete removal from the site was also expected.

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Rather than distinguishing between natural versus *human* environments on the basis of scavenger activity, a task nearly impossible in its complexity, this paper is aimed at assessing the actual intensity and extent of scattering and destruction through field observations and a planned experiment. Bone displacement was expected to be different in nature and near a human settlement.

3. MATERIAL, EXPERIMENTAL DESIGN AND METHOD

Experiments were carried out near the Late Neolithic settlement of Csabdi–Télizöldes in western Hungary (BARTOSIEWICZ & CHOYKE c.f. 1985), which covers an estimated 1.5 km^2, spread across the gently rolling southeastern slopes of the Gerecse hills (150-200 m asl), on an elevation overlooking St. László Creek on its steep, western side (ANTONI 1982).

3.1. Empirical observations

Summer field walks during the 1989 excavation season in the region directed attention to the incomplete remains of 9 sheep skeletons (Figure 1; see Table 2 below), evidently originating from previous years. Two fresh sheep carcasses were also discovered with no visible sign of trauma. They represented similar degrees of initial decomposition that would not have yet effected their skeletons.

One of these, the carcass of a ca. 1.2 year old ram was towed into a forest clearance on the left side of the creek (*Locus* 1 in Figure 1) while a ca. 5 year old ewe was deposited on the right bank between the creek and the nearby farmstead (*Locus* 2 in Figure 1). The two locations were approximately 300 m distant from each other, separated by the small creek and its narrow floodplain as well as two cultivated elevations ending in a strip of woods with bushy undergrowth, largely exploited for grazing.

During the August field season (often characterized by a 30-35 °C daily maxima), microbial activity was evidently at its annual peak owing to high temperatures and air humidity. Three weekly inspections indicated different rates of skeletonization and bone dispersal for these two carcasses. However, the impact of human presence on scavenger behavior could not be evaluated systematically, above all, owing to the difference between the ages of the individuals: three weeks after its discovery, the remains of the younger animal disappeared almost completely.

3.2. Experimental design

Scattering at the two loci was compared by measuring displacement in two sets of fresh bones. Slaughterhouse refuse from the nearby town of Tata included standard-size cattle stylopodium (humerus and femur: Figure 2) diaphyses, left behind by industrial marrow extraction, a *standardized* medium for testing hypotheses inspired by the observation of the differential attrition of sheep carcasses.

Two sets of 60 such bone cylinders (weighing ca. 20 g and 10-15 cm long each) were selected and deposited on the surface at Loci 1 (forest) and 2 (farm), where taphonomic factors unrelated to scavenging were either absent (e. g. fluvial transport) or comparable (e. g. weathering). Differences in dispersal, therefore, could be largely attributed to variability in macro scavenger activity.

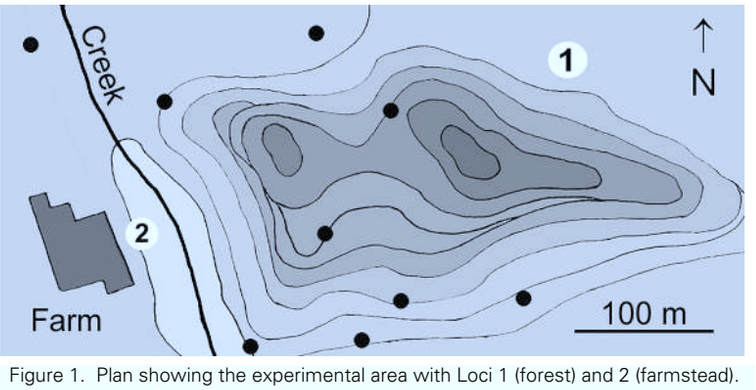

Figure 1. Plan showing the experimental area with Loci 1 (forest) and 2 (farmstead). Dots indicate the locations of sheep bone scatters.

