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## A TAPHONOMIC PERSPECTIVE IN THE UPPER PLEISTOCENE OF THE IBERIAN PENINSULA

*ABSTRACT: The arguments for the reconstruction of the hominids' economic behaviour have been discussed by many researchers in the last years. The taxonomic variability, age and mortality patterns or skeletal part profiles are ambiguous tools used in zooarchaeology. It is very usual to find them support or reject hunting or scavenging behaviours. Here we show that the use of taxonomic patterns, ages or skeletal part profiles is not the proper diagnosis for the identification of different economic strategies. On the other hand, several experiments and archaeological evidence reveal that bone surface alteration is the most efficient tool we can use in the interpretation of faunal remains and bone accumulations.*

*KEY WORDS: Hunting – Scavenging – Iberian Peninsula – Cut marks – Taphonomy – Mousterian – Upper Palaeolithic*

### INTRODUCTION

The present work contributes to the discussion on methods used in zooarchaeology to reconstruct the economy behaviour during the Pleistocene. A wide group of scholars (Vrba 1975, 1980, Binford 1981, 1984, Strauss 1992, Díez 1992, Klein, Cruz-Urbe 1994, Stiner 1994) use taxonomic patterns, skeletal part profiles, and mortality patterns to argue hominid scavenger behaviour during the Lower and Middle Palaeolithic. On the contrary, we prove the equifinality of these methods with the Upper Pleistocene faunal data of the Iberian Peninsula (Yravedra 2001). The results of our studies show that the taxonomic patterns, skeletal part profiles, and mortality patterns are similar in the Middle and Upper Palaeolithic, so that these methods are ambiguous and there are other alternatives, which are more relevant for the reconstruction of hominid behaviour. It is the study of bone surface alterations, and we have applied this method to the Middle Palaeolithic of the Iberian Peninsula.

### MATERIAL

In the present study zooarchaeological data from 106 sites of the Middle and Upper Palaeolithic of the Iberian Peninsula

are discussed (*Figure 1*), but the available information varies according to site (Yravedra 2001). Therefore there are some places with taxonomic data, skeletal and mortality profiles, whereas for others these are not available. The main consequence of this differential information is that the sites with study of bone surface modification are scarce.

In the *Appendices 1-3* we describe the location, cultural description and dating of all sites treated in this article (*Figure 1*). Now we present the sites with study of bone surface modification that we have used as example in this paper. We have selected these sites because they have a few ideal characteristics for our study. They present a good conservation of bone surface, and they are the only ones with complete taphonomic analyses. In these studies, the percentage of cut marks and tooth marks is described for different animals, anatomical profiles and sections of the appendicular skeleton.

The Moros of Gabasa cave (Huesca, Spain) is located in the northeast of the Iberian Peninsula (*Figure 1, point 15*) on a limestone escarpment south of the Pyrenean mountain chain (Subpyrenean area) in Aragon, at an altitude of 780 m above sea level. The cave is portioned into two chambers, but the prehistoric site is found only in one of them, where seven seasons of archaeological excavations were carried out from 1984 to 1994 under the direction of P. Utrilla and L. Montes.

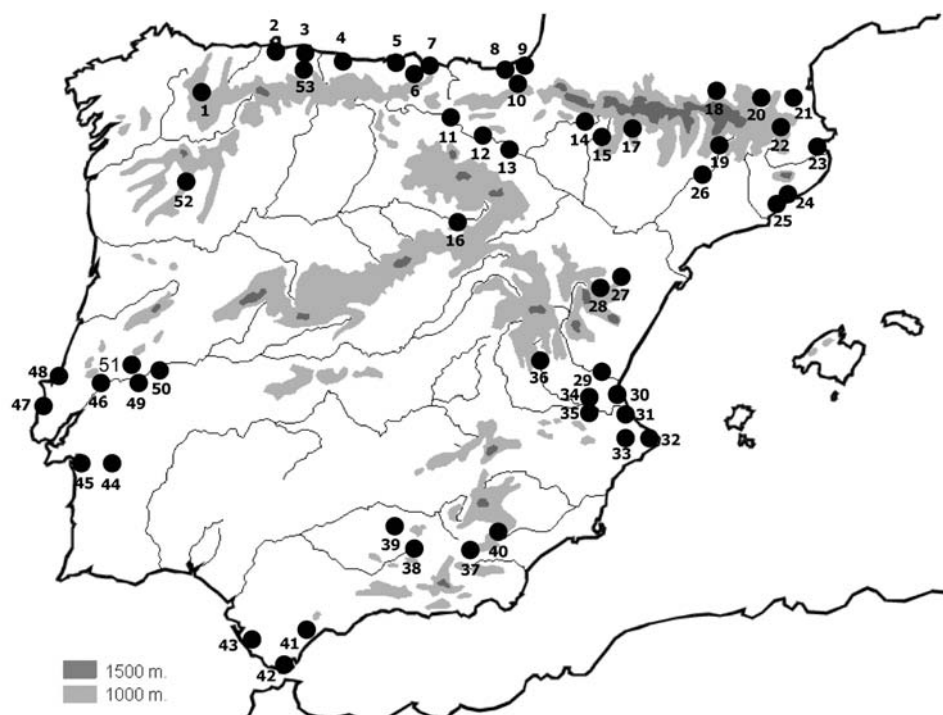


FIGURE 1. A Valiña (1), las Caldas, la Lluera, la Paloma and Sofoxó (2), Balmori, Buxu, Cierro, Coberizas, Conde, Cueto de la Mina, Collubil, la Lloseta, Cueva Oscura, Cueva Rosa, la Riera and Tito Bustillo (3), Altamira, Chufin, Castillo, Hornos de la Peña, el Juyo, el Mirón, Morín Cave, Otero Cave, la Pasiega, el Pendo, el Rascaño (4), Axlor, Atxeta, Santimamiñe (5), Bolinkoba (6), Lamiñak and Lezetxiki (7), Amalda, Ekain, Ermitia, Erralla, Urtiaga, Zatoya (8), Aitzbitarte IV (9), Abautz (10), Atapuerca sites, Dolina, Galería, Prado Vargas and Valdegoba (11), Ermita and Millán (12), Peña Miel (13), Chaves, Cova del Parco and Fuente del Trucho (14), Moros de Gabasa and los Toros (15), los Casares (16), Muricecs and L'Estret de Tragó (17), Cova 120, Els Ermitons (18), Toll and Teixoneres (19), L'Arbreda and Mollet (20), Cau del Duc de Torroella and Vilanova de Sau (21), Castell Sa Sala, Roc de la Melca, Bora Gran d'en Carreras (22), Cau de Coços (23), Abric Romaní (24), Gegant and Muscle (25), Picamoixons (26), San Anton (27), Fuente de San Luis (28), Matutano (29), Blaus (30), Bolomor, Mallaetes, Parpalló and Volcán del Faro (31), Les Cendres (32), Ratlla del Bubo (33), Cova Negra (34), Cova Beneito, Salt, Tossal de la Roca, Molí Mató (35), Verdelpino (36), Cueva Ambrosio (37), Cueva Horá (38), Boquete de Zafarraya (39), Cariguella (40), Nerja (41), Gorham's Cave, Devil's Tower (42), Higueral de Motillas (43), Escoural (44), Figueira Brava (45), Columbeira (46), Pedrera do Salemas and Gruta das Salemas (47), Lupa de Rainha and Furinha (48), Fontainhas (49), Foz do Enxarrique (50), Caldeirão (51), Lago do Mine (52), Esquilleu Cave (53).

The site includes six Mousterian levels designated with letters "a" to "h", level "e" dated between 46,500+4,440-2,800 (GrN-12809) (Blasco 1995, 1997). There are more than 5,978 determined bone remains including *Cervus*, *Equus*, *Bos*, *Capra*, *Rupicapra*, *Crocota*, *Canis* and other animals such as lagomorphs. Taphonomically, it can be said that the bone accumulation is well preserved, although bones are very fragmented due to both anthropogenic and carnivorous processes. The study of this site has recently been completed (Blasco 1995, 1997).

The Esquilleu Cave (Cillorigo, Cantabria) is placed 350 m above sea level in the steep Hermida cliff limestone complex about 40 km from the seashore (Figure 1, point 53). The ongoing excavation at this site started in 1997 under the direction of J. Baena. The site includes 35 Mousterian levels dated between 34,380±670 BP (AA-37883) (Level VI, dated by AMS) and 53,491±5,114 BP (Mad 3,300) (Level XXIII, dated by TL). The site yielded 70,180 bone remains, most of them belonging to *Capra*, with a smaller representation of *Rupicapra* and *Cervus* (Yravedra 2005). Bone preservation varies according to level. The uppermost part of the

sequence shows better bone preservation. From level XIV to level XXX, the bone preservation is bad, with the exception of levels XXI and XXIII where bones were used in hearths for combustion (Yravedra *et al.* 2005). In these levels, bone fragmentation is intense with more than 99% of bone remains being smaller than 3 cm. Due to the high number of archaeological horizons at Esquilleu, some archaeological levels were selected using the density and preservation of bone remains as guiding criteria. For *Cervus elaphus* we selected the following levels: XIF and XIII. The non-selected levels either contain scarce bone remains or bones are poorly preserved, as can be documented between levels XIV and XXX (Yravedra 2005). Large animals are infrequently represented except in the two selected levels.

The Amalda Cave (Zestoa, Guipúzcoa, Spain) is situated in a remote environment (8 km away from the coast) and 110 m above the Alzolaras Valley level (Figure 1, point 8). Excavations carried out under the supervision of J. Altuna between 1979 and 1984 (Altuna *et al.* 1990) revealed four archaeological levels from the Middle and Upper Palaeolithic. Level VII was considered typically Mousterian;

level VI was regarded as Gravettian and dated back to 27,400±1,000 BP (I-11-665) and 27,400±1,100 BP (I-11-664). Level V was, too, classified as Gravettian and dated to 19,900±340 BP (I-11-663), 17,880±390 BP (I-11-372), and level IV as Solutrean dated to 17,580±440 BP (I-11-355), 16,200±380 BP (I-11-428) and 16,090±240 BP (I-11-435) (Altuna et al. 1990). For *Cervus elaphus* and *Equus caballus* we selected the Mousterian bone remains. Each of these non-selected levels contains scarce bone remains of horses and red deer, as can be documented between levels VI-IV (Altuna 1990).

The Abric Romaní (Barcelona, Spain) is a sedimentary deposit located in the village of Capellades (50 km west of Barcelona), 280 m above sea level (Figure 1, point 24). The archaeological activity started with Amador Romaní at the beginning of the 20th century and continues until the present by different researchers. More recent excavations were undertaken by E. Carbonell in the 1980s, 1990s and 2000s. The stratigraphic sequence is almost 20 m thick and contains 27 archaeological levels, most of which are from the Middle Palaeolithic (Carbonell et al. 1994). Only in the uppermost one an Early Upper Palaeolithic industry (Archaic Aurignacian) has been found. This sequence was dated by Uranium-series between 40 and 70 ka BP (Bischoff et al. 1988). Faunal assemblages show the preponderance of red deer and horse in all archaeological layers. In this paper we selected the taphonomic information of Abric Romaní I published in Cáceres (1996) with 1936 bone remains.

The Gran Dolina Cave (Burgos, Spain) in the Atapuerca Hills of northern Spain (Figure 1, point 11) is dated to 800,000 years ago. Gran Dolina contains 11 levels (TD1–TD11). TD4, TD6, TD10, and TD11 are the only levels of any real importance. TD11 and TD10 have been fully excavated, and in TD6 the fossils of *Homo antecessor* remains were discovered. We selected the faunal remains of TD6 published in Díez et al. (1999). The excavation of TD 6 yielded 953 bone remains including large and medial animals such as *Cervus*, *Dama*, *Bos*, *Equus* and others (Díez et al. 1999). There are scarce bone remains in each of the non-selected levels as we can see, for example, in TD10 with only 250 and in TD11 with 184 (Díez 1992, Esteban 1998) pieces.

