14. FROM TORTOISES TO ELEPHANTS: THE IMPACT OF ELEPHANTS IN THE BROAD SPECTRUM DIET AT BOLOMOR CAVE (MIS 9–5 SPAIN)

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ABSTRACT

Animal exploitation strategies have occupied a prominent place in the debate about the timing and nature of the modern human behavior. The discussions have basically focused on the ability to make an intensive use of seasonal resources, to hunt large or dangerous animals and to exploit fast-moving small game. Both large-sized herbivores and small prey are therefore considered a key variable to assess fundamental aspects of the evolution of subsistence strategies. In this work we present zooarchaeological data from the Middle Pleistocene site of Bolomor Cave (Valencia, Spain, MIS 9–5e), which has been interpreted as a habitat place. Its taxonomic representation extends from very large-sized herbivores (elephants, hippopotamuses and rhinoceroses) to very small-sized animals (lagomorphs, birds and tortoises), or even exotic animals like macaque. Elephant specimens are documented along the stratigraphic sequence from level Ia, IV, V, XII, XIII and XVII. Most of the elephant individuals are immature and partially represented. Nevertheless, the bone fragments recovered coincide with the general anatomical profile of the medium- and large-sized ungulates, which is mainly characterized by stylopodials, zeugopodials and mandibles. Evidence of human use of small prey from the earliest phases of site occupation (sublevel XVIIc) is also attested in form of cut marks, intentional bone breakages, human tooth marks and burning patterns. The exploitation of small prey, alongside to the very large game identified at the site, indicates a generalist human behavior based on a broad spectrum diet (BSD), which contributes to document the diversity in the lifestyles of the human communities of the European Middle Pleistocene.

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14.1 INTRODUCTION

Foraging behavior models linked to evolutionary ecology have shown that resource intensification can take several forms. Prey choice models predict that the highly ranked prey (those providing greater energetic efficiency in relation to search, hunting, processing and handling costs) will always be taken on encounter; if the rates of encounter with the preferred prey decrease, foragers are expected to expand their diets by including more lower-efficiency resources (Broughton, 1994; Bird and O'Connell, 2006; Clark, 2011). Stiner (2005) proposes that predators can afford to ignore low-ranked prey when high-ranked ones abound, thus favoring a narrow diet that emphasizes specific types of prey. As such, an expansion of food amplitude is expected to be one of the first responses to food stress (Kaplan and Hill, 1992).

A primary method to maximize the nutritional return of an animal is to incorporate body parts with low meat/marrow utility into the diet (e.g., Binford, 1978; Grayson, 1989); therefore, variability in transport patterns can provide valuable information on resource intensification. However, different factors can play a significant role in decisions made about the transport of whole animals or anatomical body parts, including the number of components in the hunting party (or available to help move the carcasses), the distance from the kill site to the consumption place, the size and condition of the carcass and even the time of day (Binford, 1981; Bunn and Kroll, 1986; O'Connell et al., 1988, 1990; Bunn, 1993; Gifford-Gonzalez, 1993; Faith et al., 2009). Unfortunately, it is difficult to identify these factors at the archaeological level. Ethnoarchaeological studies on hunter-gatherer groups, such as the Hadza, have demonstrated that small-sized prey (classes 1 and 2 *sensu* Bunn, 1986) are usually transported whole (Oliver, 1993); however, the interpretation of transport strategies for larger animals is a bit more complex, as multiple variables could intervene. In the case of proboscideans, the Bisa people (Zambia) remove the meat from the limbs and leave the bones at the death site, but the Ituri Forest people (central Africa) move the limb elements to their campsites to extract grease and fat from the bone medullary cavities and cancellous tissues (Crader, 1983; Duffy, 1984; Haynes and Klimowicz, 2015). The common point in most accounts is that there is significant variability in the processing depending on the size and condition of the animal and the number of people seeking meat or other carcass products (e.g., Crader, 1983; Duffy, 1984; Fisher, 1992; Haynes and Klimowicz, 2015).

Beyond measures of transport strategies and carcass use and processing, elephants are considered key elements in ecosystems; observing their behavior is vital for hunting-gatherer groups to develop successful strategies. Elephants know the location of water, mineral and vegetable resources, as well as meeting places, thanks to their complex mental maps (e.g., Douglas-Hamilton, 1972; Moss, 1982). These would also provide easily traceable travel routes, which could be followed by other mammals in their search for water during periods of drought, by carnivores in search of vulnerable prey and by human groups seeking the same resources.

14.1.1 PROBOSCIDEAN CARCASS USE IN THE IBERIAN PENINSULA DURING THE LOWER AND MIDDLE PALAEOLITHIC

The association between lithic tools and megafauna remains a recurring topic in Palaeolithic research, although it has not been without controversy (e.g., Villa, 1990; Haynes, 1991; Martos, 1998; Gaudzinski et al., 2005; Villa et al., 2005). Sometimes proboscidean remains with lithics appear in the same stratigraphic context, but because there are no direct traces on the bones, such as cut marks, percussion marks or intentional bone breakages, it is difficult to support human use of these carcasses with empirical arguments (e.g., Martos, 1998; Mussi and Villa, 2008). This is a recurring problem at many European Pleistocene sites; sometimes taphonomic conditions are linked to the preservation of the record or to external factors derived from the topographic situation of the deposits, leading even some authors to propose that the elephant-human interaction does not become well established until the Upper Palaeolithic (e.g., Frison and Todd, 1986; Fosse, 1998; Gaudzinski et al., 2005; Surovell and Waguespack, 2008).

When analyzing the possible evidence of the anthropogenic processing of elephants in the Iberian Peninsula, the Lower Palaeolithic site of Fuente Nueva-3 (FN-3, Granada, Spain) stands out as one of the oldest (>1.22 Ma; Espigares et al., 2019, this volume). Its elephant record is concentrated in the upper layer of FN-3 and the count of minimal number of elements (MNE) is much lower than the number of identified specimens (NISP), which is due to the abundance of ivory fragments. The presence of coprolites and lithic tools surrounding an incomplete elephant carcass have led Espigares et al. (2013) to suggest that hominins and hyenas (*Pachycrocuta brevirostris*) may have competed for the consumption of this megaherbivore. However, the carcass does not exhibit cut marks or percussion alterations that allow it to be directly associated with human activity. At this point, it is important to mention that the archaeological sites located in this type of context present often problems with both preservation, especially of faunal specimens, and the post-depositional processes related to the geological genesis of the deposits. This fact often prevents the identification of bone surface modifications. However, more important is to highlight the intrinsic difficulty in detecting marks on megaherbivore carcasses (e.g., Huckell, 1979; Crader, 1983; Frison and Todd, 1986).

