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# Large carnivores as taphonomic agents of space modification: an experimental approach with archaeological implications

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ABSTRACT

At most Pleistocene archaeological sites it is difficult to observe structured complex spatial behaviour. This common phenomenon could be a taphonomic issue. Problems in the preservation of the original spatial intra-site distribution could be related to hominid–carnivore alternation in the use of space. In the present paper we analyse the results of our experimentation with large extant carnivores (bears, wolves, hyenas and lions) and propose these animals acted as hearth and hearth-related assemblage modifiers. In this sense, the role of carnivores in the modification of these elements can cause problems in the interpretation and visibility of modern and complex behaviour in the conception of space in the archaeological record.



## 1. Introduction

Researchers agree that not all carnivores behave in a similar way or have the same impact on animal carcasses. Each species has its own ethology and physical characteristics which influence the accumulations that they produce and the intensity with which they act on bone remains. Ethological studies focused on understanding the consumption sequence of carnivores allow us to establish significant differences in carcass handling (e.g., Blumenschine, 1988; Domínguez-Rodrigo, 1994, 2001; Capaldo, 1997; Selvaggio, 1994; Pickering, 2002).

The type of prey, skeletal representation, age at death, superficial and structural modifications on bone remains and spatial distribution are elements commonly used to recognize the degree of carnivore intervention. This degree seems to depend on the activity that these non-human predators perform at a site, i.e. the use that carnivores make of the site.

In Pleistocene contexts, the occupation of karstic areas by carnivores and hominids is well documented (Skinner, 2012). This phenomenon provides a scenario of alternation with remains left by both biological entities that often causes problems in understanding the processes of assemblage formation or isolating specific episodes within the same archaeo-stratigraphic unit. Then, it is often difficult to differentiate the contributions of each predator due to the frequent palimpsest nature of most Pleistocene archaeological sites.

However, carnivores not only act as accumulators; the smells from the remains left by human groups are attractive for them. For this reason, it is common for scavengers to access these places in search of potentially consumable elements (Binford, 1981; Rosell and Blasco, 2009). Different observations and experimental reproductions have been made, with both wild animals and animals in captivity, attempting to document the modifications made by carnivores on the faunal assemblages generated by human groups (e.g., Sutcliffe, 1970; Bunn, 1986; Bunn and Kroll, 1986; Bunn et al., 1980, 1988; Blumenschine, 1986a, 1986b, 1988; Marean et al., 1992). For instance, several experiments with spotted hyenas in the Serengeti National Park (Tanzania) were conducted by Blumenschine (1988) with the aim of identifying the timing of hominid and carnivore influence on Plio-Pleistocene

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archaeological bone assemblages. This author reproduced several archaeological contexts using bovid limb bones previously broken while fresh, which were exposed to the hyenas. The first observation was the preference of these scavengers for the fat contained in the epiphyses. The degree of destruction and tooth-marks produced on these bone portions were very high (of the order of 90% or more in several cases). Similarly, the shafts remained in their original position, but some epiphyses were transported several metres and partially or integrally consumed. Marean and Spencer (1991) and Marean et al. (1992) carried out reproductions of hominid discarded assemblages subjected to the action of captive spotted hyenas to interpret several assemblages from Olduvai. During the series, the carnivores acted on the skeletal parts with a higher proportion of fat: vertebrae, ribs and epiphyses. The common resulting pattern was an assemblage with a predominance of limb bones, similar to those generated by the anthropogenic transport of cranial and limb bones (Marean et al., 1992) or, as Blumenschine (1991) suggested, to the accumulations generated by the human scavenging of carcasses abandoned by large felids (collecting bones with marrow).

These studies were mainly focused on the damage and destruction caused by carnivores. However, other archaeological evidence, such as lithic artefacts, wood, hearths, or spatial repartition and structuring, was not used, nor discussed in depth. The role of non-human scavengers on the abandoned camps was also observed in some ethnoarchaeological studies (Binford, 1978, 1981; Binford et al., 1988; Bartram et al., 1991; Yellen, 1991; O'Connell et al., 1992).

All of the researchers coincide in that displacement of material is not common, and that this phenomenon is only produced in the cases of tension among animals. In these cases, some bones can be moved to the peripheral areas of the site. Coprolites are common and are usually found in the ash of the hearths (Bartram and Marean, 1999; Klein et al., 1999).