## METHODS

Given the large taxonomic range of macromammals represented in the 106 sites treated (Appendices 1–3), we have used only the data of more representative animals, such as *Cervus elaphus* and *Equus caballus*. The skeletal profiles were divided into anatomical regions following Yravedra and Domínguez Rodrigo (2008): cranial (including antlers, skull, mandible and dentition), axial (vertebrae, ribs, pelvis and scapulae), upper appendicular bones (humeri, femurs, tibiae, patellae, ulnae and radii) and lower appendicular bones (metapodials, phalanges, and compact bones). Skeletal and taxonomic profiles were based on NISP (Number of identifiable specimens).

The mortality and age patterns were divided in infants and adults. The bone surface modifications are analysed with bibliographic references in Gran Dolina Cave (Díez et al. 1999), Abric Romaní I (Cáceres 1996) and Moros de Gabasa (Blasco 1995), and with 10–20× hand lenses in Amalda and Esquilieu Caves. The marks were identified by using the diagnostic criteria specified in Blumenschine (1988, 1995) and Blumenschine and Selvaggio (1988, 1991) for tooth and percussion marks, and Bunn (1981) and Domínguez Rodrigo (1997, 2002) for cut marks. Next, the results obtained in our analysis are compared with the distribution of cut and tooth marks present in the experiments carried out by Blumenschine (1988, 1995), Selvaggio (1994), Capaldo (1995, 1997), Domínguez Rodrigo (1997) and Marean and Kim (1998). The work carried out by these scholars has generated a referential framework for distinguishing the order of access to carcasses, following the particular traces created by carnivores and humans, such as tooth marks and cut marks.

## Ambiguity of taxonomic patterns, body dimensions and mortality profiles

Vrba (1975, 1980), Shipman (1986) and Binford (1981, 1984) proposed that the sites with large-size animals are symptomatic of scavenging as opposed to those in which small-size animals predominate, which would be more related with hunting. Klein (1982a, b) suggested that scavenging would be characterised by a greater abundance of old and adult animals, while a hunter behaviour would show an increase in young individuals.

On the contrary, the ethnographic, palaeoecological and zooarchaeological patterns are taxonomically highly variable among each other; carnivores and human groups display a great diversity of behaviours. The carnivores hunt a variety of preys according to their size. Cheetahs are specialised in the hunting of small animals, leopards chase preys of less than 150 kg and the canids prefer less than 280 kg. Lions prefer preys of medium and big size. Similarly, human groups display a variety of behaviours and they only show specialised patterns in the Arctic societies. A zooarchaeological analysis of the Iberian Peninsula shows that until the Magdalenian there is no significant specialisation in MNI (Yravedra 2001), and until the Middle Palaeolithic and the Upper Palaeolithic red deer, goats, horses and *Bos* were well represented (Yravedra 2001, 2005, Blasco 1995, Cáceres 1996, Díez et al. 1999, Huguet et al. 1999, Dari 2003).

Other factors that must be considered in the taxonomic pattern are palaeoecology, climate and seasonality strategies. A clear example of this situation is observed in the Esquilieu Cave with a specialisation in the hunting of goats (Yravedra 2005) conditioned by the site topography. On the contrary, a few sites as the Castillo or Hornos de la Peña (Cantabria) and others present a rich faunal collection conditioned by the environmental variability and the ecological conditions associated (Dari 2003, Yravedra 2001, 2007).

For the age patterns, Domínguez Rodrigo (1996) presents catastrophic or attritional mortality pattern between

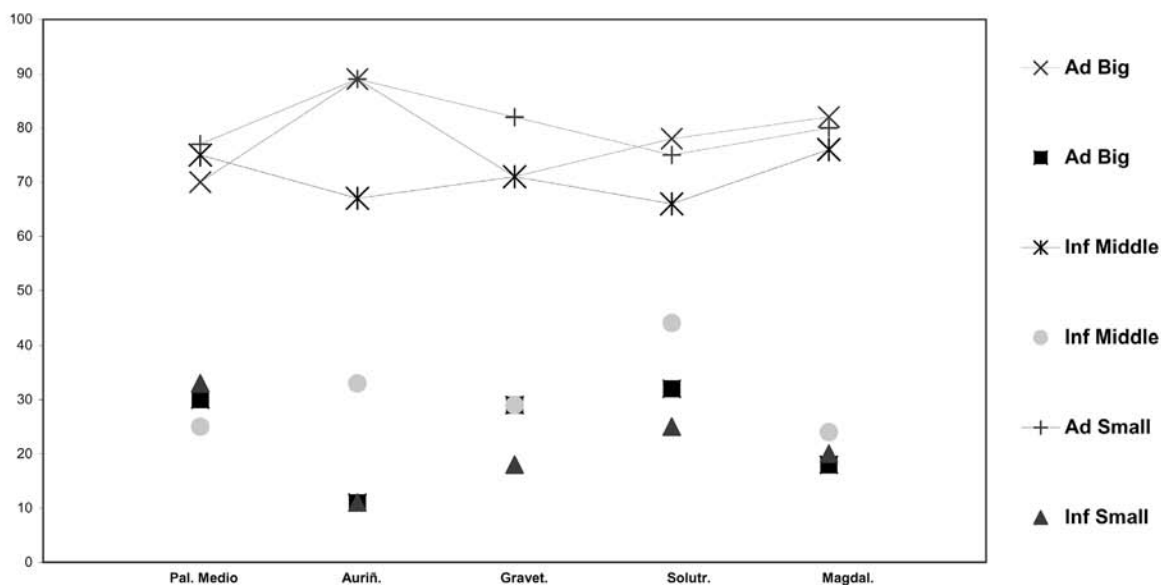


FIGURE 2. Mortality profiles in the Middle and Upper Palaeolithic of the Iberian Peninsula.

human groups and carnivores. On the Iberian Peninsula, the age patterns are relatively similar in the Middle Palaeolithic, the Aurignacian, the Gravettian and the Magdalenian (Yravedra 2001), and only in the Solutrean the ratio of infants increases (Figure 2).

#### Ambiguity of skeletal profiles

Like the other explanations, the skeletal profiles are also an ambiguous taphonomic tool for zooarchaeology. Marean and Kim (1998), Domínguez Rodrigo (1999, 2002), Marean and Cleghorn (2003), Marean *et al.* (2004), Pickering *et al.* (2003) and Yravedra (2000, 2005) have discussed the equifinality of skeletal profiles.

The interpretations related to skeletal profiles are based on the fact that the bones that are represented in the site are the bones that have been transported. For Vrba (1975, 1980), Shipman (1986), Binford (1981, 1984), Klein and Cruz-Urbe (1994), and Stiner (1994) certain profiles can indicate hunting or scavenging behaviour. The criteria on which these inferences are based suggest that a hunting behaviour will yield rich deposits of high nutritional and meat value. On the contrary, a scavenging behaviour will yield poorer results with low nutritional value. These interpretations are based on the evidence by T. E. White for whom the skeletal profiles of a site are the result of butchering practices (White 1953, 1954, 1955) and the schlep effect (Perkins, Daly 1968). Based on this, Binford noted that if the skeletal profiles of different societies, such as the Nunamiut, were the same as in those assemblages in which the hominids were the primary agents, the same representation would have to occur. On the contrary, he observed that several African and European archaeological sites showed a pattern of representation characterised by the elements of lower nutritional value. Therefore the explanation that Binford proposed to different skeletal accumulations is a consequence of the scavenging behaviour (Binford 1981,

1984, Shipman 1986, Stiner 1991, 1994, Straus 1992, Díez 1992). Also Vrba (1975, 1980), Blumenschine (1986, 1988, 1995) and Blumenschine and Madrigal (1993) propose an opportunistic behaviour based on the selective transport of bones for consuming the marrow.

This interpretation is subject to equifinality, Binford's assumptions are based on ethnographic observation of the *Nunamiut*, but the *Hadza* (Bunn *et al.* 1988, 1991, O'Connell *et al.* 1988, 1990, 1991, 1992, Hudson 1990, Bartram *et al.* 1991, Monahan 1998), the *Dassanetch* (Gifford González 1977, 1989), the *Bisa* (Crader 1983), the *San* and the *Kua* (Bartram 1993, 1995) showed a great variability in the transport of carcasses conditioned by the size of animals, the distance between the carcass and the base camp, the number of individuals that participated in the transport or the time of day. Similarly, in this group they transport only the meat to the base camp or they consume the prey at the killing site (Yellen 1977).

The ambiguity described in the discussion on skeletal profiles is conditioned also by a differential degree of conservation that can be influenced by multiple factors. These are related to processes intrinsic to the bone, such as the form, size, density, chemical composition, the age of the individual, etc., as well as to external processes, such as the erosive action, scavenging behaviour of animals or climatic action, etc.

The intrinsic conditions of the bone suggest that some have more possibilities of conservation than others. Various studies have shown that specimens of greater density are more resistant to different altering processes than the bones with spongier wave that is less dense and resistant to weathering, erosive fluvial action or the carnivores' intervention.

The specimens with more marrow and fat are less dense than those with a smaller nutritional value. This is the reason why the metapodials are denser than the other specimens and therefore their possibilities of entering the archaeological

record are greater than those of the other bones (Lam *et al.* 1998, 1999). This can be correlated with the remains that the carnivores usually leave without consuming after having acceded a carcass; the remains left behind usually contain the cranial bone and lower limbs, which show a higher bone density. That is why these elements appear with greater frequency at archaeological sites.

The methods of excavation at archaeological sites also contribute to equifinality of skeletal part profiles. In the early 1970s the main interest about archaeological bones was related to palaeoecological information. In this way only the bone remains easy to identify such as teeth, epiphyses and complete bones were collected. The selection of these elements generates a devastating pattern among the complete remains, so that only those more resistant to the destructive processes will appear: namely teeth and metapodials (Lam *et al.* 1998, 1999, Marean, Kim, 1998, Domínguez Rodrigo 1999, Pickering *et al.* 2003, Marean *et al.* 2004). This opens another debate relative to the identification of shafts at archaeological sites and the diagnosis of long limb bones (Marean, Kim 1998, Marean, 1998, Milo 1998, Costamagno 2002, Pickering *et al.* 2003, 2004, Yravedra, Domínguez Rodrigo 2008).

If the age pattern, the skeletal part profiles and the taxonomic patterns are of limited value for zooarchaeological purposes, the studies of bone surface modifications are more relevant. Before discussing them, we want to show how the skeletal part profiles of the Upper and Middle Palaeolithic sites of the Iberian Peninsula are conditioned by different factors, such as the moment of excavation or the destruction caused by carnivores.

## RESULTS

### **Skeletal profiles in the Palaeolithic of the Iberian Peninsula**

The following section will describe some of the skeletal profiles of different archaeological sites in the Iberian Palaeolithic. We have selected those levels which yield a significant number of remains of some average-sized ungulates such as horse and red deer. These patterns are shown in *Tables 1* and *2*, and to facilitate the observation of different anatomical portions they are corresponding with the portions present in the methods.

The skeletal profiles of Altamira, Castell Sa Sala, Blaus, Nerja, Bolinkoba, Lamiñak, Buxu, Ambrosio Cave, A Valiña, Cova Beneito, Cueva Horá are dominated by lower limbs and cranial elements (*Tables 1* and *2*).