A similar case can be found at the Áridos 1 site (MIS 9/11, Madrid, Spain), where a small assemblage of lithic tools was associated with the disarticulated carcass of an adult female straight-tusked elephant. The presence of hammer stones, conjoining artifacts and flakes from hand axes led the research team to propose an *in situ* knapping and re-sharpening (Santonja and Villa, 1990; Santonja et al., 2001). Significant differences between Áridos 1 and 2 have been described. In the case of Áridos 2 (MIS 11, Madrid, Spain), the partial skeleton of a large male straight-tusked elephant was preserved as a tight concentration of bones with cut marks on a scapular blade and the ventral side of a rib, which were linked to bulk flesh and viscera removal activities. In addition to these damages, tooth marks likely produced by hyaenids on the distal epiphysis of a humerus have also been identified (Yravedra et al., 2010). The combination of these alterations led Yravedra et al. (2010) to propose the existence of several access episodes and a sequence of actions in which hominins appear to have had early access to the carcass based on the cuts linked to visceral removal. The visceral content of elephant carcasses usually disappears rapidly, taken by the carnivores that access these animals primarily (Haynes, 1991, 2005). The review of the faunal materials from Áridos 2 has allowed for a refinement of the interpretations made in the first stage by Santonja and Villa (1990), where it was proposed that the animal died a natural death and, therefore, an opportunistic subsistence behavior of early humans. The backward torsion of the elephant spine was interpreted as a consequence of the drying of the carcass during its decomposition.

Other examples of associations of proboscidean remains with stone tools come from the Middle Pleistocene sites of Torralba and Ambrona (Soria, Spain; Villa, 1990; Howell et al., 1995; Santonja et al., 1999; Mussi, 2005; Santonja and Pérez-González, 2005; Villa et al., 2005). The last data place Torralba ~200 ka later than Ambrona (Santonja et al., 2014), dated to 350 ka by electron spin resonance/Uranium-series (ESR/U-series; Falguères et al., 2006). Although the presence of lithics and occasional cut marks indicates that humans visited both places, it has also been shown that natural and non-human factors played an important role in the genesis of these sites (Villa et al., 2001). Another place to highlight is the Barranc de la Boella (Tarragona, Spain), with lithic tools and *Mammuthus meridionalis* remains in stratigraphic association (Mosquera et al., 2015). Palaeomagnetic and cosmogenic nuclide analyses point to a 0.96–0.78 Ma chronology for unit II of Pit 1 (Vallverdú et al., 2014). The faunal assemblage shows a poor cortical preservation linked to chemical processes produced by lixiviation in sediments, as recorded at the nearby locality of La Mina (>500 ka; Pineda et al., 2014). Although the poor preservation of the bone surfaces makes it difficult to clarify the origin of modifications, two ribs show striae that seem to bear V-shaped cross-sections and Hertzian cones compatible with anthropogenic cuts. In the case of La Mina, bones of several species show damage that could initially be identified as cut marks, but subsequent taphonomic studies have indicated a possible post-depositional origin related to trampling processes. In the experimental study conducted by Pineda et al. (2014), trampling and cut marks were reproduced and were subjected to chemical alteration with the aim of observing how the diagnostic criteria that define cut marks are modified after an erosive action with chemical origin. These authors determined that at an experimental level, the cuts tend to preserve the symmetry and the cross-section shape, while the shoulder effect, microstriations and barbs tend to disappear gradually as the modifying process progresses. The application of these results to La Mina showed that the marks on the bones were chemically altered and, therefore, lost the diagnostic criteria necessary for a correct identification: a phenomenon that could be extrapolated to the general faunal assemblages from the localities that make up the Barranc de la Boella.

La Solana del Zamborino (Granada, Spain) is another archaeological site in Iberia that yields both proboscideans and stone tools. Its chronology has been a subject of controversy, although new magnetostratigraphic data suggested an age range between 480 and 300 ka, closer to the age of traditional Acheulean sites in Europe (Álvarez-Posada et al., 2017). Although the recovered materials have been only partially studied, *Mammuthus meridionalis* remains have been identified in the upper level (or level A) and *Palaeoloxodon antiquus* in the lower level (Ros-Montoya, 2010). The absence of anthropogenic marks on these specimens makes it difficult to establish a direct relationship between the human groups of Guadix-Baza and these large animals at the site.

With more recent chronologies, the PRERESA site (Madrid, Spain) was deposited during the second half of MIS 5, according to the OSL date of 84.126 ± 5.633 ka (Panera et al., 2014). Nevertheless, an older age was obtained by ESR, which dates the deposit within MIS 6 (Moreno et al., 2019). This site yielded 82 proboscidean bones belonging to one individual over a 130-m2 surface, although the highest concentration of industry and faunal remains was found in a 36-m2 area. The good preservation of cortical bones led to the identification of cut marks on six shaft fragments (Yravedra et al., 2012). In addition, intentional bone breakage is proposed by the presence of percussion damage and green fractures, confirming bone marrow extraction at the site. In other places, such as EDAR Culebro 1 (Madrid, Spain), no cut marks have been found on the *Mammuthus* cf. *intermedius* bones, but rather fresh bone breakages that could suggest an intentional fracturing process (Yravedra et al., 2014). Optically stimulated luminescence (OSL) and amino acid racemization (AAR) dates place this site between 120.541 ± 6.851 ka and 133 ± 28/105 ± 10 ka, respectively (Manzano et al., 2011; Silva et al., 2013).

