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FRONTISPIECE: A y B: restos craneales del ejemplar NE 78. C: húmero (vista lateral), radio (vista posterior) y ulna (vista lateral). D: atlas y axis de los tres perros de la necrópolis de Empúries.

ARCHAEOFAUNA

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Solutrean macrofauna from Cova de les Cendres (Alicante, Spain): zooarchaeological and taphonomic analysis

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ABSTRACT: Zooarchaeological and taphonomic analysis were performed on the macrofaunal remains from Solutrean levels XIII and XIV (ca. 17 and 20 ka cal BP) of Cova de les Cendres. The faunal assemblage shows predominance of red deer, followed by Spanish ibex and equids, among which wild ass (*Equus hydruntinus*) was identified. Carnivores are well represented in level XIII, especially the lynx, whereas they are very rare in level XIV. Different activities of the butchery process were documented in the main taxa, showing an intensive exploitation of different animal resources, such as meat, fur, and raw material for tools and ornaments. Our results provide new zooarchaeological data on the Solutrean hunting system and shed light on the human subsistence variations in response to late glacial climate changes in the central area of the Mediterranean Iberia.

KEYWORDS: IBERIAN PENINSULA, PLENIGLACIAL, LAST GLACIAL MAXIMUM, SOLUTREAN, ZOOARCHAEOLOGY, TAPHONOMY, MACROFAUNA

RESUMEN: Se ha realizado un análisis zooarqueológico y tafonómico de los restos de macrofauna de los niveles solutrenses XIII y XIV (ca. 17 y 20 ka cal BP) de la Cova de les Cendres. El conjunto faunístico muestra un predominio del ciervo, seguido por la cabra montés y los équidos, entre los que se ha identificado el asno salvaje (*Equus hydruntinus*). Los carnívoros están bien representados en el nivel XIII, especialmente el lince, mientras que son muy raros en el nivel XIV. En los taxones principales se han documentado diferentes actividades del proceso de carnicería que muestran una explotación intensiva de los recursos animales, como carne, pieles y materia prima para útiles y ornamentos. Nuestros resultados proporcionan nuevos datos zooarqueológicos sobre el sistema de caza solutrense y arrojan luz sobre las variaciones de subsistencia humana en respuesta a los cambios climáticos durante el Último Máximo Glacial en la zona central del Mediterráneo ibérico.

PALABRAS CLAVE: PENÍNSULA IBÉRICA, PLENIGLACIAL, MÁXIMO GLACIAL FINAL, SOLUTRENSE, ZOOARQUEOLOGÍA, TAFONOMÍA, MACROFAUNA

INTRODUCTION

The Iberian Peninsula is considered one of the ideal refugia in SW Europe for the Solutrean hunter-gatherers who were surviving the Last Glacial Maximum (*ca*. 26-19 ka cal BP) (Straus, 2013). Human adaptations to the critical climatic conditions in this context were thoroughly investigated and several syntheses of general patterns from macro to micro-regional level were recently published (e.g., Cascalheira *et al*., 2021).

As regards the Iberian Mediterranean region, the Solutrean occupation was documented in a large number of archaeological sites and multiple zooarchaeological analyses have been carried out since the 1970's. Among theme, from north to south: Cova de l'Arbreda and Cau de Coges in Catalonia (Estévez, 1979, 1987; Rueda, 1993); Cova de les Malladetes, Cova del Parpalló, Cova Beneito, and Cova del Moro in the Valencia region (Davidson,1976, 1989; Villaverde & Martínez Valle, 1992; Martínez Valle, 1996; Villaverde *et al.,* 1999, 2010; Castaño *et al*., 2008; Roman *et al.,* 2021); Cueva de Nerja, Cueva Ambrosio, Higueral-Guardia among others in eastern Andalusia (Cáceres & Anconetani, 1997; Riquelme *et al.,* 2005; Yravedra, 2007, 2008; Delgado, 2019). Nevertheless, apart from the taxonomic information, few of these works provided taphonomic data on the exploitation and consumption of macromammals.

Regarding the central area of the Iberian Mediterranean (the Cova de les Cendres site region), it is assumed that there is a significant trend for a specialized hunting system throughout the Late Pleistocene, which culminates in the Magdalenian. This would focus toward either red deer or Spanish ibex depending on the site location (near the coastline or in inland mountainous area, respectively) and likely the season, whereas large ungulates (e.g., aurochs, bisons and horses) were occasionally hunted by human groups (Pérez Ripoll & Martínez Valle, 2001; Aura *et al*., 2002; Villaverde *et al.,* 2010).

This economic model was recently demonstrated for the Gravettian and Magdalenian occupations of Cova de les Cendres, where red deer was proved to be the main big game and extensive prey exploitation was documented (Villaverde *et al*., 2019; Real, 2020, 2021). On the other hand, limited macrofaunal data was available for the Solutrean phase (Villaverde *et al.,* 1999, 2010), and besides there was lack of taphonomic works at regional level.

The purpose of this research is to provide new zooarchaeological and taphonomic information on the Solutrean subsistence strategies and complement the Upper Palaeolithic dataset of Cova de les Cendres. In this way, we aim to verify whether the ecological changes occurred during LGM have an effect on human hunting behaviour, since palaeobotanical data has shown a deterioration of environmental conditions and has assumed a reduction in the availability of food resources in the local landscape (Martínez-Varea *et al*., 2019).

MATERIALS AND METHODS

Cova de les Cendres

Cova de les Cendres is a karst cavity in the Moraira headland, about 80 km from Alicante (38°41'10''N, 00°09'09''E). It opens to the southeast among the current marine cliffs, at an altitude of about 60 m above the sea level (Figure 1). The Upper Pleistocene and Holocene human occupation was documented by extensive archaeological works carried out since the 70s. As regards the Pleistocene sequence, with Aurignacian, Gravettian, Solutrean and Magdalenian stages having been identified, the stratigraphy of Cova de les Cendres represents one of the most complete in the central-eastern part of the Mediterranean area (Villaverde *et al.*, 2012, 2019).

In this work, we present the results on the macrofaunal remains from the Solutrean levels XIII and XIV, dated between 20,050 and 24,620 cal BP (Villaverde *et al.*, 2019). These levels were highly affected by post-depositional alterations and erosive processes, which eventually have led us to consider the Solutrean sequence as a single package. Nevertheless, based on the study of the lithic and bone industry, level XIII has been recently related to Evolved Solutrean (Martínez-Alfaro *et al*., 2019). More details on the archaeological site and the stratigraphy are provided in the supplementary information (Supplementary text 1).