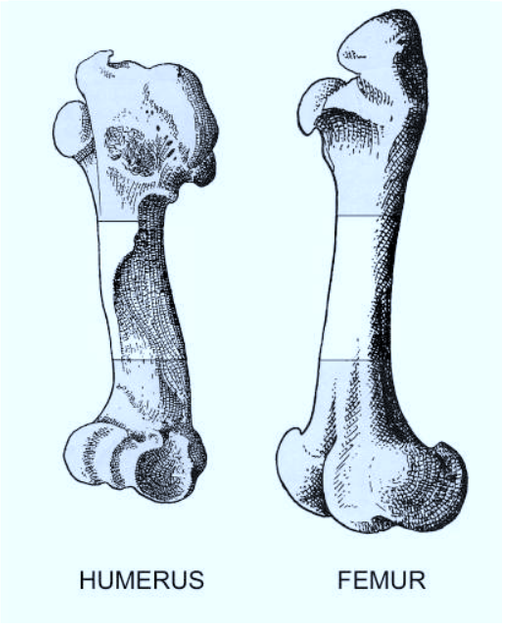

Figure 2. The position of standard diaphysis cylinders of stylopodia represented in the slaughterhouse refuse.

3.3. Methods of evaluation

Scattering, when quantified in both time and space, may be interpreted as "speed", i. e. the rate by which bones are moved around and/or ultimately destroyed by scavengers.

Approximately 50 cm diameter deposits of bone cylinders at both loci were visited weekly during a two month long field season. The center of these piles was the point from which scattering was measured and plotted. Individual bone positions were mapped in three concentric zones (0-3m, 3-6m and 6-9m). Displacements within the 18 m diameter circle were random and reversible (both centrifugal and centripetal). This is reminiscent of the equipartition of energy within a closed system. Bones carried beyond the circle, however, were considered lost. Measurements were carried out both at Locus 1 and 2. It was hypothesized that the proximity of human settlement would measurably influence the scattering of skeletal remains by scavengers.

3.4. Comparison between methods

Similarities and differences between the two paradigms, observation and experiment, are summarized in Table 1.

4. RESULTS

Observation and experimental work were used to complement each other. While the first helped in formulating hypotheses, the second was used in testing them.

4.1. Empirical observations

4.1.1 Skeletal remains inventoried during field walks

The skeletal remains of nine sheep located in the proximity of the archaeological site displayed various degrees of scavenging, but no sign of human activity. The selective preservation of various skeletal parts coincides with known anatomical properties of the artiodactyl skeleton. Bones best known for their mechanical resistance were more likely to be recovered (Table 2).

	Observation	**Experiment**
	Similarities	
Locus (microenvironment)	hypothetical factor to be studied	
Macroenvironment	rural, summer temperatures and precipitation	
Inorganic taphonomic factors	no fluvial transport or human trampling	
Bioturbation (micro)	high microbial and insect activity	
Scavenger activity (macro)	dog, wild pig, fox?	
	Differences	
Research paradigm	inductive	deductive
Duration	3 weeks	8 weeks
Documentation	descriptive	quantitative
Medium	"randomly" chosen*	highly standardized
taphonomic status	carcass	food refuse
anatomical composition	heterogeneous	homogeneous
age at death	different	comparable
degree of decomposition	different	identical

*Random here means a choice based on availability as opposed to planning

Table 1. Similarities and differences between observation and experiment in this study.

Skeletal part category	Individual									Total number in categories
	1	2	3	4	5	6	7	8	9	
femur, distal									+	1
caudal vertebra						+				1
humerus, proximal					+				+	2
tibia, proximal	+								+	2
phalanx distalis	+							+		2
scapula, distal	+				+				+	3
cervical vertebrae	+			+		+				3
rib			+				+		+	3
tibia, distal	+	+					+	+		4
mandibula	+		+		+			+		4
radius, distal		+		+		+		+		4
phalanx proximalis		+		+	+	+				4
carpus		+		+				+	+	4
atlas/axis			+	+	+			+		4
metacarpus, proximal	+		+		+	+			+	5
tarsalia	+	+		+			+		+	5
cranium	+	+	+	+		+				5
metatarsus, proximal	+	+	+		+	+	+			6
sacrum	+	+	+	+				+	+	6
lumbar vertebrae		+	+			+	+	+	+	6
ilium	+		+	+	+	+		+		6
phalanx media	+	+		+		+	+		+	6
humerus, distal		+	+	+	+	+	+		+	7
femur, proximal	+		+		+	+	+	+	+	7
metapodium, distal	+	+	+		+	+	+		+	7
thoracic vertebrae	+	+	+	+	+	+	+			7
acetabulum pelvis	+		+	+	+	+	+	+		7
radiocubitus, proximal		+	+	+	+	+	+	+	+	8
Number of categories present	**17**	**14**	**15**	**16**	**12**	**16**	**12**	**14**	**13**	**129**

Table 2 . The presence of various skeletal parts in skeletonized sheep identified during the field walk.