In the Lower and Middle Palaeolithic sites of Galería, Peña Miel G, Amalda VII or Abric Romaní I, the axial elements and upper appendicular bones are well represented. On the contrary, others like Pinilla del Valle, Moros de Gabasa, Pendo or Morín show a more partial pattern, in which these sections appear to be deficient. The skeletal profiles of horse are similar and only Galería S.O.O.7, Amalda and Torralba show a good representation of the upper limbs and axial elements.

The causes of this representation are varied and cannot be evaluated in all cases, since not all sites have been included in taphonomic analyses. Nevertheless, in some cases we can determine the causes of such representation.

For example, all the cases in which the skeletal representation is more compensated have been studied in the last years. The levels studied in Abric Romaní, Galería, Amalda or Peña Miel were excavated between the beginning of the 1980s and the 1990s. On the contrary, the sites excavated in the 1970s or before, like Solana del Zamborino, Morín, Pendo, Cueva Horá etc., are characterised by cranial elements and lower limbs.

Other sites, such as Moros de Gabasa, Pinilla del Valle or Cova Negra have been excavated more recently and their skeletal profiles are dominated by lower limbs and cranial elements, but the taphonomic analyses of Díez (1992), Blasco (1995) and Martínez Valle (1996) have shown the distortion that hyenas have caused in the bone accumulations.

In the Early Upper Paleolithic levels a similar phenomenon occurs. At the site of Riera, which was excavated at the end of the 1970s, in the Amalda Cave and in some levels of Labeko Koba excavated at the end of the 1980s, axial elements and upper limbs are well represented (Altuna 1990, Arrizabalaga, Altuna 2000).

As opposed to these levels, there are others such as those of Aitzbitarte, Morín or Santimamiñe excavated in the 1960s, in which the axial elements and upper appendiculars are not abundant. Besides, the absence of taphonomic analyses for these levels does not allow us to make inferences about other possible causes that may have influenced their skeletal profile.

For the Solutrean a change is observed. Therefore, a well compensated skeletal part profile is found in almost all levels of Riera, Caldas, Amalda, Santimamiñe, and Higueral de Motillas. The taphonomic analyses carried out at the Solutrean sites of L'Arbreda (Rueda 1993), Cova Beneito (Martínez Valle 1996), Higueral de Motillas (Cáceres, Anconetani 1997) and Ambrosio Cave (Yravedra 2005) show a lesser intervention of carnivores and only at the sites with more carnivores, such as Bolinkoba, Santimamiñe VII, Urtiaga 1 and Riera 5, there are less compensated skeletal profiles rich in lower limbs and cranial elements.

At the Magdalenian sites such as Rascaño, Morín, La Paloma, Santimamiñe, Bora Gran d'en Carreras, Volcán del Faro a. o., cranial elements and lower limbs are more abundant. These archaeological sites were excavated in the 1960's or before and the skeletal profiles suggest an archaeological selection of fragments to be saved for study. So the palaeontological and archaeological methods distinguishing identifiable and unidentifiable bones decided to discard the "non-identifiable bones". On the contrary, the sites excavated between the mid-1970s and the early 1980s such as Ekain, Erralla, Lamiñak, Riera and Zatoya show a more complete percentage of skeletal parts.

Considering the skeletal profiles of different Palaeolithic assemblages from the Iberian Peninsula, we can say that conclusions based on them are ambiguous. The

TABLE 1. Skeletal profiles of *Cervus elaphus* in the Palaeolithic of the Iberian Peninsula.

<b>LOWER PALAEOOLITHIC: CERVUS ELAPHUS</b>	<b>Skull/Tooth %</b>	<b>Axial %</b>	<b>Up. limbs %</b>	<b>Low. limbs %</b>	<b>NISP</b>
Dolina (Total) (Díez 1992)	49/40	5.2	28.7	17.4	115
Galería Tg10b, Tn6-Da, Tn6	53.5/43	16.7	22.3	7.4	215
Galería Tg10c, Tg10d, Tn5	54/37.3	26.2	14.6	5.6	233
Galería S002	45/12	37.2	7.3	10	137
Galería S006	35.3/10.3	42	20.5	2.3	88
Galería S007	44.3/26.8	38.3	11.4	6	149
Pinilla del Valle (Red Deer)	60/48	2	8.5	29.4	153
Pinilla del Valle (Fallow Deer)	74.6/65.9	1.1	5.5	18.8	452
Pinilla del Valle (Deer)	76.7/-	3.2	5	15.2	664
Torralba Total	45/2.9	22.5	14.5	21	138
Solana del Zamborino	50.4/40.1	7.3	12.4	30	137
<b>MIDDLE PALAEOOLITHIC</b>	<b>Skull/Tooth %</b>	<b>Axial %</b>	<b>Up. limbs %</b>	<b>Low. limbs %</b>	<b>NISP</b>
Amalda VII	23/6	14.1	32.2	30.3	152
Castillo	6.7/0	3.8	52.5	37	78
Morín 17 (Altuna 1973, Freeman 1981)	45.4/39 73/73	1.8 0	15.4 20	38.6 20	170 170
Gabasa A-C	51/51	1.5	20	27	66
Gabasa D	41.3/40	1.3	14.5	42.5	75
Gabasa E	54/44.6	4.5	7.8	34.5	348
Gabasa F	50.3/44.6	2	9.8	37	359
Gabasa G	34.3/29	0.2	8.2	58.3	511
Gabasa H	28.6/24	2.6	13.4	55.1	159
Peña Miel G	18/11	5	35.9	40.5	291
Cova Negra (Ripoll 1977)	58.8/50	1.4	6.8	35.2	483
Cova Negra IV	62.6/50		12.8	23.3	62
A. Romaní I	31/15.5	16.6	34.4	18.9	90
<b>UPPER PALAEOOLITHIC</b>	<b>Skull/Tooth %</b>	<b>Axial %</b>	<b>Up. limbs %</b>	<b>Low. limbs %</b>	<b>NISP</b>
Au 2 Morín 5-7	60/56	2.3	2.7	34.1	289
Au 2 Morín 5 B	54.9/50	2.1	9.1	32.9	143
Au 3 Aitzbitarte IV	57/27	3	14	19	101
Au 3 Riera 1	24.2/13.7	34.1	22	20.6	161
Au 3 Santimamiñe VIII	40.9/20	13.3	11.6	32.1	474
Au 3 Ekain VIII	61/54	18.5	11.1	7.4	54
Per 2 Morín 4	51/47.8	6.9	6.8	34.5	271
Per 2 Morín 5 A	23.6/16	12.5	11.4	49.4	271
Per 2 Amalda VI	30.3/27	13.9	24.7	32	235
Per 3 Amalda V	48.1/31.9	9.5	14.9	29.9	94
Labeko Koba IX Inf.	13/6	31	17	39	782
Labeko Koba IX Sup.	42/15	22	9	26	367
(Grav) Parpalló 9-10	45	11	22	22	2,098

<b>SOLUTREAN</b>	<b>Skull/Tooth %</b>	<b>Axial %</b>	<b>Up. limbs %</b>	<b>Low. limbs %</b>	<b>NISP</b>
Bolinkoba 4	/42.8	14.3		42.8	7
Bolinkoba 5	/90			10.5	10
El Buxu	36.5/34.1	12.1	4.8	41.5	39
Las Caldas 3	/25	24	24	28	8
Las Caldas 4	70/63	22.2		7.4	28
Las Caldas 5	10.6/5.3	21	21	51	19
Las Caldas 7	31.4/22.6	26.4	18.5	22.6	97
Las Caldas 8	41.2/22.7	18.1	18.1	22.7	22
Las Caldas 9	50/39.39	14.2	10.3	25	28
Las Caldas 11	36.6/29.3	9.7	19.4	34	41
Las Caldas 13	23.5/5.9	5.9	35.2	35.2	17
Las Caldas 14	49.9/35.7		14.2	35.7	14
C. Morín	68.7/64.7		4	27.5	51
La Riera 2-3	20.8/11.4	22.6	23.1	32.2	44
Amalda IV	37/26.3	19.3	15.8	29.7	152
El Castillo	31.1/19.7	8.6	18.3	42	952
Las Caldas 12	19/8.7	32	13.7	34.8	253
Santimamiñe	49.9/34.3	9.4	14.6	26.4	213
La Riera 4	25.5/6.2	34.1	23.1	17.2	211
La Riera 5	25.5/10.7	20.1	14.6	42.4	512
La Riera 6	24.7/11.9	23	10	43	185
La Riera 4-6	22.6/8.5	35.4	16.9	25.1	196
La Riera 7	26.9/11.2	19.3	21.3	32.1	1,889
La Riera 8	27.3/9.4	16.7	19.3	35.7	1,255
La Riera 9	27.6/11.3	20.8	20.9	30.3	1,783
La Riera 10	23.8/10.3	30.4	19.5	25.4	938
La Riera 11	18.1/6.4	38.1	16.9	25.9	824
La Riera 12	18.1/7.7	37.7	16	27.9	286
La Riera 13	15.6/4.7	38.9	16.5	26.5	643
La Riera 14	23/6.9	27.2	20	28.3	2,434
La Riera 15	20.5/7.3	28.3	18.7	31.4	1,166
La Riera 16	8/2.4	31	24.5	46.3	1,128
La Riera 17	22.7/10.7	27	16.7	24.1	719
Higueral de Motillas	34.7/4.3	10	29.6	24.9	184
El Parpalló 6	48.4/0	5	21.4	26	314
El Parpalló 7	18.7/0	20.3	28.2	32.7	139
Cova Beneito 3-5	4.4/0.9	6.8	11.2	79	116
<b>MAGDALENIAN</b>	<b>Skull/Tooth %</b>	<b>Axial %</b>	<b>Up. limbs %</b>	<b>Low. limbs %</b>	<b>NISP</b>
Ekain VI	38/21	12	23	23	47
Erralla III-I	48.1/27.2	20.9	18.8	20	48
El Rascaño 1	53.9/33.3	11.6	13.1	21.4	78
El Rascaño 2	61.1/32.8	7.5	7.5	22.5	67
El Rascaño 3	53.9/38.5		7.6	34.5	26

MAGDALENIAN	Skull/Tooth %	Axial %	Up. limbs %	Low. limbs %	NISP
Ekain VII	40.5/28.3	33.7	16.2	11.2	639
Erralla V	21.6/7.9	19.3	25.1	33.7	190
El Juyo 4	16/0.8	5.3	4.6	50.8	1,662
El Juyo 4 S	10.7/¿?	6.8	3.4	45	364
El Juyo 5	26/	8	6	54	47
El Juyo 6	25.1/¿?	8	9.1	50.1	1,462
El Juyo 7	15/¿?	7	7	56	140
El Juyo 8	12/	9	4	76	88
El Juyo 9	3/	18	15	50	30
Lamiñak 2	17/12	9	31.5	43	339
Cueva Morín 2	47.6/38	8.5	11.7	32.3	260
La Paloma 4	64/53	3.1	7	25	597
La Paloma 6	49/39.5	9.7	8.4	33	577
La Paloma 8	60.3/56	0.9	6.6	31.4	1,739
El Rascaño 4	50.1/17.9	4.3	10.7	36	223
El Rascaño 5	53.7/14.7	8.8	7.9	30.2	116
La Riera 18	20.5/9.4	25.6	21.4	31.6	1,648
La Riera 19	21/7.7	25	20	35	1,388
La Riera 20	28.2/13.2	20.6	18.2	32.9	727
La Riera 21-23	26.1/13.7	18.1	25.4	39.3	983
La Riera 24	25.8/14.1	20.7	30.5	25.7	438
Santimamiñe VI	33.3/22.7	18.5	13	38	935
Santimamiñe II-V	61.4/29	5.1	12.2	27.2	172
Tito Bustillo 1 A	20.1/13.7	19	11.6	50.2	883
Tito Bustillo 1 B	18/11.8	18.7	9.5	53.5	1,123
Tito Bustillo 1 C	20.7/13.4	16.3	13.3	49.2	1,323
Tito Bustillo 2	22.4/17.3	17.5	16.7	42.8	428
Zatoya 1 b	31.1/24.6	28.2	22	18.8	309
Chaves 2 A	33.3/8.3		16.6	49.9	12
Chaves 2 B	27.5/10.5	5.2	36.7	31.5	29
Bora Gran d'en Carreras	71/17	2.1	6	20.9	880
Parpalló 1	61.4	4.9	10.6	23	583
Parpalló 2	39/	5.7	15.5	39	398
Parpalló 3	44.7/13	7.4	17.8	30	268
Volcán del Faro	37.3/	2.7	7.2	52	286
Cendres 4	13/6	5	11	71.4	165
Cendres 3	10/5.2	2	18	73	707
Cendres 2	23.4/11	1.8	17	58.1	169
Matutano 1	24/13.6		6.3	69	104
Matutano 2	28.1/18		6.5	65.3	433
Matutano 3	13.5		5.7	77	270
Matutano 4	23.3/9.8		7.1	69.1	194



TABLE 2. Skeletal profiles of *Equus caballus* in the Palaeolithic of the Iberian Peninsula.