Methodology

The sample used for this work was retrieved from two square meters (B20 and C20) of sector B,
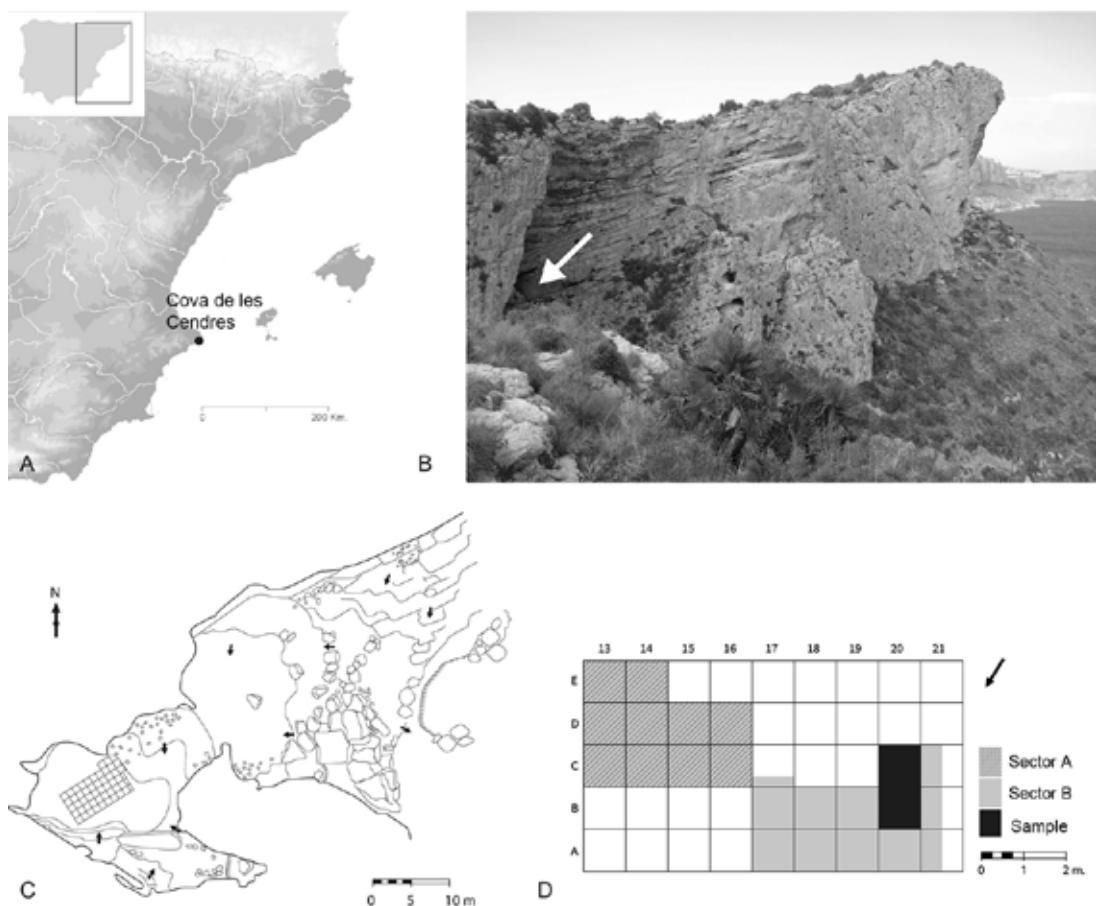
FIGURE 1
Cova de les Cendres: location (A); site overview (B); excavation trench (C); sample area (D).

corresponding to layers 8 to 12. This stratigraphic selection was made following Bel (2020)´s criteria in order to avoid post-depositional alterations that affected the Solutrean sequence (see Supplementary text 1). During the excavation, the exact provenance of the archaeological finds was determined by plotting their position with a total station theodolite. Also, the sediment was processed by means of a floating machine with two sizes of cloth mesh (1 and 0.25 mm) which allowed to collect even the tiniest specimens.

Zooarchaeological and taphonomic analyses were intentionally focused on macromammals remains, since the aim of this work was to analyse the Solutrean hunter-gatherers' big game strategies, and a detailed work on the human exploitation of leporids was already available for level XIII

(Gordón, 2017). Notwithstanding, the lagomorph remains in the sample were first counted and then separated in order to offer a quantitative comparison with the rest of faunal assemblage.

Anatomical and taxonomic identification were carried out by consulting the skeletal reference collections from Universitat de València and *Gabinete de Fauna Cuaternaria Innocenci Sarrión* (Museu de Prehistòria de València) together with classical atlases (such as Silver, 1969; Schmid, 1972). In addition, specific studies on equids were employed to differentiate between wild horses and feral ass (Davis, 1980; Eisenmann, 1986; Aceredillo, 2008; Hanot & Bochaton, 2018).

Unidentified skeletal remains were classified according to animal weight/size, and those that were anatomically undeterminable were grouped by type

of bone. As regards weight/size classification, we considered on one hand the cortical thickness and robustness of bone fragments, and on the other hand the taxonomic composition of the analysed faunal assemblage and the age of the animals (Bunn *et al.*, 1988; Blasco, 2011). Therefore, the following categories were created for the present study: very small (<20kg: *Vulpe* sp., *Lynx* sp. infantile and juvenile; *Felis silvestris;* Leporidae); small (20-100 kg: *Panthera pardus* juvenile and adult; *Lynx* sp. adult; *Equus hydruntinus* infantile*; Sus scrofa; Cervus elaphus* infantile*; Capra pyrenaica* juvenile and adult); middle (100-300 kg: *Equus ferus* infantile and juvenile; *Equus hydruntinus* juvenile and adult; *Cervus elaphus* juvenile and adult; *Bos primigenius/Bison* sp. infantile); large (300-1000 kg: *Equus ferus* adult; *Bos primigenius/Bison* sp. juvenile and adult). Likewise, anatomically unidentified bones were grouped into long bones (diaphysis of limbs, including metapodial and phalanges), flat bones (from axial and cranial skeleton, including scapula and coxal), and articular bones (carpals, tarsals, and epiphyses) (Cáceres, 2002).

Age at death was inferred from epiphyseal fusion and dental eruption and wear (Silver, 1969; Barone, 1976; Hillson, 2005). In addition, specific works on *Cervus elaphus* (Mariezkurrena, 1983; Azorit *et al.*, 2002), *Capra pyrenaica* (Pérez Ripoll, 1988; Serrano *et al.,* 2004; Llorente & Quiralte, 2016) and equids (Levine, 1982; Fernández & Legendre, 2003) were consulted. The estimated individuals were grouped as follow: infantile (deciduous teeth with wear/most of the epiphyses are unfused); juvenile (deciduous teeth with different wear stage and some permanent teeth/adult-sized bones, but still not all fused); adult (permanent teeth with different wear stage/ all epiphyses completely fused). As regards the seasonality, we considered the data on gestation and birth of wild populations (Palomo *et al.*, 2007), as well as the dental growth and wear pattern in Spanish ibex (Pérez Ripoll, 1988).

Quantification of the macrofaunal assemblage was performed by calculating the Number of Identified Specimens (NISP), the Minimum Number of Individuals (MNI) and the Minimum Number of Elements (MNE) (Lyman, 2008). Skeletal survival rate was calculated by applying the Survivorship Index (Isu) following Brain (1981) and then standardised. This was then converted into %MAU (Binford, 1978) and correlated by means of Spearman's rank correlation coefficient (Rs) with mineral bone density of the main taxa (Lyman, 1994).

Taphonomic analyses were performed using a Nikon SMZ-10A binocular microscope (10 to 50 magnifications) to identify the origin of bone modifications. Percentages of complete and fragmented elements were calculated. Long bone fractures were classified as green-bone or dry based on the morphology of breakage surfaces (fracture angles, fracture outlines and fracture edges) after Villa & Mahieu (1991). Also, the classification of fractures was implemented through the system of morphotypes created by Real *et al.* (2022), a method that can be applied to all types of bone and allows to describe both the origin of fracture and the anatomical part of the bone that is conserved.

Anthropogenic activities were documented through lithic marks, intentional bone breakage for marrow extraction and fire damage (e.g., Binford, 1978, 1981; Potts & Shipman, 1981; Pérez Ripoll, 1992; Vettese *et al.*, 2020). For each modification, multiple traits were recorded, such as length, direction, intensity, quantity, and location. In the case of burnt remains, we adapted the criteria defined by Stiner & Kuhn (1995) and created three intensity levels based on the coloration and the distribution of the fire damage (i.e., stains, partial or uniform): L1 (low intensity: from brown to black); L2 (medium intensity: from black to grey); L3 (high intensity: from light grey to white). Interpretation of anthropogenic modifications as different butchery activities (such as skinning, evisceration, dismembering, disarticulation, filleting, and tendon extraction) were made consulting experimental works on current ungulates (e.g., Binford, 1981; Pérez Ripoll, 1992; Costamagno & David, 2009; Jin & Mills, 2011; Soulier & Costamagno, 2017).

Finally, non-anthropogenic modifications were related to post-depositional processes, whereas carnivore damage was discarded following the existing literature (e.g., Fisher, 1995; Théry-Parisot *et al.*, 2004; Fernández-Jalvo & Andrews, 2016).

RESULTS AND INTERPRETATIONS

From an assemblage of 37,758 faunal remains, a total of 33,301 (88.2%) bone and tooth remains have been identified to taxon level (lagomorphs and macromammals). Furthermore, a total of 2,691 (7.1%) skeletal remains have been classified according to weight size category groups. The rest of the assemblage (1,766 remains, equivalent to 4.7%) compri-

ses unidentified bone and teeth fragments (Table 1). All calculations from here on will exclude lagomorph remains (NISP=32,663, equivalent to 86.5%) in order to better assess the macrofaunal assemblage.