As can be noted, the above-mentioned sites have the common characteristic of being located in open-air contexts. Only a few locations register proboscidean remains and lithic tools in karstic contexts, one of which is Teixoneres Cave (Barcelona, Spain), where a single fossil of *Mammuthus primigenius* was recovered from unit III, constituting 0.11% of the assemblage (44,210 to 33,060 cal ka BP). The specimen is an upper dP2, which is only present during nearly the first year of life (Álvarez-Lao et al., 2017). The presence of a single isolated dental specimen prevents a clear relationship with the human groups that inhabited the cave, as this type of remain does not usually show marks generated by such agents as humans or carnivores. In any case, its identification in the faunal

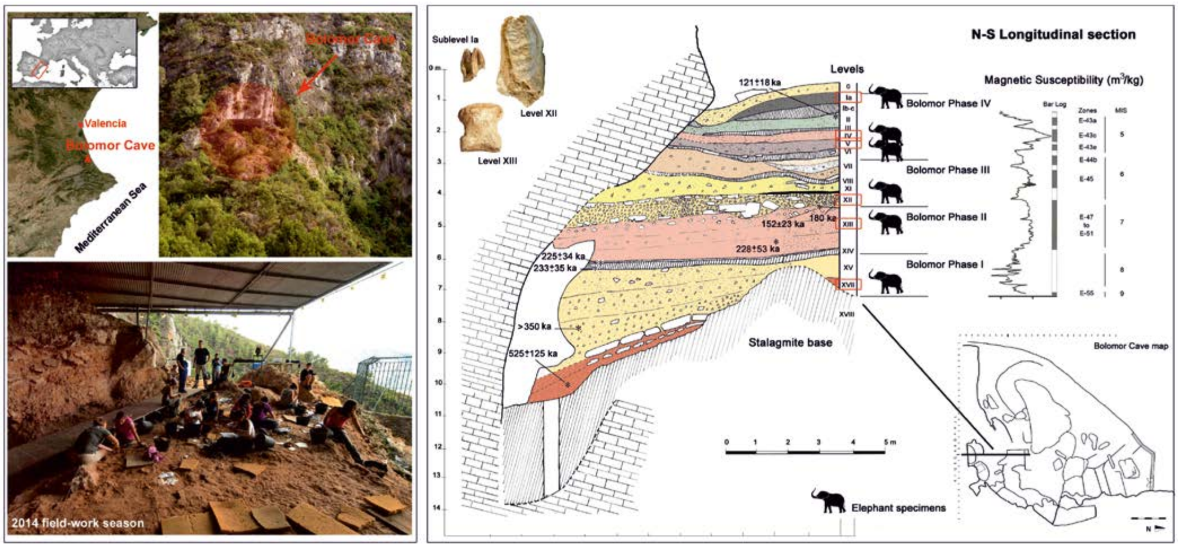

Figure 14.1: Location and stratigraphic profile of Bolomor Cave showing levels with elephant remains and radiometric dates.

record constitutes an exception for being the first Iberian find of a *M. primigenius* dP2. Its presence at Teixoneres reflects a faunal mixture in which cold-adapted species only reached the Peninsula occasionally, during the coldest episodes, sharing habitats with the local faunas instead of replacing them (Álvarez-Lao et al., 2017).

The Bolomor Cave site (MIS 9–5e; Valencia, Spain) is an interesting case study in the karst environment, as elephant remains, as well as other megafauna species —e.g., hippos, rhinos— show anthropogenic marks that allow their presence in the cave to be linked to the activity of the human groups. Our objective here is to present at the taphonomic level the proboscidean remains from the Bolomor sequence and include them within the broad spectrum diet (BSD) identified at the site (Blasco and Fernández Peris, 2012; Blasco et al., 2013a).

14.2 ARCHAEOLOGICAL AND GEOLOGICAL SETTING: BOLOMOR CAVE

The Bolomor Cave site (Fig. 14.1) is located on the southern slope of the Valldigna, ~2 km SE of Tavernes de la Valldigna (Valencia, Spain) and ~100 m above sea level. The cave belongs to the set of karstic forms developed along the northern face of the Mondúver mountain range.

The sedimentary sequence of Bolomor is formed by allochthonous material depositions of colluvial origin, along with other gravitational depositions from ceiling and wall detachments due to tectonic or weathering processes. This sedimentary filling rests directly on the Cretaceous rock that begins with lithochemical layers in the form of stacked calcite mantles. In these, layers of pure crystallized carbonate alternate with others that include ceiling detritic materials and without the presence of archaeological remains. On this base layer, others are deposited with subhorizontal projection and variable thicknesses depending on the area. The stratigraphy has 17 geo-archaeological levels from wall to ceiling in the western sector of the site (type profile), registering recurrent breccia processes with different carbonation degrees depending on the level (Fig. 14.1; Fumanal, 1993; Fernández Peris et al., 1994, 1997; Fernández Peris, 2007). An AAR dating on the dental enamel of 525 ± 125 ka has been obtained at level XVII. Thermoluminescence (TL) results have established values of 233 ± 35 and 225 ± 34 ka at level XIV and 152 ± 23 ka at level XIII. Finally, level II has provided an absolute dating by TL of 121 ± 18 ka (Fernández Peris, 2007). There is currently a programme underway, radiometric dating by OSL, ESR and palaeomagnetism, which will further refine the chronology of the entire sequence.

The faunal assemblage consists so far of 30 species (Table 14.1), including primates, carnivores, herbivores and what could be considered small prey from a zooarchaeological approach (rabbits, birds and turtles). The taxa with a higher representation along the stratigraphic sequence are red deer (*Cervus elaphus*) and horse (*Equus ferus*), followed by auroch (*Bos primigenius*), fallow deer (*Dama* sp.), thar (*Hemitragus bonali* and *Hemitragus cedrensis* at level IV), giant deer (*Megaloceros giganteus*), wild ass (*Equus hydruntinus*), steppe rhinoceros (*Stephanorhinus hemitoechus*), wild boar (*Sus scrofa*), macaque (*Macaca sylvanus*), elephant (*Palaeoloxodon antiquus*) and hippopotamus (*Hippopotamus amphibius*), among others. Although carnivores are occasional, remains of *Ursus arctos*, *Ursus thibetanus*, *Canis lupus*, *Panthera leo*, *Lynx pardinus*, *Vulpes vulpes* and *Meles meles* have also been recovered (Sarrión and Fernández Peris, 2006; Blasco and Fernández Peris, 2010; Fernández Peris et al., 2014). It is also important to highlight the presence of small animals, such as rabbits (*Oryctolagus cuniculus*), hares (*Lepus* sp.), birds (e.g., Passeriformes including Corvidae; Galliformes including Phasianidae; Columbidae; Anatidae), tortoises (*Testudo hermanni*) and occasionally fish (Salmonidae). The percentage of leporids at level IV and Anatidae at level XI together exceeds 50% of the total minimum number of individuals (Blasco and Fernández Peris, 2009, 2012; Blasco et al., 2013a).

Thus far, seven human bones and dental specimens have been recovered in total. Some come from the screening of sediments generated by the 1930s quarry works in the cavity, while others have been recovered during the excavation process, thereby having a clear stratigraphic location. Arsuaga et al. (2012) propose that the morphology of Bolomor human specimens is compatible with that of the European human fossils of the European Middle Pleistocene.