<b>LOWER PALAEOOLITHIC: EQUUS CABALLUS</b>	<b>Skull/Tooth %</b>	<b>Axial %</b>	<b>Up. limbs %</b>	<b>Low. limbs %</b>	<b>NISP</b>
Dolina (Díez 1992)	72/63	11	6	12	86
Galería Tg10b, Tn6-Da, Tn6	85/83	4	3	8	137
Galería Tg10c, Tg10d, Tn5	72/68	4	16	8.5	128
Galería S006	48/38	41	4	6	68
Galería S007	68/55	22	2	8	215
Pinilla del Valle	53/49	3.2	8	36	473
Torralba 1	41/32	31	20	9	7
Torralba 3	47/40	22	21	10	62
Torralba Total	44/36	22	25	9	346
Solana Del Zamborino	85.8/85	1.5	1.75	11	2,918
<b>MIDDLE PALAEOOLITHIC</b>	<b>Skull/Tooth %</b>	<b>Axial %</b>	<b>Up. limbs %</b>	<b>Low. limbs %</b>	<b>NISP</b>
Amalda VII	41/33	10	38	10	48
Morín 17 (Altuna 1978, Freeman 1983)	80.7/80 /85	0.7	10 15	7.6 4	129 123
Castillo	92.3	0.2	4.2	4	1,313
Gabasa A-C	73.3/73.3	2.8	8.6	16	206
Gabasa D	70/69.1	3	8	20.1	162
Gabasa E	73.3	2.8	7.1	18.2	385
Gabasa G	61.4/60.8	4.1	7.7	25.3	250
Gabasa F	65/65	3.2	7	25.2	385
Gabasa H	62.3/60.7	3.6	7.4	28.7	265
<b>UPPER PALAEOOLITHIC</b>	<b>Skull/Tooth %</b>	<b>Axial %</b>	<b>Up. limbs %</b>	<b>Low. limbs %</b>	<b>NISP</b>
Au 3 Riera 1	49/30	26.6	18.8	7	116
Au 3 Santimamiñe VIII	41/35.7	5.4	14.3	37.4	56
Per 3 Grav. VI	38.3/32.7	9.3	25.2	27	107
L. Koba IX Inf.	15/10	50	10	24	210
L. Koba IX Sup.	37/32	15	9	39	305
L. Koba VII	81/78	7	6	17	124
(Grav) Parpalló 9-10	31.5	2.5	14.5	55	201
<b>SOLUTREAN</b>	<b>Skull/Tooth %</b>	<b>Axial %</b>	<b>Up. limbs %</b>	<b>Low. limbs %</b>	<b>NISP</b>
Las Caldas 12	23/9.5	27.6	26.4	23.3	47
El Castillo 10	85.8/45.1	0.9	5.8	7.2	1,239
La Riera 2-3	45.2/30.9	3.5	26.9	18.2	126
Santimamiñe	66.2/57.1	2.6	2.6	28.6	77
<b>MAGDALENIAN</b>	<b>Skull/Tooth %</b>	<b>Axial %</b>	<b>Up. limbs %</b>	<b>Low. limbs %</b>	<b>NISP</b>
Bolinkoba 3	82.7/	2.4	2.4	12.8	87
Santimamiñe 6	59.6/53	2.9	9.5	27.3	136
Tito Bustillo 1 B	/30	2	34	44	51

MAGDALENIAN (continued)	Skull/Tooth %	Axial %	Up. limbs %	Low. limbs %	NISP
Tito Bustillo 1 A	/35	2	16	62	62
Parpalló 1	70.4/3.2	0	1.6	27.6	125
Parpalló 2	52.1/5.8	0	4	44	121

methodology used in the excavations, destruction by the carnivores or other phenomena are determinant in the anatomical patterns. The sites where cranial elements or lower limbs predominate are directly related to the activity of carnivores (Moros de Gabasa, Pinilla del Valle, Cova Negra, Cova Beneito etc.).

If the skeletal profiles, age patterns and taxonomic patterns are of limited value for zooarchaeological purposes, we need to use some more relevant alternative methods. The studies of bone surface modifications are more adequate for taphonomic analyses.

## DISCUSSION

### Bone surface modifications

The experimental analyses developed by Blumenschine (1988, 1995), Capaldo (1995, 1997), Domínguez Rodrigo (1997) and Selvaggio (1998) have allowed the building up of an appropriate referential framework based on the study of bone surface modifications. This makes it possible to differentiate between the primary and secondary access to carcasses by hominids. Thus, it can be established that cut marks appearing on diaphyseal elements are usually linked with the consumption of flesh (Bunn, Kroll 1986, Capaldo 1995, 1997, Domínguez Rodrigo 1997, Marean, Kim 1998, Milo 1998).

The different findings by Blumenschine, Selvaggio, Capaldo, Domínguez Rodrigo and others such as Marean or Bartram have allowed us to establish the patterns of bone alteration that carnivores produce in different types of access. This way, when carnivores have primary access to carcasses, between 80 and 100% of bones display tooth marks, depending on the carnivore involved and independently from the section. When there is a secondary access to carcass by carnivores, the percentage of tooth marks is reduced and varies according to sections. Blumenschine (1988, 1995), Marean, Kim (1998), Capaldo (1997) and Domínguez Rodrigo (1997) show a high proportion, between 50 and 100%, of tooth marks for epiphyses as well as metaphyses with values around 60% and a reduction for the diaphysis, displaying percentages between 15–20% (Table 4).

Domínguez Rodrigo (1997) has made similar experiments with the percentage of cut marks in order to differentiate between the primary and secondary access to carcasses by hominids. The distribution and proportion of cut marks on the upper, intermediate and lower limb bones are diagnostic criteria for the determination of human behaviour.

The primary human access shows a percentage near to 60% of cut marks on the upper limbs, the intermediate bones

present around 30% and the lower limb bones 10%. Secondary access shows a low percentage of 8% for the upper elements, 20% for intermediate elements and 50% for the lower limbs.

The application of these results to the African Pliopleistocene shows quite positive results (Domínguez *et al.* 2007), however, it has not been applied to the European Palaeolithic. Here we apply the referential marks to some Middle Palaeolithic sites of the Iberian Peninsula, such as the Esquilleu Cave, Amalda Cave, Gran Dolina 6 Cave (now TD6), Abric Romaní and Moros de Gabasa.

### Bone surface modifications on the Iberian Peninsula

The low percentage of tooth marks suggests that in the bone accumulation of Dolina 6 the intervention of carnivores was marginal (Figure 3). The frequency of tooth marks is low in all animals and all portions. On the contrary, the cut marks are on long limb bones of large, medium-sized and small animals. The frequencies of cut-marked specimens obtained for shafts, mid-shaft sections and ends in large and small animals fall outside the ranges of variation experimentally reproduced by Domínguez Rodrigo (1997) and Capaldo (1997), but the medium-sized taxon of TD6 shows cut marks inside the ranges of Domínguez Rodrigo (1997) and Capaldo (1997) (Figure 4, point 2). So the frequencies of TD6 cut marks show 43% for epiphyses, 27% for mid-shafts and 14% for shafts, and the range of Domínguez Rodrigo (1997) and Capaldo (1997) shows 35–57% and 0–100% for epiphyses, 30–80% and 36–65% for near-epiphyses and 25–74% and 15–42% for shafts (Table 3). Also the distribution of traces shows filleting activities and suggests that hominids had primary access to carcasses.

In the Middle Palaeolithic sites with bone surface modifications analysis, the higher frequencies of cut marks from upper and intermediate limb bones of horses (Figure 5) and red deer (Figure 6) in the Amalda Cave, Esquilleu Cave and Abric Romaní I suggest that hominids were the primary agents in the exploitation of carcasses to the detriment of carnivores, whose intervention seems to have been rather secondary as shown by the low frequencies of tooth marks in these sites (Blasco 1995, Cáceres 1996, Yravedra 2005).

Other bone assemblages such as Cova Negra or Cova Beneito have established that the contribution of horses and red deer is a consequence of primary human access (Martínez Valle 1996) because they show few tooth marks and a greater proportion of cut marks. In Cova Negra and Cova Beneito the distribution of cut marks suggests filleting activity and primary access to fleshed carcasses. Contrary to what Martínez Valle (1996) could observe in medium-sized animals, in the goat or chamois there are no human

TABLE 3. Percentage of cut marks in the experiments by Domínguez Rodrigo (1997), and Capaldo (1997). H: Human action, C-H: Carnivores' first access and human secondary access, H-C: Human first access and second carnivore intervention.

% MC	Domínguez Rodrigo (1997)										Capaldo (1997)		
	H	H	H	H	H	C-H	C-H	C-H	C-H	H	C-H	H-C	H-C frag.
*Tax	H1SI	H1SI	H1SI	H1SI	H1SI	H2SI	H2SI	H2SI	H2SI	Total	Total	Total	Total
3-4	2a	2b	2c	2d	2a	2b	2/3a	2/3b					
Up. limbs	45	50	77	62	50	3	17	0	8	60 (25-87)	8 (16-0)		
Med. limbs	36	36	23	38	43	27	42	40	70	30 (66-15)	20 (54-0)		
Low. limbs	19	14	0	0	7	70	42	60	23	10 (35-0)	50 (70-30)		
<b>Limbs Total</b>	<b>58</b>	<b>55</b>	<b>54</b>	<b>42</b>	<b>29</b>	<b>24</b>	<b>29</b>	<b>7</b>	<b>20</b>	<b>45 (26-64)</b>	<b>12 (0-25)</b>	<b>25 (44-18)</b>	<b>18 (10-18)</b>
<b>NISP Total</b>	73	40	24	31	48	123	42	67	66	216	298		
Ep. Prox.												50 (50-0)	32 (33-30)
Ep. Dist.												50 (100-0)	50 (25-63)
<b>Ep. Total</b>										<b>46 (35-57)</b>	<b>16 (0-33)</b>		
Met. Prox.	29	18	7	23	7	53	8	40	15	7-30	20 (8-50)		
Met. Dist.	29	27	38	23	21	23	50	40	46	20-40	30 (20-50)		
<b>Met. Total</b>										<b>45 (30-80)</b>	<b>16 (0-33)</b>	<b>47 (65-36)</b>	<b>25 (26-24)*</b>
<b>Diaphysis</b>	<b>43</b>	<b>55</b>	<b>54</b>	<b>54</b>	<b>71</b>	<b>23</b>	<b>42</b>	<b>20</b>	<b>38</b>	<b>50 (25-74)</b>	<b>8 (20-0)</b>	<b>22 (15-42)</b>	<b>13 (12-14)</b>

TABLE 4. Percentage of tooth marks in the experiments by Blumenshine (1988, 1995), Marean and Kim (1998), Domínguez Rodrigo (1997), and Capaldo (1997).