LEVEL XIII

Faunal spectrum

A total of 471 remains were identified, among which the best represented species are red deer, Spanish ibex, and equids. Other ungulates are rare and only include a large bovine (likely aurochs) and wild boar. Carnivores are mainly represented by lynx, though European wildcat, fox, leopard, and seal are also recorded in very small quantities (Table 1).

Nearly all indeterminate remains were classified as middle-sized taxa, a category that is congruent with red deer and juvenile equids. Likewise, those classified as small-sized taxa could be related to Spanish ibex, infantile red deer and equids, wild boar, and carnivores. Finally, large-sized taxa could represent adult horses and *Bos/Bison*.

	XIII			XIV			TOTAL
	NISP	%NISP	MNI	NISP	%NISP	MNI	
IDENTIFIED REMAINS	17.408			15.893			33.301
Macromammals	471		19	167		8	638
Ungulates	408	86,6	12	161	96,4	7	569
cf. *Bos primigenius*	3	0,6	1	0	0,0	0	3
Cervus elaphus	163	34,6	4	100	59,9	3	263
Capra pyrenaica	118	25,1	3	27	16,2	2	145
Sus scrofa	1	0,2	1	0	0,0	0	1
Equus sp.	89	18,9	3	16	9,6	-	105
Equus hydruntinus	0	0,0	0	1	0,6	1	1
Artiodactyla	34	7,2		17	10,2		51
Carnivora	63	13,4	7	6	3,6	2	69
Lynx sp.	37	7,9	2	4	2,4	1	41
Felis silvestris	9	1,9	2	0	0,0	0	9
Panthera pardus	2	0,4	1	0	0,0	0	2
Vulpes sp.	3	0,6	1	1	0,6	1	4
Phocidae	3	0,6	1	0	0,0	0	3
Carnivora indeterminate	9	1,9		1	0,6		10
Lagomorpha	16.937			15.726			32.663
Small mammal	106			19			125
Middle size mammal	1.198			1.311			2.509
Large size mammal	39			18			57
UNIDENTIFIED REMAINS	1.584			182			1.766
TOTAL	**18.992**			**16.075**			**35.067**

TABLE 1

Faunal abundance from Solutrean levels attending to NISP and MNI.

A minimum of 19 individuals has been calculated. Estimations were based on second phalanx for red deer (MNI=4), lower teeth for Spanish ibex (MNI=3), first phalanx for equids (MNI=3), and astragalus for lynx (MNI=2). In the case of European wildcat, different stages of epiphyseal fusion suggested a MNI of 2. All other taxa are represented by only one individual.

Estimate of age at death and seasonality

Red deer is represented by one juvenile individual aged under two years old and two adults older than three years old. Similarly, both mortality profiles of *Capra* and *Equus* show presence of one infantile individual (<1 year old) and at least one adult above five years old. According to epiphyseal fusion of juvenile individuals, the moment of death may have occurred sometime between summer and autumn.

Skeletal part preservation

The total number of estimated anatomical elements is 314. These mainly correspond to ungulates (83.6%), whereas carnivores are low represented (16.4%). Skeletal profiles of the main taxa are mostly complete, except for axial elements (Figure 2). On the other hand, this bias could be nuanced by the high number of vertebrae and ribs (NISP=319) recorded in the middle-sized taxa. Further details on the anatomical representation by %Isu and %MAU of both main and minor taxa can be found in the supplementary material (Suppl. Tables 3A and 4A).

In red deer, the most abundant elements are the phalanges, whereas there is complete absence of scapula, malleolus, and patella. The %Isu shows the highest values in second and first phalanges, and cranium. In the same way, mandible, innominate, and nearly all long limb bones are also well represented.
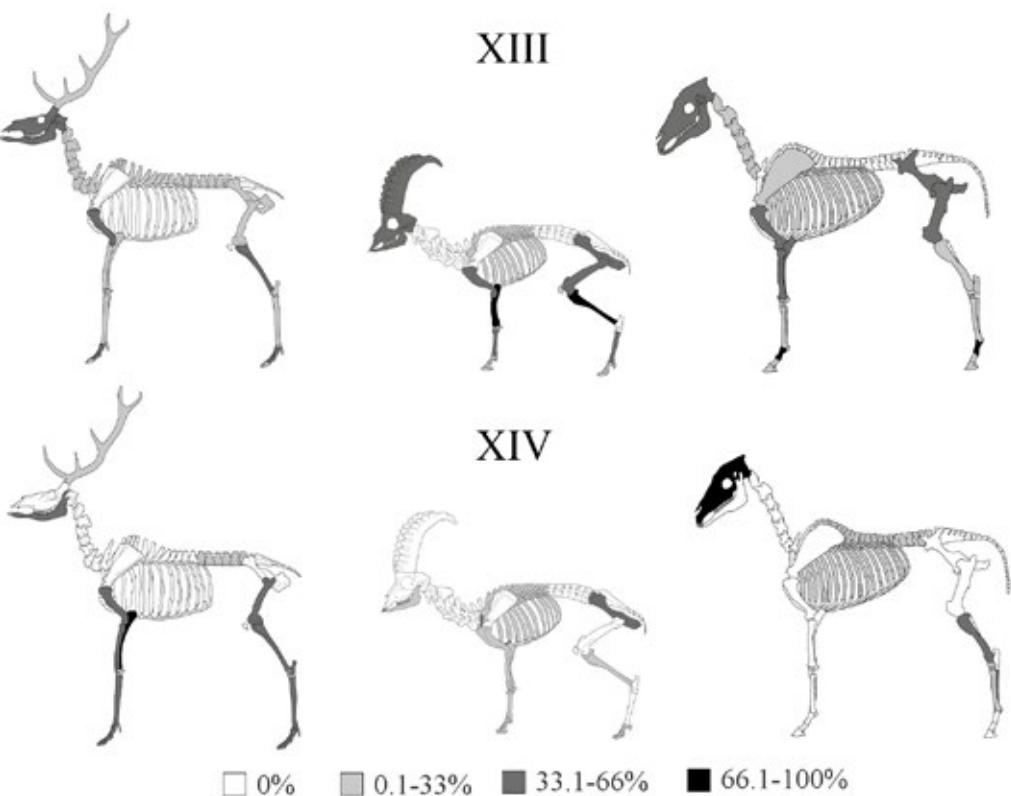
FIGURE 2
Anatomical representation of main taxa by %Isu.

In Spanish ibex, teeth are the most numerous elements, while scapula, fibula, astragalus and calcaneus are missing. According to %Isu, the best represented elements are radius-ulna and tibia, followed by femur, whereas teeth appear moderately represented.

In equid, the most abundant elements are sesamoids, tarsals, and first phalanx, whereas fibula is absent. This is partially confirmed by %Isu, which shows the highest values in the first phalanx and the mandible. Also, the appendicular skeleton bones are mostly well represented, with predominance of ulna and tarsals.

The correlation of %MAU with bone density was tested for the three ungulates. The results for red deer (R=0.462; p=0.040) and equid (R=0.599; p=0.004) show both a moderately positive correlation with enough statistical significance, while that for the Spanish ibex (R=0.349; p=0.154) is not statistically meaningful. Therefore, the bone density factor is likely responsible for the bias in skeletal preservation for red deer and equid, whereas Spanish ibex seems to be unaffected.

The remaining species of the faunal assemblage show overall poor skeletal preservation, except for lynx. This shows the highest %Isu in cranium, humerus, radius, innominate, fibula and astragalus (50%), whereas there is scarcity of axial skeleton bones and ulna is missing. Finally, among ungulates, the aurochs is only represented by mandible, scapula, and calcaneus and wild boar by one lumbar vertebra. As regards the rest of carnivores, wildcat is represented by forelimb and hindlimb bones, whereas other species only show two or three elements each.

Bone breakage

The bone assemblage is highly fragmented and only a minor part of it displays modern breakage (9.6%). On the other hand, complete elements are rare (3.9%) and generally consist of small and compact bones or unfused epiphyses, whereas complete teeth are very scarce and mostly belong to *Capra* and *Equus*. The breakage pattern shows that green-bone and undetermined fractures are the most abundant in all taxa. Also, low rates of dry fracture were recorded in ungulates (11.9% in *Equus*; 8.6% in *Capra*; 4.3% in *Cervus*) and carnivores (15.9%), while mixed fracture were only

found in *Cervus* and *Capra* (1.4% and 3.2%). The main results from fresh fracture analysis are here described, further details are available in the supplementary material (Suppl. Tables 5 and 6A).