The rank order of skeletal categories observed at these natural deposits was compared to pooled results obtained by BINFORD & BERTRAM (1977) and BRAIN (1981). Those authors recorded the attrition of sheep and goat remains after systematic butchering and dog scavenging among the Navajo and Hottentots respectively. Since *Caprine* bones were studied in each case, prey size did not bias these comparisons (c. f. HORWITZ 1998). The coefficient of Spearman rank order correlation (R= -0.138) between their pooled results and relevant categories listed in Table 2 showed no significant similarity (P=0.637). In contrast to the deposits disturbed by natural scavengers under discussion here, butchering and marrow extraction evidently distorted the anatomical composition of dismembered animal remains observed in the cited ethnographic studies.

4.1.2 Locus 1

The young ram brought to Locus 1 in the forest had been dead only for a few days. Its skin and articulations were intact, but the animal's body was already bloated. The following changes were observed:

• *Week 1*: The head, separated at the axis was dragged away to a distance of some 5 m. The front legs were also removed from the trunk and fell apart at the shoulder and wrist joints. The chest area was crushed, but remained in place, exposing the vertebrae still attached by the long ligaments. The pelvis and femora remained, more-or-less, in their original positions, with the distal extremities of the hind limbs lying nearby. Most parts became skeletonized.

• *Week 2*: Basically, the skeleton disappeared, with only scattered short bones (phalanges, left patella, 3 articulated cervical vertebrae), splinters (from the humerus, radiocubitus, and possibly tibia) and small tufts of wool indicating where the carcass once lay (Figure 3). No further observations could be made on this skeleton.

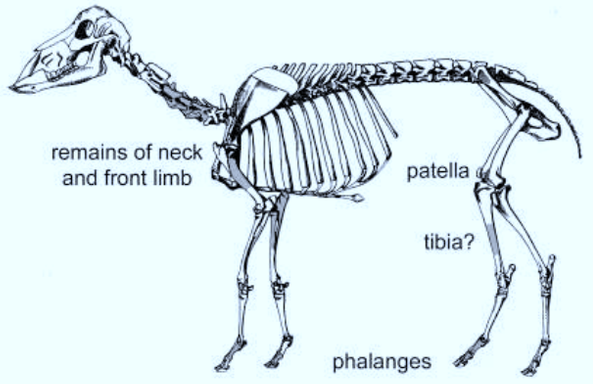

Figure 3. Skeletal parts/regions of the subadult sheep after 2 weeks (surviving bones are indicated by shading).

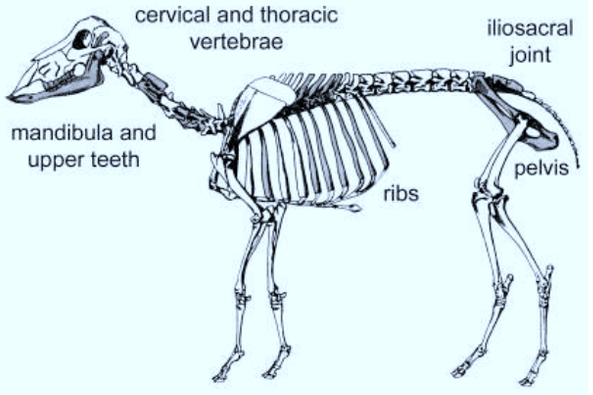

Figure 4. Skeletal parts/regions of the adult ewe after 3 weeks (surviving bones are indicated by shading).