% MD *talle (3-4)	Blumenshine (1988, 1995)		Marean and Kim (1998)		Domínguez Rodrigo (1997)	Capaldo (1997)	
	H-C	C	C	H-C	H-C	C	H-C
Up. limbs							
Med. limbs							
Low. limbs							
<b>Limbs Total</b>	<b>20 (8-45)</b>	<b>71 (33-100)</b>	<b>&gt; 80</b>	<b>8-45</b>	<b>45</b>	<b>63 (86-56)*</b>	<b>21 (27-19)*</b>
Met. Prox.							
Met. Dist.							
<b>Met. Total</b>	<b>61 (29-92)</b>	<b>80 (0-100)</b>	<b>78-87</b>	<b>50-21</b>	<b>50 (22-77)</b>	<b>72 (88-64)*</b>	<b>39 (48-31)*</b>
Ep. Prox.						100 (100-100)*	56 (72-46)*
Ep. Dist.						100 (100-100)*	61 (67-57)*
<b>Ep. Total</b>	<b>50 (100-0)</b>	<b>100</b>	<b>40-100</b>	<b>66-21</b>	<b>80 (52-100)</b>	<b>100 (100-100)*</b>	
<b>Diaphysis</b>	<b>15 (2-29)</b>	<b>80 (45-90)</b>	<b>68-76</b>	<b>10-7</b>	<b>39 (17-61)</b>	<b>57 (66-54)*</b>	<b>15 (16-14)*</b>

interventions. Small animals have not shown cut marks in contrast with the high frequency of tooth marks. It can also be observed in the *Capra* and *Rupicapra* of the Amalda Cave and Moros de Gabasa (Yravedra 2005, 2007, Blasco 1995).

In the Amalda Cave, our taphonomic analysis based on bone surface modification has shown an interpretation clearly different from that offered by Altuna (1990). Altuna's (1990) interpretations based on taxonomic and skeletal patterns suggest that hominids were hunters of *Rupicapra rupicapra* and other animals such as goats, reed deer, horses or bovinds. The high ratio of specimens corresponding to *Rupicapra rupicapra* was explained as a result of the carcass

being transported complete to the Amalda Cave. For goats, horses and red deer, the transport pattern was different; only the cranial and limb bones were carried generating a shoulder effect.

Our taphonomic analysis of bone surface shows a high frequency of cut marks suggesting a primary hominid intervention on horses and red deer (Table 5, Figures 5 and 6), contrary to what can be observed in small animals such as *Rupicapra* that show low portion of cut marks on limb bones (Figure 7, Table 6) and high frequency of tooth marks (Table 6). The human transport of carcasses of medium-sized and large animals does not provide any further evidence as to these carcasses being transported complete or

TABLE 5. Frequency of cut marks in *Cervus elaphus* and *Equus caballus* in Moros de Gabasa, Esquilieu XIF, Esquilieu XIII, Abric Romaní I, Amalda VII.

Cut Marks	<i>Cervus</i>					<i>Equus</i>		
	Gabasa	Esquil XIF	Esquil XIII	Abric Romaní I	Amalda VII	Gabasa	Amalda VII	Abric Romaní I
Up. limbs	13%	34	45	8%	21%	9%	44	25%
Med. limbs	8%	28	21	13%	29%	6%	0	66%
Low. limbs	4%	12	33	13%	6%	4%	33	
Bones with cut marks	60	37	18	8	19	22	8	4
NISP	1,518	355	87	90	167	1,634	20	73
Bones with cut marks	7%	10%	21%	9%	11%	4%	40%	5.5%

TABLE 6. Frequency of cut and tooth marks in *Capra* and *Rupicapra* of the Amalda VII Cave.

% MD	Small animal: <i>Rupicapra</i> and <i>Capra</i>		
	Upper limbs	Medial limbs	Lower limbs
Amalda VII	21.9	21.2	9.5
% MC	Small animal: <i>Rupicapra</i> and <i>Capra</i>		
	Upper limbs	Medial limbs	Lower limbs
Amalda VII	1.6	0	0

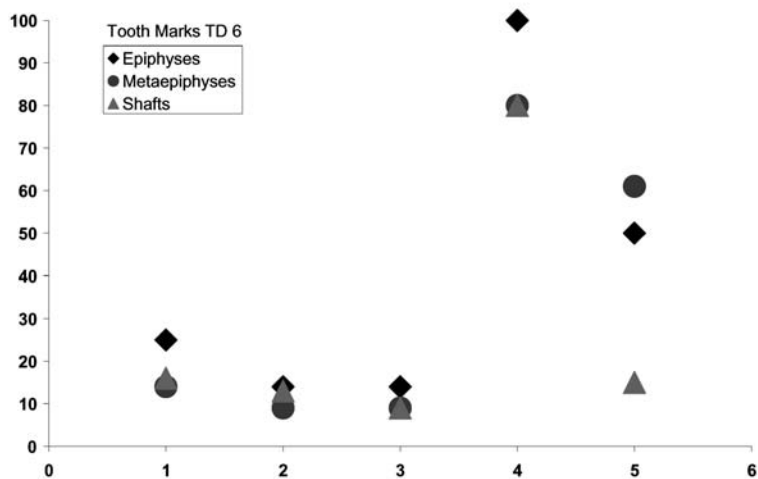


FIGURE 3. Percentage of tooth marks in large animals of TD 6 (1), in medium-sized animals (2) and small animals (3). Percentage of tooth marks in which carnivores are primary agents (Blumenschine 1988, 1995) (4), percentage of tooth marks on bones in which humans are primary agents (Blumenschine 1988, 1995) (5).

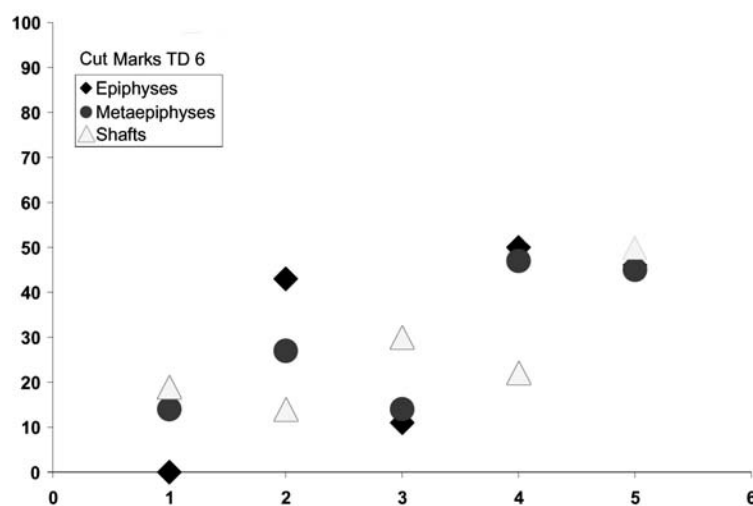


FIGURE 4. Percentage of cut marks in large animals of TD 6 (1), in medium-sized animals (2) and small animals (3), compared with the human primary access from experimental results of Capaldo (1997) (4) and Domínguez Rodrigo (1997) (5).

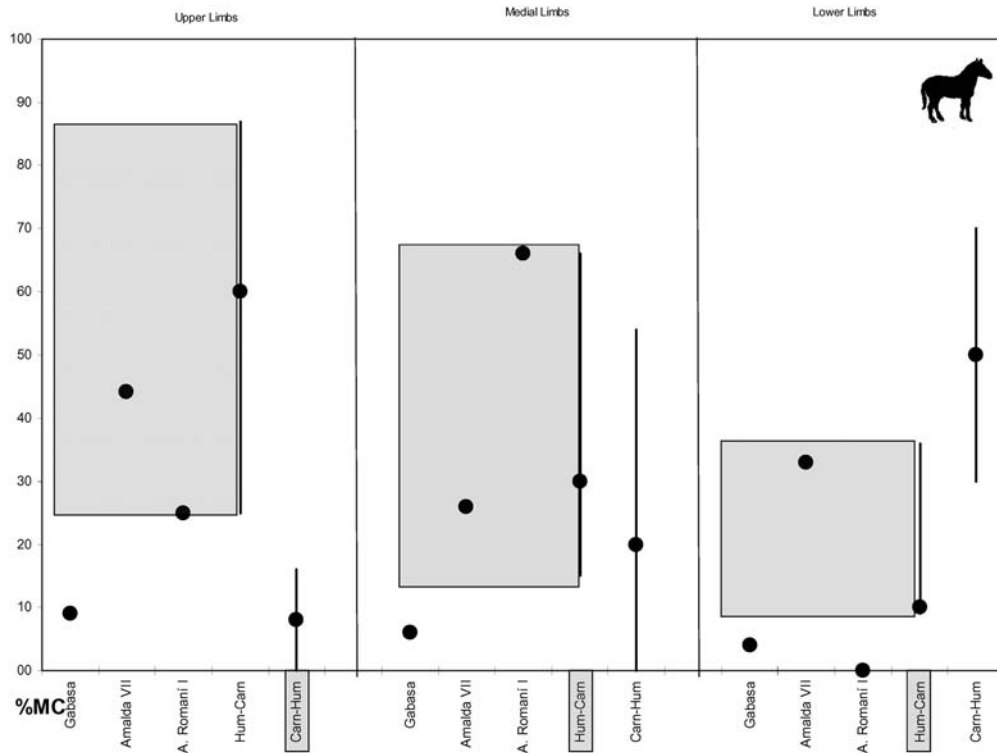


FIGURE 5. Percentage of cut marks in *Equus caballus* in the Moros de Gabasa Cave, Amalda VII, Abric Romaní I, compared with human primary access of the experiment by Domínguez Rodrigo (1997).

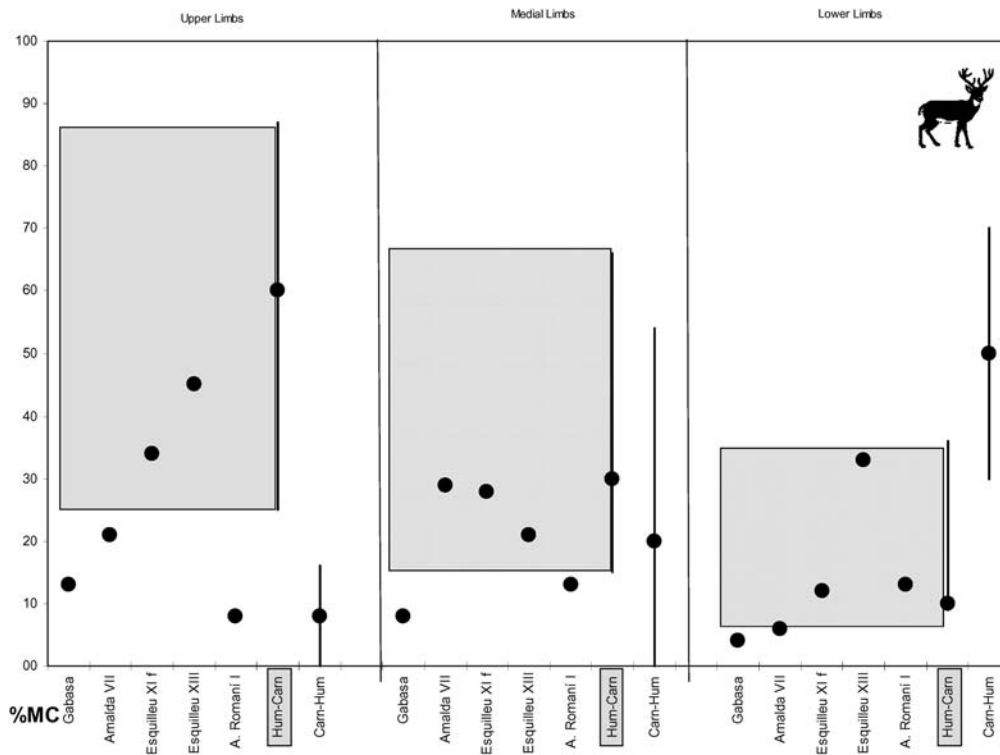


FIGURE 6. Percentage of cut marks in *Cervus elaphus* in Moros de Gabasa, Esquilleu XIF, Esquilleu XIII, Abric Romaní I, Amalda VII compared with human primary access of the experiment by Domínguez Rodrigo (1997).