In red deer, green-bone fracture represents just over 51% and mainly occurs in the limb bone shafts and phalanges, but also in one mandibular body and one lumbar vertebra. When elements are considered individually, humerus, metatarsus and first phalanx stand out (80-100%). Interestingly, a systematic trend was detected in the breakage of the first and second phalanges (Figure 4, A). These show transversely or obliquely split diaphysis, along with a variable part of the epiphyses, usually the distal one.

In Spanish ibex, green-bone fracture is nearly 40%. All long bones are affected, among which humerus and metapodials show the highest percentages (75% and 67%). Also, scarce evidence of fresh fracture was observed on one coxal (33%) and phalanges (20-25%).

In equid, green-bone fracture represents just 15%, though it affects several skeletal elements. Nearly all the appendicular skeleton is involved, except for the ulna, the metacarpus, and the pelvic girdle. Likewise, fresh fracture in the axial skeleton was observed on one cervical vertebra and one proximal rib.

Regarding the minor taxa, green-bone fracture was documented in two out of the three aurochs remains (scapula and calcaneum), whereas in carnivores this was rather uncommon (about 16%) and mostly concerned the lynx.

Anthropogenic modifications

Modifications caused by human activity have been identified in 24.6% (NISP=447) of bone remains, mostly in ungulates and indeterminate taxa (Table 2, Figures 3-4).

Intentional bone breakage performed by means of either percussion or torsional loading techniques has been documented in 56 remains (12.5% of anthropogenic modifications). The most abundant percussion marks are cortical flakes 1-3 cm in length, which thickness suggests these likely belong to middle-sized taxa. Also, a modest amount of impact notches has been observed on the hedge of fresh fractured bone shafts. These are usually found isolated rather than multiple, and most-

SOURCE	TYPE OF MARK	*Cervus*	*Capra*	*Equus*	Carnivores	Indet.	Total
Level XIII		**58**	**51**	**32**	**15**	**291**	**447**
Intentional breakage	Peeling	0	0	1	0	2	3
	Cortical flake	0	0	0	0	34	34
	Percussion notch	7	4	1	0	7	19
Lithic	Incision/Scrape	0	0	0	0	2	2
	Incision	29	21	14	4	84	152
	Scrape	4	4	2	0	8	18
	Deep striation	2	4	3	1	3	13
	L1	3	6	4	1	42	56
Fire damage	L2	10	11	6	8	90	125
	L3	3	1	1	1	19	25
Level XIV		**57**	**10**	**6**	**2**	**327**	**402**
Intentional breakage	Cortical flake	0	0	0	0	9	9
	Percussion notch	4	1	0	0	4	9
Lithic	Incision/Scrape	3	0	0	0	2	5
	Incision	23	5	3	2	29	62
	Scrape	5	1	0	0	4	10
	Deep striation	2	0	0	0	0	2
	L1	9	2	1	0	52	64
Fire damage	L2	10	1	2	0	188	201
	L3	1	0	0	0	39	40

TABLE 2

Anthropogenic modifications classified by source and type of mark in identified and unidentified taxa.

ly show semi-circular shape. Since this evidence seems to be related to marrow extraction processes, it is noteworthy that the red deer shows percussion notches even on phalanges, whereas in equid, the sole evidence was found in the mandibular body. Finally, torsional loading has been documented by three cases of *peeling*, a type of fracture produced by flexing the shaft by hand. All of them were observed on ribs, one of which belongs to equid.

Secondly, cutmarks produced by means of lithic tools account for 41.4% (NISP=185) of anthropogenic modifications and mainly consist of incisions. Multiple butchery activities were identified in the main ungulates (Figure 3), though aurochs and lynx also displayed some evidence (the complete set of butchery marks and their anatomical location can be found in the Suppl. Table 7). Overall, the filleting process was the most frequently documented (23 cutmarks), followed by disarticulation (18), and skinning (15). On the other hand, less common butchery activities include tendon removal (5), evisceration (3) and dismembering (2).

Despite *Cervus* showing the highest number of cutmarks, the entire "*chaîne opératoire*" was identified only for *Capra*. Also, nearly all the activities were observed in *Equus*, even though the quantity of cutmarks is lower than in the other two ungulates. Among minor taxa, the lynx showed cutmarks related to skinning and disarticulation, and in aurochs dismembering and disarticulation were identified. Furthermore, aside from the consumption purpose, we also documented two cutmarks related to other activities, likely with ornamental goals. These consisted of an atrophied red deer canine with multiple incisions on the root, and a diaphysis of a middle-sized taxon, which showed clustered weak impressions produced by a lithic tool in oblique direction.