4.1.2 Locus 2

The ewe was left lying some 30 m from the farmstead. Although her muzzle and orbits were partially skeletonized, all articulations and the skin were intact. The following changes were observed:

• *Week 1:* The head was tossed aside, with mandibles dislocated. The front limbs of the animal (attached to the body only by the musculature of the scapula) were first removed and carried away from the axial skeleton, largely in one piece. The iliosacral and hip joints remained articulated. Pieces of the left tibia and the hock joint as well as metacarpal bones were found in the vicinity of the trunk. The rib cage was disturbed but remained largely in place.

• *Week 2:* The atlas fell off from the calvarium. With the exception of the left forearm, long bones from the skeleton disappeared from the immediate area. The lumbar section of the vertebral column was also missing, with the sacrum and pelvis only slightly shifted from their oirginal positions. The rib cage together with the thoracic (and adjacent cervical) vertebrae remained, more-or-less, in place.

• *Week 3:* The calvarium was demolished, but some upper teeth as well as the mandibles were left behind. The pelvis and iliosacral joint, and a few articulated cervical and thoracic vertebrae remained in the area. Some rib fragments and short bones remained around the place the carcass had originally lain (Figure 4).

These patterns largely reflect anatomical properties of the ruminant skeleton as characterized by the ranking of joints in the natural sequence of disarticulation (HILL 1979). It is also this rank order by which, however, scavengers can dismember the carcass most easily. The early stage of scavenging (Week 1) also reflected "anchoring" by the vertebrae (BEHRENSMEYER 1983: 98), i. e. parts of the axial skeleton remained more localized than limbs which tend to be more easily removed and carried away.

Dogs were active at both spots, while evidence of wild pig was also found in the form of claw prints and pig droppings at Locus 1 in the forest. Suid gnawing marks, however, could not be identified owing to the high degree of bone destruction. The joint efforts of at least two major scavenging species seem to have accelerated the rate of destruction in the forest. Scavenging by domestic pigs, widely documented in the ethnographic literature (PETERSON 1917: 94; RAPPAPORT 1968: 58; GREENFIELD 1988), was not reckoned with within the research area, since the few individuals kept at the farmstead were permanently penned.

4.2. Experimental results

Slaughterhouse refuse was placed at the two previously used loci (Figure 1). Figures 5 and 6 show the location of bone diaphyses left within the two, 18m diameter circles at the end of the experiment (Week 8). Most bones taken outside the circles were carried off beyond sight. On the basis of the low intensity of gnawing on the remaining pieces one may conclude that scavengers "played" with the robust bone cylinders, rather than consuming them on location. On these bones, both Suid and Canid toothmarks could be distinguished at Locus 1 in the forest. In contrast to the rapid disappearance of the young sheep carcass in the forest, the number of bone cylinders declined at a faster rate near the farmstead.

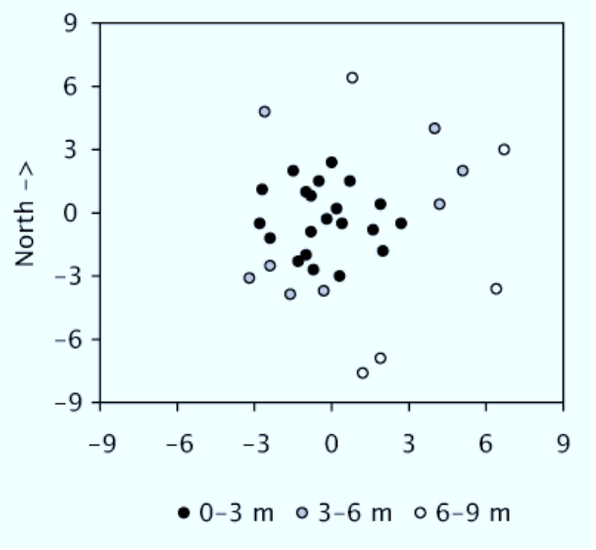

Figure 5. The distribution of bones by 3 m zones at the forest site after 8 weeks.