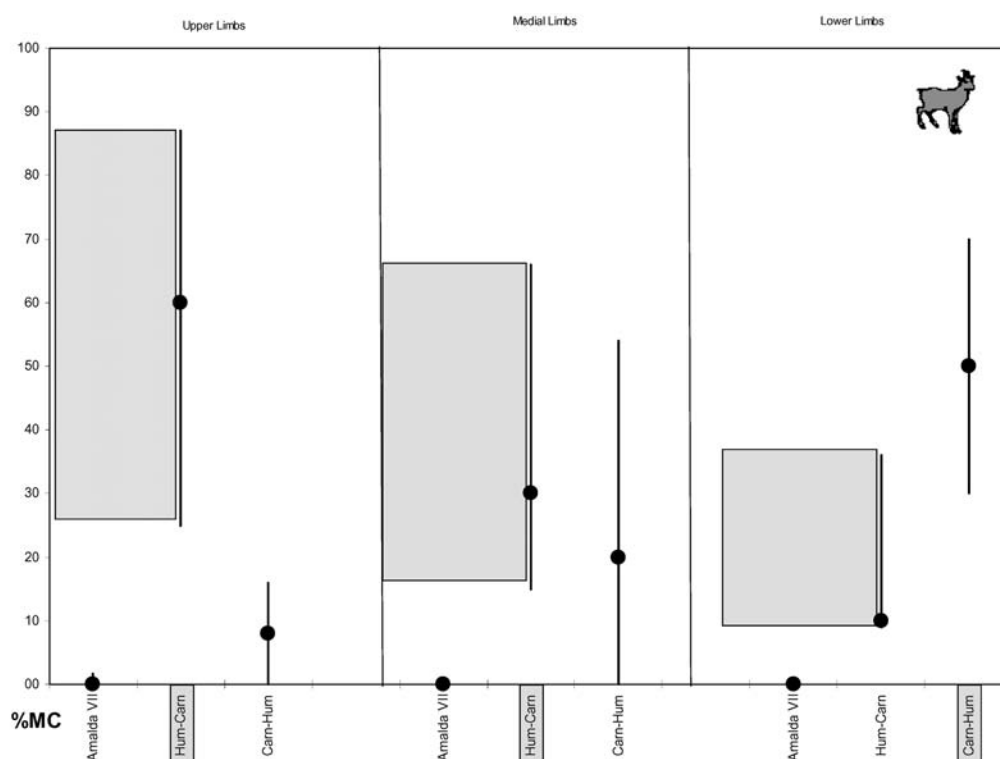


FIGURE 7. Percentage of cut marks in *Rupicapra* in the Amalda Cave compared with human primary access of the experiment by Domínguez Rodrigo (1997).

only by specific portions. Due to the distortion that carnivore post-ravaging had caused in human-made bone accumulations, we are not able to discern the original patterns of bone accumulation made by humans.

The taphonomic study of the Middle Palaeolithic sites shows an early human access to medium-sized and large animals to the detriment of carnivores whose intervention seems to have been secondary. The skeletal part profiles are not a diagnostic tool in the determination of hominid and carnivore access, they are subject to equifinality (different processes with the same end products), and the understanding of skeletal part profiles should be analysed with the study of bone surface in order to precise the sequence played by pre- and post-depositional processes.

## CONCLUSIONS

In this paper we show that skeletal part profiles, taxonomic and age patterns are ambiguous tools for zooarchaeology. They are subject to equifinality, and they do not explain the human behaviour. These analyses are not diagnostic for distinguishing early or late human access to carcasses or different order of intervention to bone assemblages. We prove that the skeletal part profiles of the Iberian Peninsula are similar in all times and that they are conditioned by the intervention of carnivores, the excavation times and others processes such as the differential conservation or the fragmentation pattern.

The referential framework elaborated by Domínguez Rodrigo (1997), Capaldo (1997), Blumenshine (1995), Selvaggio (1998) and others showed that the studies of bone surface modifications seem to be more adequate for the interpretation of zooarchaeological sites. The present work introduces the taphonomic analysis of some Mousterian sites of the Iberian Peninsula. The study of bone surface shows an early human access to carcasses and a secondary intervention of carnivores in large and medium-sized animals such as horses and red deer.

The distribution and frequency of cut marks associated with filleting and defleshing in horses and red deer at several sites like TD6, Amalda Cave, Abric Romaní I, Esquilieu Cave and Moros de Gabasa confirm the primary human intervention in carcass processing and the scavenging applied by carnivores. These studies also suggest that the *Capra* and *Rupicapra* of Moros de Gabasa (Blasco 1995) and the Amalda Cave (Yravedra 2005) show no evidence of human intervention and presence of tooth marks efficient in the interpretation of Palaeolithic sites.

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APPENDIX 1. Location, description and dating of Cantabrian sites.

SITE	LEV.	LOCATION	CULTURE	DATING BP	GEOGRAPHIC ENVIRONMENT	NEXT SITES	EXCAVATIONS	REFERENCES
Abauntz Cave	E	Navarra	Magdalenian	15,800*350	32 m above the Ulzama River level, 610 m ASL, 40 km from the coast. Abrupt environments.	Isturitz, Maya, Zatoya, Urtiaga Santimamiñe	Barandiarán 1976–1979	Altuna <i>et al.</i> 2002
Aitzbitarte IV Cave	2–3 4 5	Guipúzkoa	Magdalenian Solutrean Aurignacian	Dryas II–III 17,950*100 19,550*100	220 m ASL, 7 km from the coast. Valleys and plains.	Ekain, Aitzbitarte III	Marqués del Valle 1892–1906; Barandiarán 1960–1964	Altuna 1972
Altamira Cave	4 1–2	Cantabria	Magdalenian Solutrean	15,910–13,900 15,490	161 m ASL, 11 km from the coast. Valleys and plains.	Linar, Tres Aguas, Cueva Ventí	1900–1930	Altuna, Straus 1976
Amalda Cave	IV V VI VII	Guipúzkoa	Solutrean Gravettian Gravettian Mousterian	17,580–16,090 19,000–17,880 27,400*1,100 Würm I	205 m ASL, 8 km from the coast. Abrupt environments.	Ermittia, Ekain Urtiaga	Altuna 1979–1984	Altuna <i>et al.</i> 1990
Atxeta Cave	E F	Vizcaya	Magdalenian Solutrean	Dryas I	20 m ASL, 15 km from the coast. Valleys and plains.	Atxurri, Bolinkoba	Barandiarán 1959–1960	Castaños 1983b
Axlor Cave	3–4 V–VI VII VIII	Vizcaya	Mousterian Mousterian Mousterian Mousterian	Würm II–III Würm II Würm II Würm I–II	360 m ASL, 35 km from the coast. Abrupt environments.	Lezetxiki	Barandiarán 1967–1974	Altuna 1980
Balmori Cave		Asturias	Magdalenian Solutrean	15,000–13,000	600 m ASL, 30 km from the coast. Abrupt environments.	Riera, Cueto de la Mina	Marqués del Valle 1921	Straus 1977, 1983, Altuna 1972
Bolinkoba Cave	3–bc 4–d 5–e 6–f	Vizcaya	Magdalenian Solutrean Solutr.–Gravet. Gravettian		350 m ASL, 37 km from the coast. Abrupt environments.	Axlor, Atxurri, Santimamiñe	Aranzadi 1932–1933; Barandiarán 1941	Castaños 1983a, Straus 1983
Buxu Cave		Asturias	Solutrean		350 m ASL, 19 km from the coast. Abrupt environments.	Huelga, Riera, Balmori, Cueto de la Mina	Menéndez 1990s	Straus 1983, 1992, Soto 1984
Caldas Cave	I–VIII 3–6 7–19	Asturias	Magdalenian Solutrean Solutrean Solutrean	12,860–13,400 17,050–18,310 18,310*260 19,000–19,030	160 m ASL, abrupt environments.	Rosa, Hornos de la Peña, Candámo, Paloma	Álvarez, Corchón 1968–1971; Corchón 1980s–2000s	Corchón 1981
Castillo Cave	6–8 10 12–18 19 20 21–26	Cantabria	Magdalenian Solutrean Aurignacian Mousterian Mousterian Mousterian Acheulean	16,850–10,310 38,700*1,900 43,000–39,000 128–118,000	195 m above the Pas River level. Valleys and plains, 30 km from the coast.	Hornos de la Peña, Pastega, Covalejos, Moendas	Alcalde del Río 1910–1914; Obermaier, Breuil 1916–1925; Cabrera 1980s	Cabrera 1984, Klein, Cruz-Uribe 1994, Dari 2003
Chufín Cave	A–B	Cantabria	Solutrean	17,420*200	140 m ASL, mixed environments.	Castillo	Cabrera 1977	Quesada 1997
Cierro Cave	2 3 4–5 6–8	Asturias	Magdalenian Magdalenian Solutrean Aurignacian		57 m ASL, 9 km from the coast. Mixed environments.	Rosa	Jordá 1958–1959	Straus 1977, 1983
Coberzas Cave	A3B2 A4	Asturias	Magdalenian Solutrean		60 m ASL, 1.6 km from the coast. Valleys and abrupt environments.	Riera, Cueto de la Mina, Tito Bustillo	Clark 1969; Obermaier, Marqués del Valle 1921	Straus 1983, 1992, Altuna 1972