The lithic industry from Bolomor has been classified as a techno-complex of the early Middle Palaeolithic, which is older than the classical regional Mousterian, although without connection to the Acheulean industries (Fernández Peris, 2007; Fernández Peris et al., 2008). The lithic record is composed of more than 50,000 pieces, of which only 11% are retouched tools. The typological and technological characteristics allow us to define the lithic assemblage as a techno-complex of small flakes (with non-laminar microlithism) and as having a predominance of side-scrapers and denticulates. The pieces feature intense reuse and recycling in the upper levels (Fernández Peris, 2007; Cuartero, 2008). The raw materials consist mainly of flint, limestone and quartzite, and they come from marine, colluvial and fluvial rocks located at areas near the site, but also from more remote areas such as the Xùquer and Serpis basins (~15 km from the site). The variability identified throughout the sequence is limited and seems to be marked by the occupational characteristics of each level. In fact, the assemblages acquire some complexity in the most recent levels of the sequence, when occupations seem to have been more intense (Fernández Peris, 2007). It is also worth mentioning that several bone retouchers have been recovered at levels XVII, XIII and XII, and they demonstrate the inclusion of softer materials within the lithic operating sequences (Blasco et al., 2013b; Rosell et al., 2015; Blasco, 2019).

Evidence of the controlled use of fire has been documented at levels II, IV, XI, XII and XIII (Fernández Peris et al., 2012). Hearths from Bolomor are morphologically simple, with no apparent overlays and flat bases. Their appearance is lenticular, with diameters between 30 and 120 cm and an average thickness of 5–10 cm. One of the four hearths from level IV also includes thermally altered centimeter-sized clasts at its base. Level XI yielded seven simple hearths without internal structuring and that seem to correspond to short-term combustions according to experimental reproductions (Fernández Peris et al., 2007). Finally, two combustion structures have been documented at sublevel XIIIc that show a preparation of the area prior to ignition with stones at the base. An AAR dating of 228 ± 53 ka on malacofaunal remains from the area around the hearths was carried out by the Biomolecular Stratigraphy Laboratory of Madrid, Spain. This chronological frame places Bolomor Cave as one of the oldest evidence of the controlled use of fire in southern Europe to date (Fernández Peris et al., 2012; Vidal-Matutano et al., 2019).

14.3 METHODS

The methodology of the faunal analysis in this study has followed the published standards for Taphonomy, with special emphasis on bone modifications produced during carcass processing (e.g., Lyman, 1994, 2008).

The high degree of fragmentation in Bolomor bone assemblages has made it difficult to conduct taxonomic and anatomical identification. Nevertheless, the "unidentified" fragments have been included in the zooarchaeological analysis by classifying them anatomically according to their morphological characteristics into long bones, flat bones and articular bones (e.g., carpal, tarsal and patella) and, at a taxonomical level, into body size classes that depend on the animals' weight and age (Bunn et al., 1988; Blasco et al., 2013a): 1) very large size or classes 5–6 (taxa weighing >1,000 kg; e.g., elephant, rhinoceros, hippopotamus), 2) large size or class 4 (300–1,000 kg), 3) medium size or class 3 (100–300 kg), 4) small size or class 2 (20–100 kg), and 5) very small size or class 1 (<20 kg). Dental replacement and wear have been used as indications to determine the age at death of the animals that make up the assemblage, as well as the degree of bone epiphysation and cortical tissue type (compact in adults or more porous in immature individuals). The accounting of the analyzed specimens has been carried out according to indices, such as the number of specimens (NSP), number of identified specimens (NISP), the minimum number of elements (MNE) and minimum number of individuals (MNI). These indicators allow the minimum anatomic units (MAU) and their relative frequencies to be established (Emerson, 1993).

Bone surface modifications that are produced by biological agents (mainly hominins and carnivores) have been treated at both the macroscopic and microscopic levels. For this, a binocular magnifier (120×) has been used systematically. Selected specimens have also been observed using a 3D digital microscope (HIROX KH-8700). Regarding anthropogenic damage, special attention has been paid to cut marks (e.g., Lyman, 2008), which have been grouped into incisions, sawing marks, chops and scraping marks. Other characteristics, such as their location and orientation have also been noted. The criteria described by Maguire et al. (1980) and Blumenschine and Selvaggio (1991) have been used to identify carnivore damage. As with the cut marks, alterations were recorded by considering the anatomical portion where they are located. Bone fragmentation has been analyzed following the nomenclature described by Villa and Mahieu (1991). In addition, recent (during or after excavation) or old fractures (at or close to the time of deposition) were distinguished according to changes in color at the edge and in the angle that the breakage plane presents. To identify anthropogenic percussion marks, we used the diagnostic elements defined by Blumenschine and Selvaggio (1988), Capaldo and Blumenschine (1994), Domínguez-Rodrigo and Barba (2006) and Pickering and Egeland (2006).

Bone thermal alteration has been analyzed in terms of presence/absence and based mainly on color changes and other physical alterations, such as fissures, fractures or cracks (e.g. Stiner et al., 1995). The intensity degrees have been classified into six categories: grade 0 for unburned bones and grade 5 for calcined ones. As in the case of the other alterations, the anatomical area where burning appears has also been noted.

Finally, faunal specimens were also analyzed for post-depositional alterations that include root etching, fissures, calcite coating/breccia and black

NISP	**Ia**	**Ib-c**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**XI**	**XII**	**XIII**	**XIV**	**XV**	**XVIIa**	**XVIIc**
Pisces indet.					2					1						
Testudo hermanni	465	10	9	67	526	84				4		4		4		
Bufo sp.					4										1	
Pyrrhocorax sp.					6											
Corvidae indet.					20											
Passeriformes indet.					25						13				5	9
Phasianidae indet.					24										18	10
Galliformes indet.					19						8				8	
Cygnus olor											1					
Anas sp.					29						21					16
Aythya sp.					34					202						
Anatidae indet.															4	
Columba sp.					34											
Strigidae indet.					1											
Aves indet.	32	3			17	18						2		22		
Castor fiber										2	2					
Oryctolagus cuniculus	167	28	5	52	789	297				262	135	182		1156	620	457
Lepus sp.		1						1							5	
Macaca sylvanus					1						2			1		
Palaeoloxodon antiquus	11				5	2					3	8			4	4
Meles meles		3														
Ursus arctos				2	1	1										
Ursus thibetanus	2												1			
Vulpes vulpes					2											
Canis lupus	2				2							2			4	
Lynx pardinus					2						1					
Panthera leo					3											
Carnivora indet.	2	3		2	5	1						2		1		
Equus ferus	28	4	1	5	65	2				2	165	11		41	77	56
Equus hydruntinus	3	2	1		16											
Stephanorhinus hemitoechus		1		1						3	6	2		3	8	1
Sus scrofa	17	1		7	115	3										
Hippopotamus amphibius	4	2		3	46	2										
Dama sp.	9	3	1	2	91	6				4	17	5		4	27	13
Cervus elaphus	271	18	7	55	647	18	3			55	325	51		50	177	132
Megaloceros giganteus										2	5			2	10	8
Cervidae indet.	20	4	1	4								1		5		
Bos primigenius	146	11	12	61	213	16	3		1	2	35	2		1	24	22
Hemitragus bonali										16	4	12		23	28	6
Hemitragus cedrensis	4	1	1	4	121	2										
Caprinae indet.	36	2	4	5		19	1					5		7		