Finally, fire damage represents the most common anthropogenic modification. It affects 11.4% of the macrofaunal assemblage, among which indeterminate taxa represent the majority. Spanish ibex shows the highest rate of burnt remains (15.2%), followed by equid (12.3%) and red deer (9.8%). Carnivores are also represented in this respect, although taxonomic identification of burnt remains was limited to six elements of lynx (16.2%) and one of wild cat. The assessment of fire damage intensity has given similar results in both determinate and indeterminate taxa. Overall, medium intensity (L2) burn damage was scored in 61% of bone remains, low intensity (L1) was rather common too (27%), whereas calcination (L3) was the less frequent (12%) (Table 2).
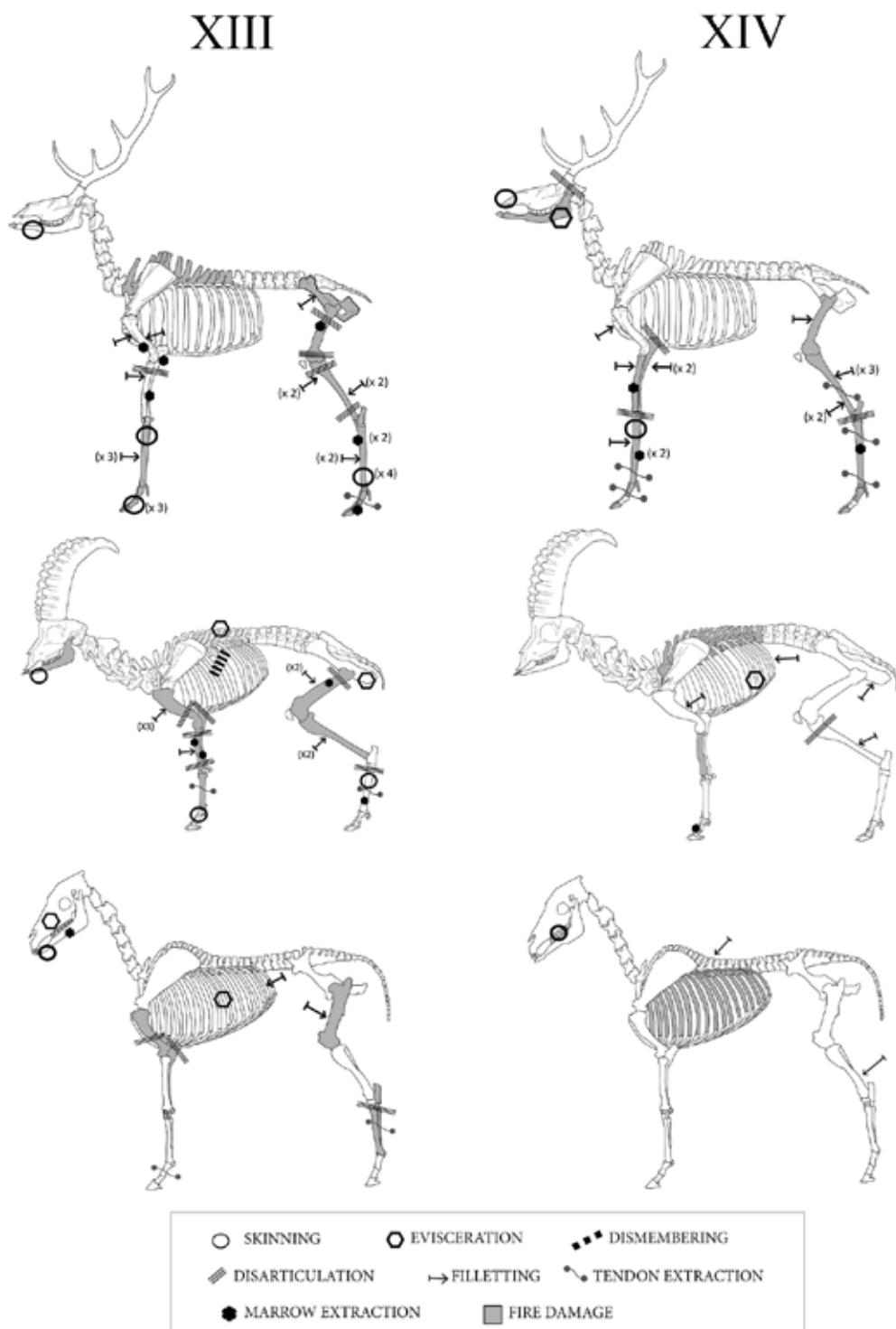
FIGURE 3·
Butchery activities and fire damage representation in main mammal taxa.
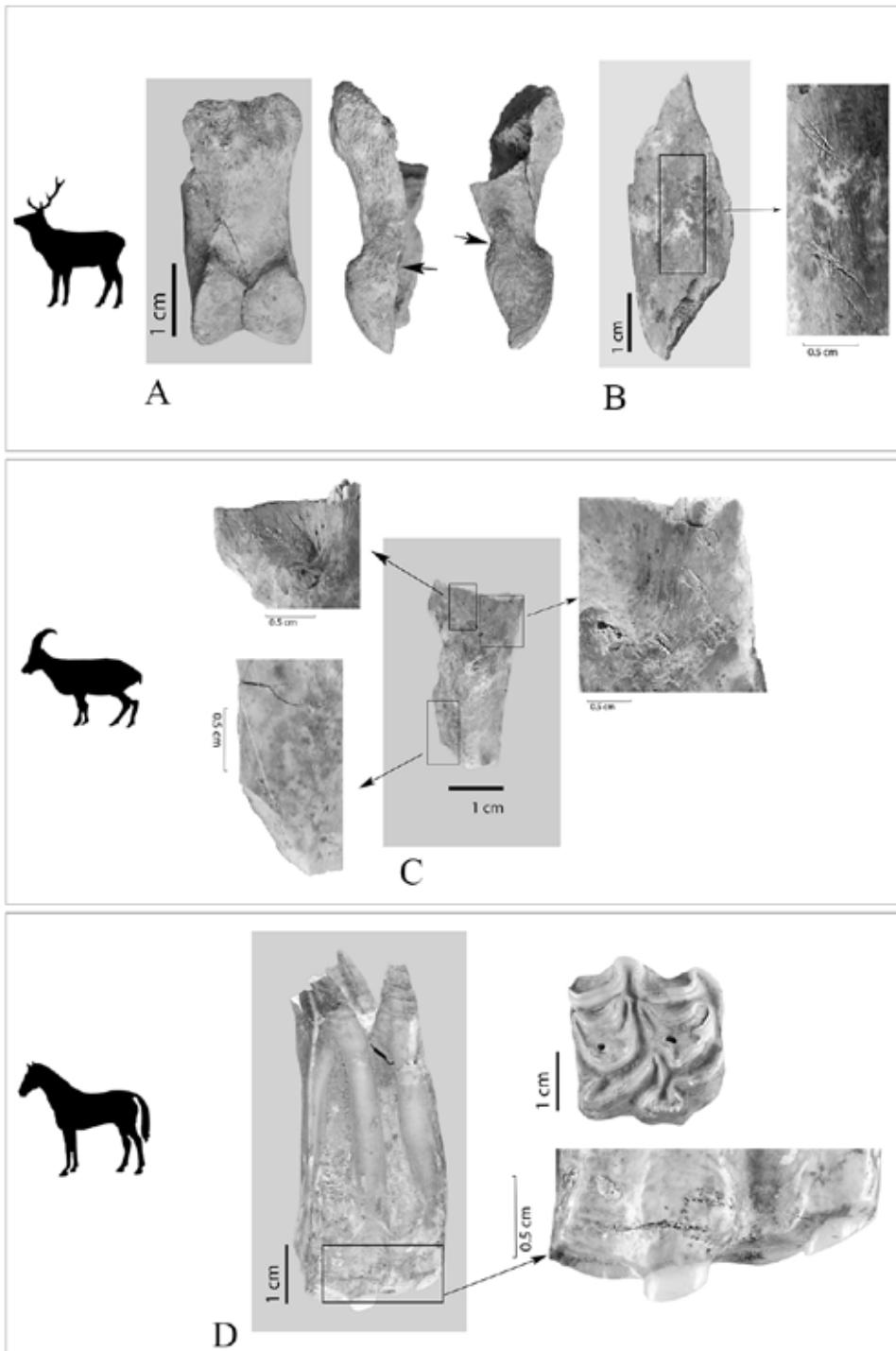
FIGURE 4·

Anthropogenic modifications on faunal remains. Red deer (level XIII): second phalanx with double percussion notches (A); metatarsal with incisions. Spanish ibex (level XIII): femur with incisions, scrapes (left) and deep striations (right) (C). Wild ass (level XIV): Upper premolar (P3/) with incisions (D).

LEVEL XIV

Faunal spectrum

The sample is composed of 167 macromammal remains, among which red deer stands out. Other ungulates are represented by Spanish ibex and equids, which include *E. hydruntinus* (identified by means of a complete P3/). Carnivores are very rare and only include lynx and fox (Table 1).

Indeterminate remains are abundant and were mostly classified as middle-sized taxa, with very scarce representation of small and large-sized taxa. As regards the middle size group, this distribution could rather nuance the low representation of equids or increase that of the red deer. Likewise, the reduced proportion of small-sized taxa is coherent with the low representation of both Spanish ibex and carnivores, whereas the large size group could be related to adult horses.

Overall, a minimum of eight individuals was estimated. The calculation was based on the MNE of ulna for red deer (MNI=3), and on different epiphyseal fusion stages of the second phalanx in Spanish ibex (MNI=2). Other taxa were represented by one individual.

Estimate of age at death and seasonality

For both red deer and Spanish ibex, two age groups have been identified: one of young individuals aged under one year old (one MNI for each genus) and other of subadults aged about three years old (two of red deer and one of Spanish ibex). Also, the wear stage of a M1/ of *Capra* suggests that the moment of death took place in autumn. Finally, as regards equid, the P3/ of *E. hydruntinus* shows an advanced stage of wear that could be related to an adult aged eight or nine years old.

Skeletal part preservation

A minimum of 132 anatomical elements has been identified in the assemblage. These belong almost entirely to ungulates, whereas only six elements have been documented for carnivores. As can be observed in Figure 2, skeletal profiles of the main taxa are generally incomplete. For further

data on %Isu and %MAU refer to the supplementary material (Suppl. Tables 3B and 4B).

The Red deer shows the best preservation, although there is absence of several cranial and axial elements and both scapular and pelvic girdles are missing. On the other hand, the remains of the extremities and hindlimb bones are abundant. This profile is confirmed by the %Isu, even though the best represented element is ulna (66%).

In Spanish ibex, there is a lack of many axial and cranial elements, along with femur and metatarsus, whereas the extremities are abundant. Based on the %Isu value, the most frequent elements are innominate and sternum (50%), followed by mandible (25%), but the extremities are low represented.

For the genus *Equus* a total of 16 skeletal elements have been quantified, none of them belonging to the forelimb. According to %Isu, skeletal representation appears dominated by cranium (100%), tibia and residual metatarsals (both 50%).

As regards carnivores, their skeletal representation is scarce and only includes four long bones of lynx, one fox tibia, and one caudal vertebra of some indeterminate species.

Lastly, the correlation between %MAU and bone density was only tested for red deer since other taxa are poorly represented. The result indicates positive correlation (Rs=0.48; p=0.028), hence the bias in this taxon skeletal profile was likely caused by a phenomenon of different preservation rather than a selective transport of the prey.