Collabil Cave		Asturias	Solutrean			290 m ASL, 25 km from the coast. Valleys and abrupt environments.	Cierro, Rosa, Caldas		Altuna 1972
El Conde Cave	A B C D E	Asturias	Aurignacian Aurignacian Aurignacian Mousterian Mousterian			Mixed environments.	Conde de la Vega del Sella 1915		Straus 1977, 1992
Cueto de la Mina Cave	B-D E-F G H	Asturias	Magdalenian Solutrean Gravettian Aurignacian	11,650-11,630		30 m ASL, abrupt environments.	Riera, Balmori		Straus 1983, 1992
Ekain Cave	6 7 8 9-10	Guipúzkoa	Magdalenian Magdalenian Natural Ursus Châtelperonien?	12,050*190 16,510-15,400 10,900*450 >30,600		80 m ASL, 12 km from the coast. Mixed environments.	Amalda, Urriaga, Ermitia		Altuna, Mariezurrena 1984
Ermitia Cave	C D E F	Guipúzkoa	Magdalenian Magdalenian Solutrean Solutrean			125 m ASL, 3 km from the coast. Mixed environments.	Ekain, Urriaga, Amalda		Straus 1983, Altuna 1972
Erralla Cave	I II-III V-VI	Guipúzkoa	Magdalenian Magdalenian Magdalenian	12,310*190 16,270-15,740		230 m ASL, 15 km from the coast. Abrupt environments.	Ermitia, Ekain, Amalda, Urriaga		Altuna <i>et al.</i> 1985
Esquilieu Cave	3-35	Cantabria	Mousterian			350 m ASL, abrupt environments.	Ebarrio, La Mora		Yravedra 2005
Hornos De La Peña Cave	III IV	Cantabria	Magdalenian Mousterian	18,230-20,700		280 m ASL, 24 km from the coast. Mixed environments.	Castillo		Straus 1977, 1983
Juyo Cave	4b 6c 7 8-14	Cantabria	Magdalenian Magdalenian Magdalenian Magdalenian	13,920*240 11,400*300 14,440*180		92 m ASL, 5 km from the coast. Valleys and plains.	Pendo, Ruso		Barandiarán <i>et al.</i> 1987
Labeko Koba Cave	IX VII V-IV	Guipúzkoa	Châtelperonien Aurignacian Aurignacian	34,215*1,265 31,455*925 30,625*820		246 m ASL, 28 km from the coast. Mixed environments.	Lezetxiki		Arrizabalaga, Altuna 2000
Lamiñak Cave	Rev.	Vizcaya	Magdalenian			Valleys and plains.			Castaños 1988
Lezetxiki Cave	I II III-VIII	Guipúzkoa	Magdalenian Gravettian Mousterian			345 m ASL, 30 km from the coast. Abrupt environments.	Labeko Koba		Altuna 1972
Lloseta Cave		Asturias	Magdalenian	15,200-15,500		Valleys and plains.	Rosa		Utrilla 1981
Morfn Cave	II III IV/V Vb-c 6-7 8-9 10 11-12 13-17 22 FF1 RA RAP	Cantabria	Magdalenian Solutrean Gravettian Aurignacian Aurignacian Châtelperonien Mousterian Mousterian Mousterian Aurignacian Aurignacian Aurignacian	20,710*340 32,145-29,515 28,515*735 28,515-36,950		55 m ASL, 7 km from the coast. Valleys and plains.	Pasiega, Covalejos		González Echegaray, Freeman 1978
Oscura Cave	6 7	Asturias	Magdalenian Solutrean			50 m ASL, 2 km from the coast. Valleys and plains.	Rosa		Straus 1977, 1983

Otero Cave	2ab 3 4-6 8-9	Cantabria	Magdalenian Magdalenian Aurignacian Mousterian		60 m ASL, 4 km from the coast. Valleys and plains.	La Chora	González, García Guinea 1969	González Echegaray <i>et al.</i> 1966
Paloma Cave	4 6 8	Asturias	Magdalenian Magdalenian Magdalenian Magdalenian Mousterian	12,750-11,900 14,600*160	155 m ASL, 650 m from the coast. Valleys and plains.	Sofóxó	Hernández Pacheco 1914	Hoyos, Martínez 1980
Pasiega Cave		Cantabria	Magdalenian Mousterian		180 m ASL, 24 km from the coast. Valleys and plains.	Morín	Alcalde del Río	Straus 1977, 1983
Pendo Cave	2 3-4 5a 5-7 8 8a-b 8d-16	Cantabria	Magdalenian Aurignacian Gravettian Aurignacian Gravettian Aurignacian Mousterian	14,830-10,800	85 m ASL, 8 km from the coast. Valleys and plains.	Ruso, Santián	González Echegaray 1953-1957; Montes 1992-1996	Fuentes 1980
Rascaño Cave	1 2 3 4 5-6 7-8 9	Cantabria	Magdalenian Magdalenian Magdalenian Magdalenian Solutrean Solutrean Solutrean Solutrean Solutrean Solutrean Solutrean Aurignacian Aurignacian	50-30,000 12,000-10,480 12,896-12,282 15,173*160 15,988*193 16,483*131 27,240+950-810 >27,000	275 m ASL, 6 km from the coast. Abrupt environments.	Salitre	González Echegaray 1950-1974	González Echegaray, Barandiarán 1981
Riera Cave	24 23-21 20 19 17 16 15 14 12 10 8 4 1	Asturias	Magdalenian Magdalenian Magdalenian Magdalenian Solutrean Solutrean Solutrean Solutrean Solutrean Solutrean Solutrean Aurignacian Aurignacian	10,890*430 12,620-10,340 17,160-12,360 16,420-15,230 17,070-16,900 18,200*610 17,225-15,600 15,690*310 17,210*350 19,820*350 20,690-15,860 20,970*620 20,860-19,620	55 m ASL, 1 km from the coast. Valleys and mixed environments.	Cuerto de la Mina, Buxu, Los Azules	Clark, Straus 1976- 1979	Altuna 1986
Rosa Cave		Asturias	Solutr.-Magdal.		55 m ASL, 11 km from the coast. Valleys and plains.	Cierro	Jordá 1969	Straus 1983
Sofóxó Cave		Asturias	Magdalenian		75 m ASL, 18 km from the coast. Valleys and plains.	Paloma	Conde de la Vega del Sella 1916	Utrilla 1981
Santimamiñe Cave	C (6) D (7) E (8) 2-5	Vizcaya	Magdalenian Solutrean Aurignacian Gravettian	9,470*400	150 m ASL, 5 km from the coast. Valleys and mixed environments.	Bolinkoba, Alturri	Barandiarán 1918- 1926, 1960-1962	Straus 1983, Castaños 1984
Tito Bustillo Cave	2 1C 1B 1A	Asturias	Magdalenian Magdalenian Magdalenian Magdalenian	14,890*410 14,930-14,240 14,220*300 15,400*450	5 m ASL, at the coast. Valleys, plains and mixed environments.	Riera, Buxu, Cuevona, Cueto de la Mina	Moure Romanillo 1972-1974	Altuna 1976
Urriaga Cave	D-E F-G I	Guipúzkoa	Magdalenian Magdalenian Solutrean	10,280*190 17,950*140	130 m ASL, 1.5 km from the coast. Valleys and mixed environments.	Ekain, Ermitia, Analda, Aitzbitarte	Barandiarán 1926, 1928-1936, 1954, 1955, 1959	Altuna 1972
Zatoya Cave	II-B3	Navarra	Magdalenian	11,480*270	900 m ASL, 70 km from the coast. Valleys and mixed environments.		Barandiarán 1975- 1980	Barandiarán, Cava 1989

APPENDIX 2. Location, description and dating of Atlantic and inland sites of the Iberian Peninsula.

SITE	LEV.	LOCATION	CULTURE	DATING BP	GEOGRAPHIC ENVIRONMENT	NEXT SITES	EXCAVATIONS	REFERENCES
Algar do Casais (open-air site)		Portugal	Solutrean	18,620*±2200	Valleys and plains.	Pego do Diabo		Cardoso 1993
Algar João Ramos (open-air site)		Portugal	Magdalenian	14,100*±330	Valleys and plains.	Cabeço do Morto	1900s	Cardoso 1993
Ambrona (open-air site)	Inf. II-IV Va-b	Soria	Acheulean	300,000 Riss	1,150 m ASL, valleys and plains.	Torralba	Marqués de Cerralbo 1907-1909; Howell 1962-1963, 1983; Aguirre 1973; Santonja 1990s	Díez 1992
Aridos I (open-air site)	4 niv.	Madrid	Acheulean	350,000	650 m ASL, plains and fluvial environments.	Aridos II	Santonja <i>et al.</i> 1971-1976	Santonja <i>et al.</i> 1980, Díez 1992
Aridos II (open-air site)		Madrid	Acheulean	350,000	650 m ASL, plains and fluvial environments.	Aridos I	Santonja <i>et al.</i> 1971-1976	Santonja <i>et al.</i> 1980, Díez 1992
Caldeirão (open-air site)		Portugal	Magdal.-Solutr. Mousterian	14,450*±890 27,600*±600	Valleys and plains.	Almonda		Cardoso 1993
Casa do Moira (open-air site)		Portugal	Solutrean- Magdalenian		Valleys and plains.	Furinha	Straus 1988; Nevi Delgado 1867	Cardoso 1993
Casares Cave		Guadalajara	Mousterian	Würm I-II	Valleys and mixed environments. 850 m ASL		Barandiarán 1967, 1968, 1969	Altuna 1973
Chaves Cave	1c-2a-b	Huesca	Magdalenian	12,800-12,020	663 m ASL, abrupt environments.	Cueva del Parco	Baldellou 1975; Utrilla 1984-1990	Castaños 1993
Condeixa (open-air site)		Portugal	Acheulean	Mindel	Valleys and fluvial environments.			Cardoso 1993
Dolina Cave	T11-TD1	Burgos	Acheulean		900-1,000 m ASL, valleys and plains.	Sima de los Huesos, Sima del Elefante, Galería	Carbonell, Bermúdez de Castro 1980-1990s	Díez 1992, Esteban 1996, Díez <i>et al.</i> 1999
Ermита Cave	1-4 5a 5b 6	Burgos	Mousterian	31,100*±550	60 m ASL, valleys and plains.	Millán	Moure 1971, 1993, 1994	Moure <i>et al.</i> 1997, 1972, Delibes 1972
Escoural (open-air site)		Portugal	Solutrean Mousterian	19,300*±115 48,900*±5500	Valleys and plains.	Montemor-o-Novo, Évora	Dos Santos 1960s, 1990	Cardoso 1993
Figueira Brava (open-air site)		Portugal	Mousterian	30,900-30,000	Valleys and plains.	Gruta das Salemas	Cardoso 1987-1990	Cardoso 1993
Fontainhas Cave		Portugal	Aurignacian	22,730-890-700	Valleys and plains.	Columbeira	1879-1880	Cardoso 1993
Foz do Enxarrique		Portugal	Mousterian	34,000-32,000	Fluvial environments.		1982-1993	Cardoso 1993
Fuente del Trucho Cave	LBB ALB AR	Huesca	Mousterian		640 m ASL, abrupt environments.		Valdellou, Mir 1979-1984	Martínez Moreno 1993, Montes 1988
Furinha Cave		Portugal	Mousterian Solutrean	80,880-42-31	Valleys and plains.		Delgado 1984	Cardoso 1993
Galería Cave	U.I U.II U.III U.IV	Burgos	Acheulean	118+71-49 177-317,000 256±33 211±32	900-1,000 m ASL Valleys and plains.	Sima de los Huesos, Sima del Elefante, Galería	Jordá 1965; Crusafont 1976; Carbonell, Bermúdez de Castro 1980-1990s	Díez 1992, Carbonell <i>et al.</i> 1999, Huguet <i>et al.</i> 1999, Díez <i>et al.</i> 1999
Gruta da Nascente do Almonda Cave		Portugal	Mousterian	Riss-Würm	Valleys and plains.		Paco 1947; Zilhão 1991	Cardoso 1993