Table 14.1: Number of identified specimens (NISP) throughout the stratigraphic sequence of Bolomor Cave. Data from levels Ia, Ib-c, II, III, V, VI, VIII, XIII and XV were taken from Fernández Peris (2007), and data from levels IV, XI, XII and XVIIa/c were taken from Blasco and Fernández Peris (2012) and Blasco et al. (2013a). *Lepus* sp. data were taken from Sanchis Serra and Fernández Peris (2011) and *Ursus thibetanus* from Sarrión and Fernández Peris (2006). NISP shown in *Palaeoloxodon antiquus* corresponds to a material review that includes specimens from recent excavations.

	Ia	IV	V	XII	XIII	XVIIa	XVIIc	NISP
Teeth	8	5	2	1	3	4	4	27
Maxilla					1			1
Mandible				1				1
Humerus	3							3
Tibia					2			2
Carpal/tarsal				1				1
Phalanx					2			2
NISP	**11**	**5**	**2**	**3**	**8**	**4**	**4**	**37**

Table 14.2: Proboscidean specimens (NISP) from Bolomor Cave.

stains from manganese oxide deposits (Lyman, 1994).

14.4 RESULTS

The Bolomor stratigraphic sequence yields a high fauna diversity with *Cervus elaphus* as the predominant taxon at all levels, followed by *Oryctolagus cuniculus*, *Aythya* sp. at level XI, *Equus ferus* at XII and *Testudo hermanni* at Ia and IV (Table 14.1; Blasco, 2008; Blasco and Fernández Peris, 2009, 2012; Blasco et al., 2013a; Fernández Peris et al., 2014). The presence of *Palaeoloxodon antiquus* has been registered at levels I, IV, V, XII, XIII and XVII with a total of 37 remains (Table 14.2), being more abundant at levels I (NISP = 11), XIII (NISP = 8) and XVII (NISP = 8). Apart from these remains, 14 fragments of long bone shafts have also been recorded without clear diagnostic elements that allow them to be attributed to the family Elephantidae, but which can be classified into classes 5–6 or a very large-size category (NISP I = 1; XII = 3; XIII = 2; XVII = 8). Most elephant specimens were recovered during the excavation process, thereby having a clear stratigraphic location; nevertheless, others were retrieved from sediments disturbed by 1930s quarry works. In these cases, their stratigraphic attribution was conducted based on the sedimentological criteria of the breccia in which the fossils were embedded.

Most of the recovered specimens are dental fragments, both molars and tusks (NISP = 27). An almost complete mandible (with the lower edge preserved) of an immature individual in the case of level XII and a maxillary fragment in XIII have also been retrieved; the remaining specimens correspond to acropodials (NISP = 2) and basipodials (NISP = 1) and mostly to the upper and intermediate limb bones, highlighting the distal humerus (NISP = 3) and the tibia (NISP = 2). Of the 37 fragments identified at the taxonomic level, only 23 allow the age at death to be established; among these, 15 belong to immature individuals (65%). This fact contrasts the age profile determined for the rest of the Bolomor animals, where adult individuals predominate in classes 2–4 with percentages ranging between 92% at level XVIIa and 83% at level IV (Blasco and Fernández Peris, 2012; Blasco et al., 2013a). On the contrary, the skeletal profile of elephants does seem to fit *grosso modo* with that documented for ungulates of classes 2–4, which is characterized by a high representation of cranial and appendicular bones and an almost total absence of vertebrae and ribs, especially marked in classes 3–4 (Fig. 14.2).

The high presence of dental fragments (73%) is a limitation in the search for taphonomic signals of anthropic origin, as the teeth do not usually bear cut marks or other evidence resulting from the nutritional use of carcasses. Despite this, cut marks have been identified on a right mandible of an immature elephant individual from level XII (Fig. 14.3B). This specimen shows five incisions on the vestibular surface of the mandibular body, following an oblique orientation that tends towards