Bone breakage

Nearly the whole assemblage is fragmented (NISP=1,476), with high prevalence of old fracture (90.7%) compared to recent damage (6.7%). Complete bones represent only 1% and mostly include unfused epiphyses and compact elements, among which the P3/ of *hydruntinus*. Similarly, red deer and Spanish ibex only show six and one complete elements respectively.

The breakage pattern shows different rates of green-bone fracture among ungulates. The highest percentage of fresh fracture was recorded in red deer (47%) and Spanish ibex (35%), whereas equids showed this feature on just two elements and for carnivores there is no evidence at all. Dry fracture was only documented in two specimens

(one of *Capra* and the other of carnivore), whereas undetermined fracture is the most common in all taxa. Furter data on breakage pattern and fresh fractures is available in the supplementary file (Suppl. Tables 5 and 6B).

In red deer, green-bone fracture mostly concerns the limb bones and the extremities, along with one mandibular body. The highest proportions were found in radius/ulna, metacarpus, and tibia (80-100%). First and second phalanges were also affected (approx. 60%) and tended to show a transversely split shaft with variable portions of distal epiphysis.

In Spanish ibex, fresh fractures were mostly located in the forelimb, the tibia, and the extremities. In the same way, equids and indeterminate artiodactyls were respectively affected on the tibia and metapodial and on the tibia and scapular body.

Anthropogenic modifications

Anthropogenic modifications affect 26.5% (NISP=402) of the sample and were mainly found in red deer and indeterminate taxa (Table 2, Figure 3-4).

Intentional bone breakage represents the less frequent modification (4.4%) and was only documented by nine cortical flakes and as many percussion notches, with no relation between them. Both types show the same features as described for their peers in level XIII, thus they have been interpreted as evidence of marrow removal activity.

Moreover, 79 lithic cutmarks were determined, equivalent to 19.7% of anthropogenic modifications and almost entirely represented by incisions. A remarkable difference in the number of cutmarks was recorded among ungulates, of which red deer is clearly the most affected. On the other hand, it is noteworthy that two cutmarks were also observed among the few carnivores 'remains.

Overall, the best represented activities are filleting (17 cutmarks), disarticulation (7) and tendon extraction (6). By contrast, no trace of dismembering was detected, while few cutmarks of evisceration and skinning were identified (2 and 3, resp.). Among the latest, the most outstanding evidence was found on the sole remain of *E. hydruntinus,* a P3/ which shows transversal incisions on labial view (Figure 4, D). More information on the but-chery marks is available in the supplementary material (Suppl. Table 8).

Lastly, fire damage was detected on 20.1% (NISP=305) of the macrofaunal assemblage and represents by far the most common anthropogenic modification (76%). Nevertheless, only a small minority of burnt remains belong to identified taxa, among which red deer shows the highest ratio (20%), followed by equid (17.6%) and Spanish ibex (11%), whereas carnivores are not represented. Looking at the intensity level of fire damage, it appears that identified taxa show similar values of L1 and L2, while only one remains was recorded in L3. On the other hand, indeterminate remains are clearly more affected by intensity L2 (67.4%), while little difference was detected between L1 (18.6%) and L3 (14%) (Table 2).

DISCUSSION

Last Glacial Maximum macrofauna in the Moraira headland

The faunal assemblage presented here shows remarkable quantitative difference of macromammals identified remains between the two levels (471 in level XIII versus 167 in level XIV). This bias has affected both taxonomic and taphonomic analyses, which eventually have produced poorer results for the scarcest assemblage, especially in terms of species richness. That being said, the taxonomic spectrum indicates that the most prevalent big game prey at Cendres is red deer, followed by Spanish ibex and equid. The two levels show different percentages of the three ungulates and a clear increment of the main taxon in level XIV. The predominance of red deer is consistent with the previous zooarchaeological work on level XIII (Villaverde *et al.*, 1999, 2010), but also with the taxonomic data for the Gravettian and Magdalenian levels of Cendres (Villaverde *et al.*, 2019; Real, 2021).

Moreover, we have recently argued that the significant share of equid remains in level XIII suggests a relation with the paleoenvironmental changes occurred during LGM (Monterrosa *et al.*, 2021). Of these, the most relevant involved the drastic temperature decrease (10 C˚ cooler than nowadays) and the semi-arid landscape, as inferred by anthracological data for this region (Martínez-Varea *et al.*, 2019). This hypothesis seems to be corrobo-

rated by the identification of *E. hydruntinus* in level XIV, since its natural habitat (meadow and steppes) involves cold and arid climate, as was proved by Sanz-Royo *et al.* (2020).

Carnivores differ greatly in their representation in the two Solutrean levels. Level XIII shows a good number of remains (13.4%), mostly of lynx, while other identified species include wildcat, leopard, fox, and seal. This latter was also documented in the Gravettian phase (level XVIA) (Villaverde *et al.*, 2019) and could be indicative of an occasional frequentation of the coastline, some 15-20 km from the cave in OIS2. Instead, carnivores in level XIV are scarce (3.6%) and only lynx and fox were documented. Similar fluctuations in the rates of carnivores were also recorded in the Magdalenian levels, as well as the predominance of lynx (Real, 2020). Also, in the studied sample a minor number of anthropogenic modifications were documented on carnivore remains, whereas carnivore damage on bone remains (e.g., gnawing marks) was not identified. This implies that the agent of the bone accumulation is anthropic and as a consequence, the cave was not shared with other competitors during the Solutrean phase.

Finally, it is worth considering that our estimated quantification of lagomorph remains (above 90%) has turned out to be coherent with the previous result provided by Gordón (2017) on level XIII, in which an intensive prey exploitation was clearly documented.

Solutrean hunters' subsistence strategies

Our data shows that human hunting strategy at Cendres relied on herds of ungulates composed by almost the same proportion of adult and young individuals under two years old. Estimated age at death of the youngest herbivores suggest that the hunting episodes took place between summer and autumn. In the case of red deer, this pattern would indicate that the hunting strategy was focused on familial groups, which aggregate between spring and late autumn. As for Spanish ibex and equid, since their sex is unknown, the hunting activity could have been addressed to maternal herds or separate groups of males.

The exposed data corresponds with the same period of occupation inferred by the analysis of fau-

nal and plant records in the other Upper Palaeolithic levels (Villaverde *et al.*, 2019; Real, 2020). On the other hand, our result could also implement the previous study on level XIII, which set the human occupation of the cave between autumn and spring and highlighted a specialised hunting strategy oriented towards adult males of red deer (Villaverde *et al.*, 2010). If this is the case, the Solutrean hunter-gatherers could have benefited from Cendres ecotone in different moments all over the year, adapting their hunting techniques according to the season. A similar feature was observed in Andalusia, where the Solutrean faunal assemblages both from the coastal site of Cueva de Nerja (158 m a.s.l.) and the mountainous site of Cueva Ambrosio (1060 m a.s.l.) were related to year-round hunting activities specialised on Spanish ibex (Riquelme *et al.*, 2005; Yravedra, 2007, 2008).

The taphonomic analysis has detected an intensive exploitation of animal resources. Anthropogenic modifications were mostly found in red deer and Spanish ibex, to a lesser extent in equids and scarce in carnivores (nearly all in the lynx). Similar patterns in the butchery activities were found in other faunal assemblages, such as Cova Beneito and Cueva Ambrosio, especially for what concerns cutmarks on the Spanish ibex (Martínez-Valle, 1996; Yravedra, 2007). Furthermore, skeletal profiles of the main taxa are mostly complete, hence the preys were likely hunted in a radius of 5-8 km and then transported to the cave, where the carcasses were eventually processed. Absent and less frequent skeletal elements have been justified with different preservation of less dense bones and partially balanced by indeterminate remains.

The breakage pattern shows that green bone fractures occurred in all taxa, even if with different proportions. This feature has been related to biostratinomic processes, which in this anthropic context can be interpreted as butchery activities. In this sense, percussion notches and cortical flakes have been associated with bone marrow extraction and consumption. In ungulates, intentional bone breakage mostly concerns long limb bones which contain high levels of bone marrow and fat. A similar pattern was observed in Cueva Ambrosio, though percussion marks on scapula and ribs were absent in our sample (Yravedra, 2007). Furthermore, even the last calories reserve was exploited, since the breaking of red deer phalanges seems to be systematic (Figure 4, A) and some other cases were documented in Spanish ibex. This fracture pattern is

repeated in the Magdalenian occupation of the cave (Real, 2021) and matches with the processing of phalanges observed in the Solutrean level of Cueva de las Caldas (Asturias) (Mateos Cachorro, 1999).