On this basis, carnivores do not only destroy or modify the bones, but they can also affect the original position of the remains, altering significantly the spatial distribution left by human groups (Binford et al., 1988). This situation has made us question how large carnivores react to a recently abandoned structured hearth with a hearth-related assemblage, an element that can attract their attention powerfully (smells of meat, organic tissues or fat remains). This variable has not been contemplated by previous studies and is an important factor to value the degree of alteration or loss of spatial and behavioural information after a secondary access of carnivores.

To study this idea, we have carried out an experimental series with large extant carnivores in the *Parque de la Naturaleza de Cabárceno* (Cantabria, Spain) with the objective of tackling a case-specific archaeological problematic using experimental archaeology as understood by Domínguez-Rodrigo (2008) and as part of "middle-range" theory, based on the testing of alternative hypotheses (Binford, 1981; Gifford, 1981).

## 2. Experimental series: methodology

The animals in *Parque de la Naturaleza de Cabárceno* (Penagos, Cantabria, Spain) live in a semi-free state. Each animal group has enclosures of several hectares limited by natural barriers (cliffs) except for the visitors' observation points, which are enclosed by artificial integrated fences. The park policy is to interact as little as possible with the animals, which live in extensions and only food is provided for them. Consequently, animals live according to their instincts and no population control or other human interference is developed. Probably, animals living in a non-free state present misbehaviour in some aspects compared to wild animals. Nevertheless, the aim of our experiment is to prove capacities, which are not erased in semi-free state animal populations.

The experimental series consisted of the reproduction of a structured hearth (with associated stone blocks in a circular form) with faunal remains, wood and wood charcoal and a hearth-related lithic assemblage, inside four different carnivore enclosures in the park.

The large carnivores selected for the experiment were those that were most common in the alternation in the use of caves with human groups in European Pleistocene. Namely bears, lions, wolves and hyenas. These animals in consensus with the Veterinary Service of the Park, were not fed the day before the experiment so the game factor could be eliminated.

A team of three archaeologists and two guards (for safety reasons) entered the animal enclosures and constructed a hearth with a ring of local Cabárceno limestone ($n = 12$). These rocks were between 10 and 20 cm in size and were angular in shape (to avoid false increased displacements). The dimension of the combustion structure was 50 cm in diameter following the average size of some of the recorded Pleistocene hearths, which vary between 20 cm and 100 cm in diameter (e.g. Farizy, 1990, 1994; Mellars, 1996; Barton, 2000; Soler, 2001; Cabrera et al., 2004; Cain, 2005; Daujeard and Moncel, 2010; Slimak et al., 2010). Inside the experimental structure, a first layer of oak charcoal was deposited (0.4–0.6 kg), a second layer of dry oak leaves followed to help the combustion (0.05–0.1 kg) and finally oak wood was deposited over (0.5–1 kg). On top of all these layers, different fractured fresh cow limb bones (*Bos taurus*) were deposited. These bones were previously defleshed but contained traces of meat and fat, specially located on the epiphyses. The hearths were lit using ecological fuel briquettes (made of wood chips, paraffin and resin), so non-chemical additives were present.

Surrounding the combustion structure, five lithic tools (two flakes, a biface, one hammer stone and one stone anvil), where placed to observe if these hearth-related elements were spatially perturbed by the carnivores. All the lithic elements were documented, using silicon moulds and 3D scanning technology before and after the experimentation. The objective was to register all the kinds of modifications these materials might suffer. All these lithic artefacts were not used to deflesh the bones in order to not modify tools morphology before animals interact with them. Nevertheless, they were slightly impregnated with fat to generate the same effect as if they have been used to process the carcasses.

Before the hearths were lit, the structure and surrounding elements were documented with photogrammetry so future changes were observable in comparison with the non-modified hearth (N-MH) during the experimental series.

The mapping in the present experimental reproduction has been developed by photogrammetric techniques. The georeferencing process was established with a total station and GPS positioning techniques. The main objective was to record two scenes in detail in the shortest time (before and after the intervention of the animals).

Using stereoscopic pairs taken with calibrated optical cameras, we obtained 3D point-clouds that were combined and triangulated to acquire a high-resolution surface of the scene. All data obtained was processed with PhotoModeler Scanner v.6 software. The point-clouds were georeferenced by using targets measured with total station (Leica TCRM1205) that linked them to a provisional local system. Inside this system, other points strategically distributed in the near landscape were measured. Their position was also calculated in ETRS89 global reference system coordinates with a dual frequency RTK GPS (Leica GPS900) connected to the Cantabrian GNSS net. This way, it was possible to transfer all positions to the already mentioned reference system.

The experimental hearth (EH) burned in all cases for more than 40 min and less than 100 min. After this, the enclosure was