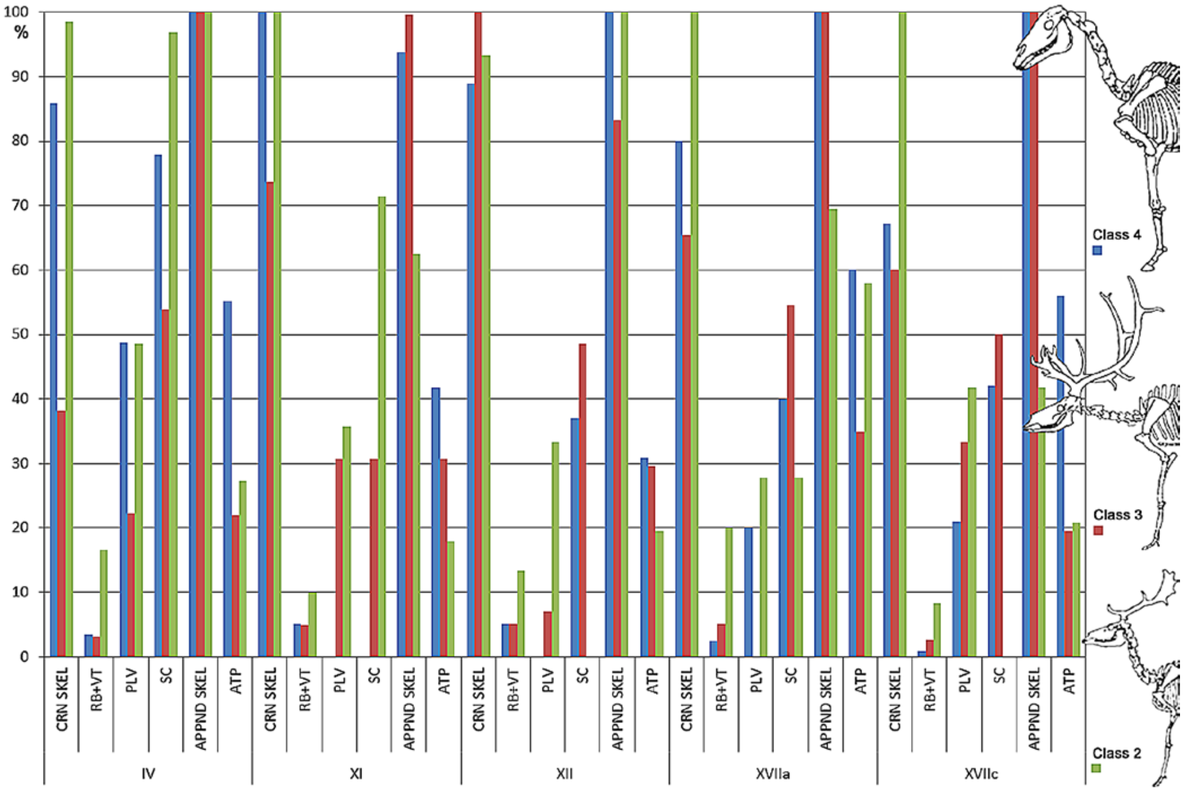

Figure 14.2: Graphic representation of anatomical profiles (%MAU) of classes 2–4 from levels IV, XI, XII and XVII. Abbreviations: CRN SKEL = cranial skeleton; RB+VT = ribs and vertebrae; PLV = pelvises; SC = scapula; APPND SKEL = appendicular skeleton; ATP = autopodial bones.

a longitudinal and straight arrangement (with a slightly curved tendency in one of the striations). The presence of these modifications points to defleshing activities related to the removal of a cheek. The remaining proboscidean bones do not show clear anthropogenic marks, although their fracture planes indicate a fresh state at the moment of breaking open, showing mostly curved/V-shaped planes, oblique angles and smooth edges (68%). Thermo-alteration is present on the proboscidean remains that come from levels I and IV, with nine affected specimens in total (24%). The observed alteration degrees are 2 and 3, which describe brown and to a lesser extent blackish colors, with both partial and widespread occurrence.

The carnivore activity is very low or practically absent in animals of classes 2–4, with percentages between 0.5% at level IV and 5.8% at level XII (see Blasco and Fernández Peris, 2012 and Blasco et al., 2013a for more details). In the case of elephant specimens, partial loss of cancellous tissue has been detected, especially on epiphyses, sometimes associated with moderate erosion of the cortical. This is especially visible in the case of a first phalanx from level XIII (Fig. 14.3A). Apart from this damage, black stains from manganese oxide deposits (NISP = 25; 67%) and calcite coating/breccia (NISP = 21; 57%) have been identified as predominant post-depositional alterations. These modifications indicate that the cave was relatively damp, with intermittent dry periods, although the cracking rarity suggests that the dampness was more or less constant without abrupt changes. Damage in the form of root etching has also been recorded in 27% of the proboscidean specimens (NISP = 10), indicating the entry of light into the cave. On the contrary, no remains have been detected that present visible degrees of rounding and polishing that would suggest dynamics of significant spatial dislocation.

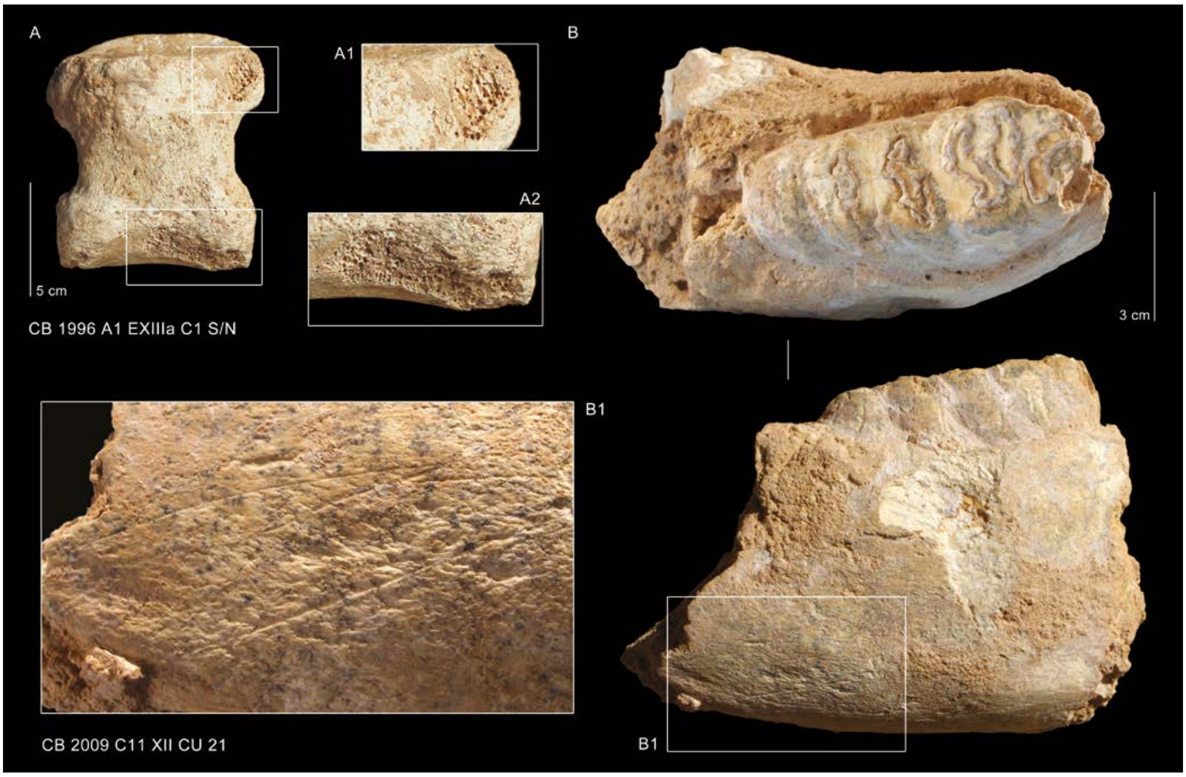

Figure 14.3: Elephant first phalanx with cortical tissue loss on articular edges (**A**) and elephant mandible showing cut marks on body (**B**).