With regard to equids, fresh fracture is more uncommon than in artiodactyls and concerns both axial and appendicular skeleton. The only percussion notch was identified in the mandible, an element that in equids is nearly rich in bone marrow as humerus or tibia (Outram & Rowley-Conwy, 1998). The morphology of this last fracture (the plantar view of the mandibular body is conserved) together with the documented fresh fractures are compatible with the breakage pattern observed in the Arbreda cave, where Solutrean groups specialised in the hunting of horses (Estévez, 1979; Rueda, 1993).

Cut marks on cortical bones have been related to specific steps of the "*chaîne opératoire*", which proved that preys were first skinned, then eviscerated and dismembered to facilitate the following process of disarticulation and filleting. The last two activities are by far the most represented out of the whole process, although it would be risky to speculate about meat preservation rather than immediate consumption. Moreover, this bias could also be related to the low preservation of cranial and axial elements, where the other butchery activities are generally observed.

In the same way, the shortage of identified articulations, along with the abovementioned percussion marks, might correspond to intensive grease-rendering, following the model proposed by Manne *et al.* (2012) for the Solutrean faunal assemblage at Vale Boi (southwestern Portugal). The authors claim that fat retrieving from spongy bones might have been more convenient than simply concentrating on marrow fat exploitation, even though this process was supposed to require a long time and complex preparation. However, our sample is reduced, and grease-rendering still has to be confirmed in the Mediterranean Iberia. In addition, the Solutrean levels at Cendres have suffered severe erosive and sedimentary processes which interfered with the stratification in some excavated area (Roman & Villaverde, 2014), hence one cannot discard that this factor might have played a significant role in bone remain preservation.

When burn damage is considered, the predominance of black and black-grey colouring in both levels has been interpreted as a proxy of high intensity combustion. It is likely that the preys were roasted with the main purpose of consumption, although it can be discarded the use of fire to make bone fragmentation easier as proposed for the Magdalenian levels (Real, 2020). Furthermore, the high rate of uniformly charred remains and the minor share of calcined remains might suggest the reutilization of waste as additional heating source and cleaning maintenance of the settlement (Théry-Parisot, 2002). This practice had already been presumed with regard to rabbit remains, which show the same intensity colouration (Gordón, 2017).

Finally, a minor part of the cutmarks in our sample was related to the activity of tendon removal, a resource that besides consumption, was likely used to make glue, thread, and ropes (Soulier & Costamagno, 2017). This is coherent with the Solutrean practice of making tools and ornaments by exploiting raw material documented by Martínez-Alfaro *et al.* (2019). In this sense, two remains in level XIII might correspond to hard tissue exploitation activity. On one hand, the incisions observed on the red deer canine were interpreted as a failed attempt to pierce the tooth for ornamental purpose, since other specimens with complete perforation were found in the same level as well as in the Gravettian and Magdalenian levels. Likewise, the bone-shaft that displayed lithic marks unrelated to any butchery activity, was identified as a bone retoucher following Mozota (2015). According to the author, the linear weak impressions recorded in the use zone are typically produced by percussion on fresh bone with the purpose of reshaping a lithic tool.

CONCLUSIONS

The zooarchaeological and taphonomic evidence of Cova de les Cendres has allowed to document the hunting behaviour of Solutrean human groups in the Moraira headland. The derived information has been interpreted and integrated with the previous study carried out by Villaverde *et al.*, (2010).

As in the case of other Upper Palaeolithic Mediterranean sites (i.e., Beneito, Parpalló, Malladetes), lagomorph is the most abundant taxon (ca. 90%) since this small prey was steadily hunted all year around to complement the large game subsistence strategy. Another common feature is the anthropogenic nature of most bone modifications, which indicates that during the Pleniglacial carnivores were considered by the human groups more as an eco-

nomic resource than as a threat in the occupation of the cave. This is also confirmed by the mortality profiles of the main taxa, which suggest that Cendres was frequented by human groups in different moments throughout the year.

Overall, our study highlights that, despite red deer being confirmed to be the predominant large game prey, Spanish ibex and equids were also relevant in the Solutrean diet. Also, the increment in equids representation might corroborate the open landscape inferred by the anthracological data. Human groups would carry out the hunting activities in the surrounding of the site and all preys were transported complete to the cave, where they were butchered. Faunal resources were intensively exploited by humans not only for consumption purposes, but also for obtaining raw materials to make tools and ornaments, while the waste was probably used as firewood.

To conclude, the exposed data is congruent with the analysis of the rest of archaeological materials (lithic and bone industry, plant remains) (Villaverde *et al*., 2010; Martínez-Alfaro *et al*. 2019; Martínez-Varea *et al*., 2019), which altogether prove that several domestic activities took place in the cave, suggesting that the site was repeatedly occupied by the Solutrean groups.

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SUPPLEMENTARY MATERIAL

See supplementary material at https://revistas.uam.es/archaeofauna/article/view/archaeofauna32.1_003

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SUPPLEMENTARY TEXT 1: COVA DE LES CENDRES

Cova de les Cendres is located in Teulada-Moraira (Alicante), on the karst escarpment that connect Punta de Moraira and Cap de la Nau. The cavity is made up of two distinct parts: one exterior and well exposed to the sunlight, with detachments of large blocks from the drip, and another interior area, poorly lit and wider than 600 m². In this latter part of the cavity, thirteen Palaeolithic levels were excavated between 1995 and 2017. The excavated area covered over 21 m² and was organised in two sectors, named A and B, with different stratigraphic conditions related both to human activity and complex sedimentary processes.

The cultural adscription of all levels was determined except for the lower one (XVII), which was poor in archaeological records and could represent the base. According to that, the Pleistocene sequence comprises of the Aurignacian (levels XVID and XVIC), the Gravettian (levels XVIB, XVIA, XV), the Solutrean (levels XIV and XIII) and the Magdalenian (levels XIIB, XIIA) (Villaverde *et al.,* 2019).

The entire Palaeolithic sequence is sustained by a rich series of absolute dates, both through radiocarbon methods and by AMS, which provides a solid chronological framework. Regarding the Solutrean occupation, on which our study was focused, ^{14}C dates show a chronological range between 24,620 cal BP (Beta-287544) and 24,030 cal BP (Beta-287545) for level XIV, and between 23,230 cal BP (Beta-118026) and 20,050 cal BP (Beta-287542) for level XIII (Villaverde *et al.,* 2019).

The two Solutrean levels were excavated in 1999 and 2000, over an area of approx. 11 m2 (the so-called sector B). The average depth of the sedimentary record was way larger in level XIII (approx. 45 cm) than in level XIV (less than 10 cm), a difference that eventually biased the abundance of the archaeological finds. Moreover, both levels showed a complex structure composed of laminations caused by erosive processes that displaced and re-deposited archaeological records from the underlying levels. In addition, since the strata were leaning on a flowstone, the excavated area showed irregular surface and dips with respect to the general trend of the sedimentary package. For these reasons, previous works on level XIII were led to consider the whole level as a single package (Roman & Villaverde, 2014; Villaverde *et al.* 2010; Bel, 2020).

In this sense, Martínez-Alfaro *et al*. (2019) have recently published a typological study of the lithic and osseous industry retrieved in level XIII, which showed a mixture of archaeological materials associated with both Upper Solutrean and Solutrean-Gravettian phases. According to the authors, by comparing the different projectiles recovered in Cendres with those found in other sites with similar chronologies in the Mediterranean area (such as Parpalló, Malladetes, Beneito, la Boja, Finca de Doña Martina or Ambrosio), level XIII can be related chiefly to the Evolved Solutrean.