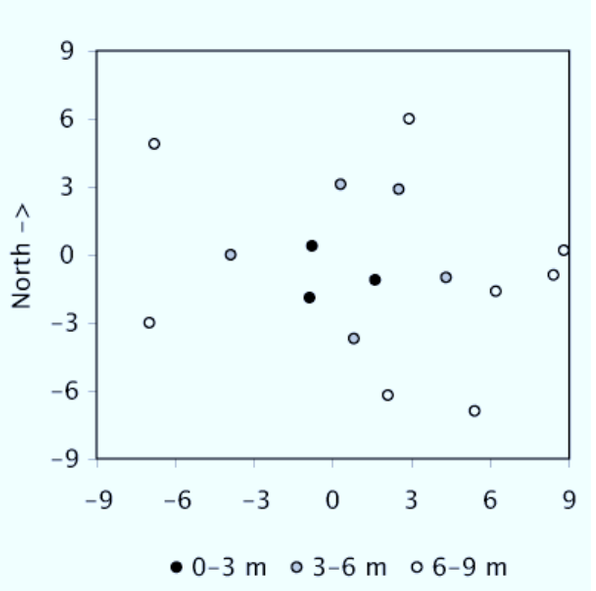

Figure 6. The distribution of bones by 3 m zones at the farm site after 8 weeks.

Figure 7, as well as negative exponents in Table 3, show that the non-linear diachronic trend starts with a steep "feeding frenzy" near the farmstead, but the initial momentum of displacements seems to dissipate, as random movements homogenize the distribution of bones remaining within the study area. Steady centrifugal transport would have produced a linear equation, while the results obtained emulate the aforementioned entropic model. Owing to the non-closed nature of the system, however, constants in these equations cannot be defined.

Bones in the forest were removed from the 18m diameter circle less vigorously: more than half were still scattered within the circle at Locus 1 by the end of the experiment. Even the center of the original deposit could be recognized (c.f. Figure 5). Only about a quarter of the bones could be recovered at Locus 2 near the farm and the place of the original deposit cannot be identified (c.f. Figure 6). These tendencies are supported by very high and significant ($p \leq 0.001$) coefficients of correlation. The difference is also apparent in the changes of between-zone percentual distributions (Figure 8).

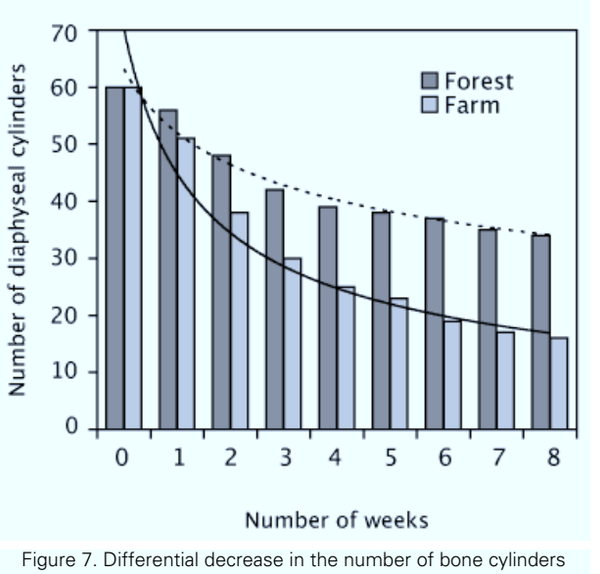

Figure 7. Differential decrease in the number of bone cylinders at the two loci.

Locus	Type	Regression equation	Coefficient of correlation	Bone survival after 8 weeks	
				n	%
1	forest	$y = 63.179\ x^{-0.281}$	r = 0.984***	34	56.7
2	farmstead	$y = 70.203\ x^{-0.648}$	r = 0.982***	16	26.7

Table 3. Decrease in the number of standard size cattle stylopodium diaphysis cylinders by locus.