14.5 DISCUSSION AND CONCLUSIONS

Human hunting of medium-sized ungulates is commonly accepted in Palaeolithic research; however, megafauna procurement through this technique is still under debate (Lupo and Schmitt, 2016). Binford (1987) suggested marginal scavenging as the main strategy for procuring elephants. In contrast, the hunting of proboscideans by prehistoric humans has been suggested at several Middle (e.g., Germonpré et al., 2014, this volume) and Upper Palaeolithic sites (e.g., Fladerer, 2003; Bosch et al., 2012; Brugère, 2014; Germonpré et al., this volume), mostly based on indirect zooarchaeological evidence. The truth is that determining whether these animals were hunted or were part of opportunistic activities related to secondary accesses to resources is a difficult issue to address, especially in such localities as Bolomor Cave. However, this is not only difficult at sites interpreted as habitat places in caves, but also in open-air sites. These localities usually present numerous taphonomic problems, which often make it difficult to identify anthropogenic bone alterations and, consequently, zooarchaeological interpretations. In addition, it should also be borne in mind that the high proportion of biomass available in animals the size of an adult elephant, rhinoceros or hippopotamus makes it difficult for the lithic tool to contact the bone when the access is primary. That is, the amount of meat available through this type of access does not favor the continuous contact of the stone tool with the processed skeletal element (unlike in a secondary access, where the extraction of dried meat attached to the bone would favor a higher proportion of sawing marks and prominent incisions). Some ethnographic studies confirm this fact by describing how large muscle masses, cartilage and periosteum thickness in the elephant carcasses make it difficult for the lithic tool to come in contact with the bone after disarticulating (e.g., Huckell, 1979; Crader, 1983; Frison and Todd, 1986). In fact, most proboscidean-lithic tool sites have one aspect in common, regardless of how varied the records are: the absence or scarcity of exploitation traces of proboscidean meat by humans (Gaudzinski et al., 2005). Despite this, and considering these limitations, some authors suggest the development of hunting strategies on these animals at such sites as Biache-Saint-Vaast (France; Auguste, 1995) or La Cotte de St Brelade (Jersey, U.K.; Scott, 1980; but see also Scott et al., 2014 and Smith, 2015). Scott (1980) proposed the existence of complex hunting techniques that would take advantage of the physical environment to facilitate capture —mammoth drive events—–from the megafaunal bone heaps of layers 3 and 6.1 of La Cotte. However, in a subsequent study, Scott et al. (2014) contended that the terrain surrounding the site prevented such drives, and instead suggested a strategy of hunting individual mammoths in the valley beneath the fissure, followed by the transport of selected body parts uphill to the site. New taphonomic analyses conducted by Smith (2015) confirm that Neanderthals occasionally exploited megafauna species (mammoth, woolly rhino) at this site; however, their acquisition and role in the human diet still remain ambiguous. In other localities, another type of access has been suggested in which there may not be direct anthropic intervention in the death of animals. These are natural traps in lakes, where animals with a significant weight could get caught in the mud. An example of this phenomenon is suggested at La Polledrara (Italy), where elephant bone tools identified as human-made were also retrieved (Anzidei, 2001; Anzidei and Cerilli, 2001). For Poggetti Vecchi (Italy) Aranguren et al. (2019) proposed that the elephants died due to natural causes and were butchered soon after, as minimal carnivore damage was observed. In addition, the lack of weathering led these authors to suggest that 1) the butchery was carried out onshore and then the bones rapidly ended up submerged or 2) the bones were semi-submerged while being defleshed and were completely underwater almost immediately after butchery. Nevertheless, it has not been possible to distinguish between a possible primary (and immediate) access and an anthropic use after the natural death of elephants at a large number of sites, such as in Torralba and Ambrona in Spain (Villa et al., 2005) and Kärlich-Seeufer in Germany (Gaudzinski et al., 1996).

Beyond the procurement method, elephants are an ideal food source to meet human nutritional needs due to their combination of protein and fats, with half the potential calories contained in fats (see Ben-Dor et al., 2011 for more details; Ben-Dor and Barkai, this volume). Isotopic studies provide direct evidence of the consumption of proboscideans and indicate recurrent consumption in specific European environments (Bocherens, 2011; Bocherens et al., 2015; Bocherens and Drucker, this volume). It has been suggested that high isotope values could only be the result of habitual dependence on terrestrial megafauna and that mammoths could have been the most important protein source (Drucker and Bocherens, 2004). Nevertheless, there have been criticisms of methodological and interpretation problems with stable isotope analysis, including our way to understand how the carbon isotopic signature is related to other prey species —that is, how δ13C is consumed by herbivore taxa with different diets (e.g., Lee-Thorp and Sponheimer, 2006). Another criticism is that most of these isotopic studies have been undertaken on Neanderthal fossils located within the northern area of Neanderthals' range and therefore, within very specific ecosystems. This fact has undoubtedly limited the generalizability of the findings, because as soon as new data from the southern and western regions were added, a more varied diet containing plants and occasionally marine resources emerged (Salazar-García et al., 2013; Fiorenza et al., 2015). Nevertheless, and despite the fact that regional variation in the Neanderthal diet is currently assumed, terrestrial meat continues to show up as a major resource in all the studies. The importance of proboscideans in the Palaeolithic diet is further emphasized through sites such as Bolomor Cave, to which selected anatomical parts of the elephant body were transported. Other examples are found at the Neanderthal site of Spy, in Belgium, and the Early and Late Palaeolithic site of Ma'anshan in China (Zhang et al., 2010; Germonpré et al., 2014, this volume). In the case of Bolomor, the skeletal profile of elephants is very biased, with a primary representation of cranial elements (mandible, maxilla and dental fragments), limb bones (tibia, humerus) and, to a lesser extent, basipodials and phalanges. It should be noted that no axial elements or pelvises have been recovered. This fact coincides with the general skeletal representation of ungulates of classes 3–4 from the site, and it leads us to think that the preparation system of the carcass for transport at the procurement place or killing site was similar. The fact that most of the individuals are immature also means that the weight of elephants found in Bolomor is less and, therefore, their transport after dismemberment is more feasible and manageable. Although there are many variables to consider (see e.g., Binford, 1981; Bunn and Kroll, 1986; O'Connell et al., 1988, 1990; Bunn, 1993; Gifford-Gonzalez, 1993; Faith et al., 2009), most ethnographic studies agree that animal weight is an important condition when making decisions regarding the transport of anatomical parts to the habitat place (e.g., Bunn and Kroll, 1986; O'Connell et al., 1988, 1990). Several studies report how some present-day groups, such as the Ituri Forest people, perform a selective transport (limb bones) when the animal has a considerable weight, or they move to the death site, establishing temporary camps around the elephant while the butchery process lasts; other cases are also documented in which groups, such as the Bisa of Zambia, deflesh the carcass, leaving the bones at the death site (e.g., Crader, 1983; Duffy, 1984; Fisher, 1992). These latter options could fit with the anthropogenic activities related to animals exceeding 1 tonne of weight, as in the case of Bolomor. That is, the under-representation of such large prey species could be related to the occasional displacement of human groups to the kill sites or explained as the sole and exclusive transport of the animal external resources (e.g., meat) to the site, leaving no archaeological signature after being consumed. Proof of this is the existence of several European open-air sites that have been interpreted as hunting ground or natural traps in which the skeletal representation of very large animals is usually characterized by their high anatomical integrity, such as in the French site of Biache-Saint-Vaast (Auguste, 1995). In some of these localities, intentional bone breakage has also been identified, such as in the PRERESA and EDAR Culebro 1, Spain (Yravedra et al., 2012, 2014). This fact would support the *in situ* anthropogenic use of these animals. In the case of Bolomor, no diagnostic criteria for an intentional fracturing in the form of percussion notches or pits have been detected, but green-bone fractures have been documented, and they could be indirectly related to bone marrow extraction, activity widely recorded on the rest of the ungulates from Bolomor (Blasco and Fernández Peris, 2012; Blasco et al., 2013a). An intentionally broken elephant bone shaft has been registered in Notarchirico (Italy), although it is not specified whether there are percussion marks or only fresh fractures (Mussi, 2005: p. 408).