Grua das Salemas Cave	2-3 4	Portugal	Solutrean Aurignacian	20,000 25,000	Valleys and plains.	Correio Mor, Salemas	Camarate França 1959	Cardoso 1993
Lorga de Dine Cave		Portugal	Mousterian	+30,000	Valleys and plains.	Vinhais, Bragança	1964	Cardoso 1993
Lupa de Raimha Cave		Portugal	Aurignacian	25,580*1490	Valleys and plains.	Columbeira, Fontainhas	Almeida 1968-1969	Cardoso 1993
Mealhada Cave		Portugal	Acheulean	OIS 6	Valleys and fluvial environments.	Ermita	1879	Cardoso 1993
Millán Cave	1a-c	Burgos	Mousterian	37,600*700	Valleys and mixed environments.		García Soto 1980-1986	Alvarez <i>et al.</i> 1992
Moros de Gabasa Cave	A B C D E F G H	Huesca	Mousterian	W III W III W III 46,500 W II-III W II	780 m ASL, valleys and abrupt environments.	Fuente del Trucho, Castelló de Pla	Montes, Utrilla 1984-1994	Blasco 1995
Nova de Columbeira Cave		Portugal	Mousterian	26,400*750 28,900*950	Valleys and plains, 10 km from the coast.	Casa da Moura	Veiga Ferreira 1962; Roche 1971	Cardoso 1993
Pedreira do Salemas Cave		Portugal	Mousterian	29,900-27,000	Valleys and plains.	Salemas, Correio Mor	1959-1960	Cardoso 1993
Pego do Diabo Cave		Portugal	Mousterian	28,120*800	Valleys, plains and fluvial environments.	Correio Mor, Salemas	Zilhão 1988	Cardoso 1993
Peña Miel Cave	C E, G, H	Rioja	Aurignacian Mousterian	39,999*10,500 45,500*1,300	840 m ASL, valleys and mixed environments.		Lartet 19th cent.; Utrilla 1980-1986	Utrilla 1987
Pimilla del Valle Cave		Madrid	Mousterian	90-150,000	1,000 m ASL, valleys and mixed environments.		Alfárez 1981-1988; Baquedano 2000s	Diez 1992
Prado Vargas Cave	B	Burgos	Mousterian		952 m ASL, mixed environments.		1986	Navazo <i>et al.</i> 1993
Solana del Zamborino (open-air site)		Granada	Acheulean		Valleys and plains.	Gaudix, Baza	Botella 1970s	Diez 1992
Torralba (open-air site)		Soria	Acheulean	450-300,000	1,000 m ASL, valleys and fluvial environments.	Ambrona	Marqués de Cerralbo 1907-1909; Howell, 1962-1963; Aguirre 1973; Santonja, Mora 1990s	Diez 1992
Valdegoba Cave		Burgos	Mousterian		930 m ASL, valleys and abrupt environments.		Diez 1987	Diez 2006
A Valina Cave	1	Galicia	Châtelperronian	34,800+1,900 -1,500	620 m ASL, valleys and plains.		César Llana 1987-1988.	Fernández 1993
Vertelpino	5	Cuenca	Magdalenian	13,970-12,930	1,000 m ASL, mixed environments.	Cuenca	1980s	Rubio, Valiente 1985

APPENDIX 3. Location, description and dating of Mediterranean sites of the Iberian Peninsula.

SITE	LEV.	LOCATION	CULTURE	DATING BP	GEOGRAPHIC ENVIRONMENT	NEXT SITES	EXCAVATIONS	REFERENCES
Ambrosio Cave	1-7	Almería	Solutrean	16,500*200 (2) 16,620*280 (4) 16,950*1,400 (6)	1,000 m ASL, valleys.		Ripoll 1958-1968, 1983-1986	Yravedra 2005
L' Arbreda II Cave	3 4	Cataluña	Aurignacian Mousterian	25,000-20,000	200 m ASL, valleys and plains.		Corominas 1973	Rueda 1993, Estévez 1979
L' Arbreda Cave	A B C D E Eb F Ga Gbc	Cataluña	Magdalenian Solutrean Solutrean Gravettian Aurignacian Aurignacian Mousterian Mousterian	13,000 17,320-17,700 20,120 22,590-25,830 32,000-30,000 37,700-39,000 34,100-41,400	200 m ASL, valleys and plains.		Corominas <i>et al.</i> 1972-1971, 1947; Ripoll 1975-1978; Carbonell 1974	Rueda 1983, Estévez 1979
Abri Agut		Cataluña	Mousterian		Valleys and plains.	Abrie Romani	Ripoll 1970	Estévez 1979
Abrie Romani	A,B,C,D, E,F,G,H, I,J,K L-Z	Cataluña	Mousterian	39,000-70,000 40,800 (A) 46,200 (E) 45,000 (I) 50,000 (J) 56,500 (W) 66,000 (Aa)	Valleys and plains.	Cingleña del Carpelló, Abri Agut	Font, Vidal 1911; Ripoll, Laplace 1959; Ripoll, Lumley 1961; C.R.P.E.S 1983- 1988; Carbonell 1990s	Cáceres 1996, Estévez 1979
Beneito Cave	B2-1 B5-3 B6 B7-8 B9 C1-3 C4 D1 D2-4 5-4	Alicante	Solutr.-Gravet. Solutr. Evol. Solutr. Evol. Gravettian Aurign. Evol. Aurignacian Aurignacian Moust. F Moust.-Châtelp. Magdalenian	16,580*480    26,959*890 33,900*1100 30,160*680 38,800*1900	Valleys and mountains.		Iturbe 1980s, 1990s	Martínez Valle 1996
Blaus Cave		Valencia			1,000 m ASL, 2 km from the coast.		Casabo, Rovira 1987-1990s	Martínez Valle 1996
Boquete de Zafarraya Cave	A-D	Granada	Mousterian	35,000-30,000	1,100 m ASL, plains and valleys.		Barroso 1990s	Barroso 2003
Bora Gran d'en Carreras Cave		Cataluña	Magdalenian Solutrean Mousterian	11,470*500	200 m ASL, mixed environments.		Alsinus 1871-1995; Busons 1907; Corominas 1930s; Perico, Maluquer 1943-1944	Estévez 1979
Cau de les Goges Cave		Cataluña	Solutrean		Plains.		Pallares 1915-1920	Estévez 1979, 1980
Cau del Duc de Torroella Cave	3 4	Cataluña	Lower Palaeolithic Mousterian		200 m ASL		Pericot 1971; Vert <i>et al.</i> 1975	Estévez 1979
Cau del Duc d'Ullà Cave		Cataluña	Lower Palaeolithic Mousterian		200 m ASL		Pericot 1972, Vert 1974-1979;	Estévez 1979
Castell Sa Sula		Cataluña	Magdalenian		600 m ASL, valleys and abrupt environments.	Cingle Vernel	Carbonell 1979 Valls 1977	Estévez 1979



Les Cendres Cave	IV III-1	Valencia	Magdalenian Magdalenian	15,820*150 (XII) 12,650*80 (XI) 13,840*85 13,320 (X)	Ca. 50 m ASL, 0.2 km from the coast.	Cueva Fosca, Parpalló	Villaverde 1981, 1986-1991, 1991-1999	Villaverde <i>et al.</i> 1997, 1999
Cova 120	4-6	Cataluña	Mousterian	50,000-148,000 OIS 5	460 m ASL, abrupt environments.	Alto Garrotxa	1975-1989	Rueda 1993
Cova del Corb		Valencia	Mousterian		200 m ASL	Calaveres, Penya Roja, Be-Nirrana	1983	Sarrion 1990
Cova Negra Cave	3-6-2	Valencia	Mousterian	W I-II	100 m ASL, mixed environments.	La Petxina	Viñes 1928-1933; Pericot <i>et al.</i> 1950-1957; Villaverde 1980s	Martínez Valle 1996
Devil's Tower Cave	3 6	Gibraltar	Mousterian	>30,000 177,000	Abrupt and coastal environments.	Gorham's Cave, Deadman's Beach	Garrod 1925-1927	Barton 1988
Els Ermitons	4 5	Cataluña	Mousterian	35,000 36,480*1,800	370 m ASL	Espassa	Mir <i>et al.</i> 1975	Estévez 1979
Fuente de San Luis Cave		Valencia	Mousterian	Würm II	385 m ASL, 40 km from the coast.		1987-1988	Sarrion 1990
Gegant Cave	1-4	Valencia	Mousterian		Plains.		Almera 1975	Estévez 1979
Gorham's Cave	B D G N-U	Gibraltar	Solutrean Gravettian Mousterian	18,000-14,000 27,860-28,700 47,000-49,000 125,000*100,000	Abrupt environments.	Ibex Cave, Deadman's Beach	Waechter 1948-1954; 1995	Barton 1988
Higueral de Motillas Cave		Cadiz	Solutrean		Plains.			Cáceres, Anconetani 1997
Horá Cave	25	Granada	Mousterian		Mixed and abrupt environments.		Botella, Pellicer 1960s, 1970s, 1980s	Fuentes, Mejde 1975
Mallaetes Cave	5 4 3-2	Valencia	Solutrean Solutrean Solutrean Aurignacian	20,140*140 16,300+1,500	10 km from the coast.	Bolomor, Parpalló	1939-1945	Davidson 1976
Matutano Cave	1(I) 2(I) 3(Ii) 4(Iii) 5(Iii) 6(Iv)	Castellón	Magdalenian Magdalenian Magdalenian Magdalenian Magdalenian Magdalenian	12,090*170 11,410*610 12,390*190 12,130*180 12,460±180 13,960*200	351 m ASL, 5 km from the coast.	Tossal de la Font, Blaus	Olària 1979-1989	Olària 1999
Mollet Cave	2 4-3 6-5	Cataluña	Aurignacian Mousterian Mousterian	Würm III Würm I-II Würm-Riss	200 m ASL		Corominas 1947-1948, 1972; Ripoll 1958; Mir, Salas 1976; Maroto 1980	Estévez 1979, Rueda 1993
Muricecs Cave		Cataluña	Aurignacian Mousterian		560 m ASL		Guitart 1969	Estévez 1979
Muscle Cave		Cataluña	Mousterian		200 m ASL, alluvial environment.	Punta de les Coves	1976	Estévez 1979
Nerja Cave	A B C D E F	Málaga	Magdalenian Magdalenian Magdalenian Magdalenian Solutrean Aurignacian	14,570*540 11,380-11,830 12,270-10,110 15,900-18,420	158 m ASL, 1 km from the coast.		Pellicer, Jordá 1962-1990	Pellicer, Acosta 1995

Olopte B Cave		Cataluña	Mousterian	15,000–12,900				Canal 1974	Estévez 1979
Parco Cave	11–4	Lleida	Magdalenian	13,225 13,891 14,557 16,056 16,888 17,554 18,387 19,386 20,718	458 m ASL, 10 km from the coast.	Chaves	1987	García, Fullola 2006	
Parpalló Cave	1 2 3 4 5 6 7 8 9–10	Valencia	Magdalenian Magdalenian Solutrean Solutrean Solutrean Gravettian			Mallaetes, Cèndres, Volcán del Faro	1929–1931	Davidson 1989	
Picamoixons		Tarragona	Upper Palaeolithic		Valleys and mixed environments.		1988, 1978	Perales, Fernández 1990	
Ratlla del Bubo	4–3	Lleida	Solutrean					Martínez Valle 1996	
Roc de la Melca Cave		Cataluña	Magdalenian	20,900*400	Plains and valleys.		Oliva 1961–1969	Estévez 1979	
Salt Cave	A–G	Alicante	Mousterian	Würm II	Mixed environments.	Beneito, Tossal de la Roca	1960, 1970, 1990	Sarrion 1990, Barton 1984	
Teixoneres Cave		Cataluña	Mousterian		775 m ASL		Villalta 1970	Estévez 1979	
Toll Cave	B–L	Cataluña	Mousterian		700 m ASL		Thomas 1955–1957	Estévez 1979	
Tossal de la Roca	4 3 2 1	Alicante	Magdalenian	15,360*1,100 14,000 12,480*250 10,000	669 m ASL, 22 km from the coast, plains.	Beneito, Salt	Cacho <i>et al.</i> 1995	Cacho <i>et al.</i> 1995	
Volcán del Faro Cave	6–23	Cataluña	Magdalenian		Floodplain of the Júcar River.	Parpalló	1930s–1940s, 1971–1972	Davidson 1972, 1989	
Vilanova de Sau Cave		Valencia	Magdalenian	11,500–16,000 20,000–35,000	700 m ASL, mixed environments.		1978	Vila i Mijà 1987	