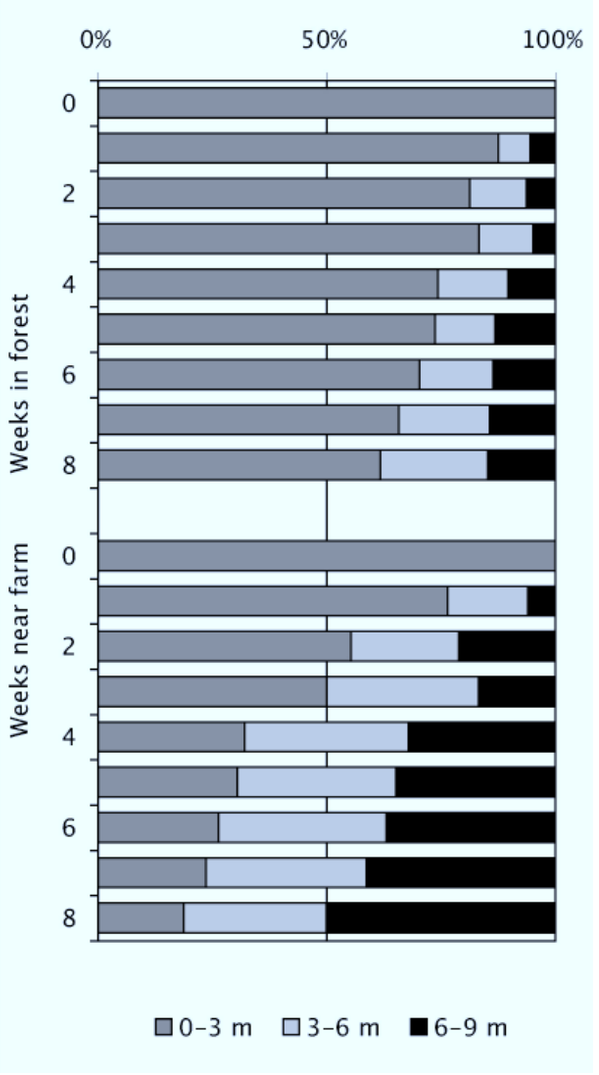

Figure 8. The percentual distribution of surviving bone cylinders within 3m concentric zones.

5. DISCUSSION

In archaeological terms, the observations and experiments presented here correspond to two different taphonomic categories. In the first case, complete carcasses (with meat still attached) represented a great variety of skeletal remains, while the experiment was carried out using a collection of uniform, defleshed bones. Archaeologically, they correspond to carcasses (observation) versus consumption refuse (experiment). The impact of scattering is thus, *per definitionem*, different between the two situations.

5.1. Observations

The anatomical composition of the 9 incomplete skeletons inspected during the field walk was different from that of settlement refuse described in classical ethnoarchaeological studies. The remains observed may be considered natural deposits, similarly to the two complete carcasses whose rapid destruction by scavengers was monitored in this study. Scavenging seemed more intensive in the forest. The rapid disappearance of the carcass, however, may have been accelerated by the sheep's young age. Scavenging was very intensive at both loci, possibly also aided by faster decay during the summer-early fall. The decomposition of an undisturbed fox carcass in a forest location has recently been documented by GAL (2004). In the absence of macro scavenger activity it took six months, between February and July, to reduce this small body to a skeleton. Understandably, a natural acceleration of the process started during the late spring.

5.2. Experiment

Results of the planned experiment, however, refuted the hypothesis that the dispersal of bones was more intensive given the absence of humans at the forest location. The experiment should be considered superior to our observations for two methodological reasons:

1. Age difference between the two sheep carcasses may have directly influenced scavenger impact.

2. The observation of two dead sheep was limited to only three weeks. Random differences in scavenger behavior were more reliably averaged during the longer, 8 week experimental period.

In the proximity of the farmstead scavengers, other than strongly territorial dogs, may be discounted for the following reasons:

1. Wild pigs were spotted several times on the left bank of the creek at the edge of the forest, but never crossed the water.

2. The activity of foxes in disturbing the pile of bones near the farmstead is similarly unlikely.

3. Domestic cats are not avid scavengers, and the size of bone cylinders would have excluded them from serious participation anyway.

Dogs, apparently, exploited this situation very efficiently. In addition, since the bone cylinders had little nutritive value, dog scattering was almost certainly influenced by hoarding behavior rather than merely by consumption.

Even in the absence of human disturbance, the bones piled up at Locus 1 in the forest decreased more slowly. Evidence of wild boar activity was seen here, although traces of canids (dog and possibly fox) could also be observed.