Unlike most mammals, elephant bones show a different medullary cavity with a prominent cancellous or trabecular tissue. CT scans conducted on limb bones of adult individuals of *Palaeoloxodon antiquus* show small medullary cavities compared to the size of bones, especially in the case of the femur, and the humerus and tibia of older individuals (Boschian et al., 2019). These data contrast those provided by some individuals of *Elephas maximus*, where bones do not include marrow cavities (Nganvongpanit et al., 2017). These characteristics could make the process of extracting fat yellow marrow in elephants more difficult or laborious than in other animals. Although it has been registered that some present-day indigenous groups, such as the Ba-Mbuti of Zaire (Turnbull, 1961; Duffy, 1984), break the elephant limb bones to remove the bone marrow, this practice seems uncommon in other populations (Clark, 1977; Crader, 1983). Some accounts describe a relatively simple technique to obtain bone marrow that consists of partly splitting open the elephant bone, then hanging it in the sun for the oil to drain

(Tabler, 1963); however, the development of this technique would imply the existence of containers of some kind to collect the liquid fat. A fact that attracts attention is the lack of evidence of bone marrow exploitation in the Clovis sites (Haynes, 1991; Haynes and Krasinski, 2010; Haynes and Klimowicz, 2015). Taphonomic analyses carried out at these sites suggest that elephants were hunted regularly, a circumstance that perhaps led to the dismissal of marrow removal because the group already had sufficient food resources (Yravedra et al., 2012). In contrast, Haynes (1991) argues that the limb bone marrow of subadult individuals would have been relatively unattractive, and that the marrow of adults could have had low nutritional value due to malnutrition.

Cut marks can be considered the most direct taphonomic evidence of carcass processing. In the case of Bolomor, incisions on a mandibular fragment of an immature elephant have been identified. These are located on the vestibular surface and can be related to the extraction of the muscular pack that makes up the dewlap. As mentioned, cut marks are uncommon on elephant bones, either due to preservation problems (especially in open-air sites) or by the animal's own anatomy (especially if the carcasses are processed after a primary access; e.g., Huckell, 1979; Crader, 1983; Frison and Todd, 1986). Despite these considerations, most accounts agree that there is significant variability in the processing depending on the size and condition of the animal and the number of people seeking meat or other carcass products (e.g., Crader, 1983; Duffy, 1984; Fisher, 1992; Haynes and Klimowicz, 2015). Despite the limitations, this type of bone surface modification has been detected at several sites. One of the oldest examples of elephant exploitation in Eurasia is Gesher Benot Ya'aqov (Israel), where the damage below the nasal opening, together with the missing basicranial and palatal regions in the cranium, were interpreted as possible deliberate brain extraction and trunk removal (Goren-Inbar et al., 1994). Cut marks were described at the Middle Pleistocene site of Bilzingsleben (Germany; Mania, 1990), as well as at Belchatów (Poland) on a *Mammuthus trogontherii* rib, probably linked to flesh filleting (Pawłowska et al., 2014). Other examples can be found at Kulna (Czech Republic; Moncel, 2001) and Molodova I (Ukraine; Demay et al., 2012). Disarticulation cut marks on proboscidean ribs and long bone shafts were reported at Castel di Guido (Italy; Mussi, 2005), although subsequent taphonomic revisions detected abrasion processes that altered the cut marks substantially (Boschian and Saccà, 2010; Saccà, 2012). In the Iberian Peninsula, Áridos 2 (Spain) yielded a cut-marked scapula and rib, indicating defleshing and evisceration (Yravedra et al., 2010), and PRERESA yielded six cut-marked shaft fragments linked to meat extraction activities (Yravedra et al., 2012). The case of Bolomor is significant, as it is the only peninsular site in cave that records cut marks on proboscidean specimens. This fact establishes an association between elephants and hominins in a different way than that observed at other Middle Pleistocene open-air sites of Iberia, which have been interpreted as kill sites or natural traps (see above). This evidence also completes the broad spectrum diet identified at the site, which includes small prey (e.g., tortoises, rabbits and birds) as well as animals exceeding a weight of one tonne (e.g., rhinoceroses, hippopotamuses and elephants; Blasco and Fernández Peris, 2012; Blasco et al., 2013a).

Some researchers have proposed that proboscidean exploitation was opportunistic and of secondary importance during most of the Pleistocene (Gaudzinski et al., 2005; Smith, 2015). Furthermore, zooarchaeological approaches have demonstrated that while megafauna species appear to be present in many Middle Palaeolithic faunal assemblages, other prey species outweigh them frequently. This might be the case with Bolomor, although we cannot forget that this view comes from a karstic site in which prey above a certain weight were usually brought in selected body parts and therefore, does not reflect the scenario that other open-air localities with elephants describe. Beyond this, the picture that emerges from the Bolomor data indicates, on the one hand, the diverse environments that hominins were able to exploit; and on the other, the decision-making of human groups when selecting resources within the territory and bringing them to the cave. Bolomor Cave helps us to decisively characterize the subsistence strategies of Middle Pleistocene human groups, demonstrating high adaptability, not only in the wide and varied spectrum of prey, but also in the methods and techniques of obtaining resources.

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