6. CONCLUSIONS

Analogy in archaeological interpretation means 'assaying any belief about non-observed (archaeological) behavior by referral to observed behavior which is thought to be relevant' (ASCHER 1961). This study has shown that:

• Scattering refuse bone by dogs was *not limited* by human presence: bone removal and destruction were more intense closer to the settlement than in a parallel natural setting. This again directs attention to the massive role of dogs played in distorting archaeological bone assemblages.

• The distribution of bone refuse near the farmstead was evened out in a more clear-cut, "entropic" manner by dog scavenging, possibly including *hoarding behavior*. The forest sample remained relatively localized.

Methodological aspects of the results may be summarized as follows:

• The intensity of scavenging varies with the type of skeletal remains (carcass vs. bone refuse).

• Results of sporadic observations were inferior to those of the planned experiment: age differences between the two sheep and, possibly, unequal levels of decomposition distorted the end results of the inductive study.

• In the absence of precise data on scavenger density, the absolute time intervals are difficult to interpret. The two sheep were skeletonized and intensely scattered within 2-3 weeks. The mass of standardized experimental bits, while better suited for quantification, were probably less attractive to scavengers.

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REFERENCES

ANTONI, J.
1982 *Öskori elödeink Csabdiban* (Our prehistoric ancestors in Csabdi). Régészeti Kutatások a Dunántúlon I. Székesfehérvár.

ASCHER, R.
1961 Analogy in archaeological interpretation. *Southwestern Journal of Anthropology 17(4)*, 317-325.

BARTOSIEWICZ, L.
1984 Csabdi - Télizöldes: Taphonomy in the western section of the Neolithic site. *Alba Regia XXI*, 235-240.

BARTOSIEWICZ, L. & CHOYKE, A. M.
1985 Animal exploitation at the site of Csabdi–Télizöldes. *Béri Balogh Ádám Múzeum Évkönyve,* 181-194.

BEHRENSMEYER, A. K.
1983 Patterns of natural bone distribution on recent land surfaces: implications for archaeological site formation. In J. CLUTTON-BROCK and C. GRIGSON (eds.): *Animals and Archaeology 1: Hunters and their prey. British Archaeological Reports International Series 163.* Oxford, 93-106.

BINFORD, R. L. & BERTRAM, J. B.
1977 Bone frequencies and attritional processes. In R. L. BINFORD (ed.): *For theory building in archaeology*. Academic Press. New York, 77-152.

BRAIN, C. K.
1981 *The hunters or the hunted?* University of Chicago Press. Chicago.

BUCKLAND, W.
1823 *Reliquiae diluvianae, or, observations on the organic remains contained in caves, fissures, and diluval gravel, and on other geological phenomena, attesting to the action of an universal deluge.* Murray. London.

EFREMOV, I. A.
1940 Taphonomy: a new branch of paleontology. *Pan-American Geologist 74*, 81-93.

ENLOE, J. G., DAVID, F. & BARYSHNIKOV, G.
2000 Hyenas and hunters: zooarchaeological investigations at Prolom II Cave, Crimea. *International Journal of Osteoarchaeology 10,* 310-324.

GÁL, E.

2004 "Én tyúkokra vadászom, az emberek meg énrám vadásznak." Esettanulmány egy vörös róka (*Vulpes vulpes*) tafonómiai vizsgálatáról ("I hunt chickens; men hunt me". A case study of taphonomic investigations on a red fox [*Vulpes vulpes*]). Paper presented at the 2004 Fall Meeting of Hungarian Archaeozoologists in Visegrád, October 16, 2004.

GREENFIELD, H. J.

1988 Bone consumption by pigs in a contemporary Serbian village: implications for the interpretation of prehistoric faunal assemblages. *Journal of Field Archaeology 15*, 473-479.

HILL, A.

1979 Disarticulation and scattering of mammal skeletons. *Paleobiology 5,* 261-274.

HORWITZ, L. K.

1998 The influence of prey body size on patterns of bone distribution and representation in a striped hyena den. *Economie Préhistorique: Les comportements de subsistence au Paléolithique. Editions APDCA, Sophia Antipolis.*

PETERSON, A. E.

1917 *New York as an 18th century municipality prior to 1731.* PhD Thesis, Columbia University. New York.

RAPPAPORT, R. A.

1968 *Pigs for the ancestors.* Yale University Press. New Haven and London.