Other works focused on the Solutrean occupation of Cendres so far. Regarding the archaeobotanical record, the study of Martínez-Varea *et al*. (2019) has newly provided anthracological and carpological data that shed light not only on the landscape surrounding the cavity, but also on the hunter-gatherers' plant resource exploitation during LGM. From a climatic point of view, a significant rise in aridity was detected based on the reduction of pine woods, alongside the increment of juniper and woody Fabaceae. Moreover, since these species point to the supra-Mediterranean belt, the mean annual temperature in the Moraira headland was estimated between 8 and 13ºC, while the current mean is about 17 ºC.

Another interesting aspect of the Solutrean landscape is the position of the coastline. According to geomorphological data, this was about 15 km far away from the cavity and a broad coastal plain had emerged, with wetlands and lakes on it and dunes near the shoreline (Fumanal *et al*., 1993). The hight diversity of environments around Cova de les Cendres is also supported by the aforementioned archaeobotanical data, which documented a variety of species from different biotopes (*ibid.*).

With regard to the faunal record, scant zooarchaeological works were carried out for the Solutrean phase until now. Firstly, an early study was performed on a sample of bone remains from the survey (squares A17-B17) excavated in 1998 (Villaverde *et al*., 1999, 2010). This work gave a general picture of the faunal spectrum (macromammals, lagomorphs and birds were studied) in the entire Palaeolithic sequence of Cendres, but a comprehensive taphonomic analysis was missing. As concerns the Solutrean levels, the faunal assemblage was mainly composed of leporids (about 80%) followed by red deer and Iberian ibex, alongside with

few remains of equids, bovids and carnivores (lynx mostly).

More recently, two taphonomic studies were carried out on samples of faunal records from level XIII, one of which was focused on leporids (Gordon, 2017) and the other on equids (Monte-rrosa *et al.,* 2021). Overall, both works documented several types of anthropogenic modifications (such as lithic marks, fresh fractures, and fire damage) and related themes to intensive activities of processing and consumption of small and big game.

SUPPLEMENTARY TEXT 2: METHODOLOGY

The sample used for this work was retrieved from two square meters (B20 and C20) of sector B, corresponding to layers 8 to 12. This stratigraphic selection was made following Bel (2020)´s criteria in order to avoid the post-depositional alterations that affected the Solutrean sequence (see Supplementary Text 1).

During the excavation, the exact provenance of the archaeological finds was determined by plotting their position with a total station theodolite. Also, the sediment was processed by means of a floating machine with two sizes of cloth mesh (1 and 0.25 mm) which allowed to collect even the tiniest specimens. The present study includes the analysis of all large and small prey mammals, except for lagomorphs.

Anatomical and taxonomic identification were carried out by consulting the skeletal reference collections from Universitat de València and *Gabinete de Fauna Cuaternaria Innocenci Sarrión* (Museu de Prehistòria de València) together with classical atlases (such as Silver, 1969; Schmid, 1972). In addition, specific studies on equids were employed to differentiate between wild horses and feral ass (Davis, 1980; Eisenmann, 1986; Aceredillo, 2008; Hanot & Bochaton, 2018).

Unidentified skeletal remains were classified according to animal weight/size, and those that were anatomically undeterminable were grouped by type of bone. As regards weight/size classification, we considered on one hand the cortical thickness and robustness of bone fragments, and on the other hand the taxonomic composition of the analysed faunal assemblage and the age of the animals (Bunn *et al.*, 1988; Blasco, 2011). Therefore, the following categories were created for the present study: very small (<20kg: *Vulpe* sp., *Lynx* sp. infantile and juvenile; *Felis silvestris;* Leporidae); small (20-100 kg: *Panthera pardus* juvenile and adult; *Lynx* sp. adult; *Equus hydruntinus* infantile*; Sus scrofa*; *Cervus elaphus* infantile*; Capra pyrenai-ca* juvenile and adult); middle (100-300 kg: *Equus ferus* infantile and juvenile; *Equus hydruntinus* juvenile and adult; *Cervus elaphus* juvenile and adult; *Bos primigenius/Bison* sp. infantile); large (300-1000 kg: *Equus ferus* adult; *Bos primigenius/ Bison* sp. juvenile and adult). Likewise, anatomically unidentified bones were grouped into long bones (diaphysis of limbs, including metapodial and phalanges), flat bones (from axial and cranial skeleton, including scapula and coxal), and articular bones (carpals, tarsals, and epiphyses) (Cáceres, 2002).

Age at death was inferred from epiphyseal fusion and dental eruption and wear (Barone, 1976; Silver, 1969; Hillson, 2005). In addition, specific works on *Cervus elaphus* (Mariezkurrena, 1983; Azorit *et al.*, 2002), *Capra pyrenaica* (Pérez Ripoll, 1988; Serrano *et al.,* 2004; Llorente & Quiralte, 2016) and equids (Levine, 1982; Fernández & Legendre, 2003) were consulted. The estimated individuals were grouped as follow: infantile (deciduous teeth with wear/most of the epiphyses is unfused); juvenile (deciduous teeth with different wear stage and some permanent teeth/adult-sized bones, but still not all fused); adult (permanent teeth with different wear stage/ all epiphyses completely fused). As regards the seasonality, we considered the data on gestation and birth of wild populations (Palomo *et al.*, 2007), as well as the dental growth and wear pattern in Iberian goat (Pérez Ripoll, 1988).

Quantification of the macrofaunal assemblage was performed by calculating the Number of Identified Specimens (NISP), the Minimum Number of Individuals (MNI) and the Minimum Number of Elements (MNE) (Lyman, 2008). Skeletal survival rate was calculated by applying the Survivorship Index (Isu) following Brain (1981) and then standardised. This was then converted into %MAU (Binford, 1978) and correlated by means of Spearman's rank correlation coefficient (Rs) with mine-

ral bone density of the main taxa (Lyman, 1994).

Taphonomic analysis were performed using a Nikon SMZ-10A binocular microscope (10 to 50 magnifications) to identify the origin of bone modifications. Percentages of complete and fragmented elements were calculated. Long bones fractures were classified as green-bone or dry based on the morphology of breakage surfaces (fracture angles, fracture outlines and fracture edges) after Villa & Mahieu (1991). Also, the classification of fractures was implemented through the system of morphotypes created by Real *et al.* (2022), a method that can be applied to all types of bone and allows to describe both the origin of fracture and the anatomical part of the bone that is conserved.

Anthropogenic activities were documented through lithic marks, intentional bone breakage for marrow extraction and fire damage (e.g., Binford, 1978, 1981; Potts & Shipman, 1981; Pérez Ripoll, 1992; Vettese *et al.*, 2020). For each modification, multiple traits were recorded, such as length, direction, intensity, quantity, and location. In the case of burnt remains, we adapted the criteria defined by Stiner *et al.* (1995) and created three intensity levels based on the coloration and the distribution of the fire damage (i.e., stains, partial or uniform): L1 (low intensity: from brown to black); L2 (medium intensity: from black to grey); L3 (high intensity: from light grey to white). Interpretation of anthropogenic modifications as different butchery activities (such as skinning, evisceration, dismembering, disarticulation, filleting, and tendon extraction) were made consulting experimental works on current ungulates (e.g., Binford, 1981; Pérez Ripoll, 1992; Costamagno & David, 2009; Jin & Mills, 2011; Soulier & Costamagno, 2017).

Finally, non-anthropogenic modifications were related to post-depositional processes, whereas carnivore damage was discarded following the existing literature (e.g., Fisher, 1995; Théry-Parisot *et al.*, 2004; Fernández-Jalvo & Andrews, 2016).

	Cervus elaphus					*Capra pyrenaica*					*Equus sp.*				
	NISP	%NISP	MNE	%Isu	%MAU	NISP	%NISP	MNE	%Isu	%MAU	NISP	%NISP	MNE	%Isu	%MAU
Antler	1	0,6	1	12,5	20,0	1	0,8	1	33,3	25,0	-	-	-	-	-
Cranium	1	0,6	1	25,0	40,0	1	0,8	1	33,3	50,0	1	1,1	1	33,3	44,4
Maxilla	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	1	1,1	1	33,3	44,4
Mandible	6	3,7	3	37,5	60,0	6	5,1	2	33,3	50,0	4	4,5	4	66,7	88,9
Upper teeth	1	0,6	1	1,8	3,3	2	1,7	2	5,6	8,3	2	2,2	2	3,0	4,0
Lower teeth	2	1,2	2	2,5	4,4	13	11,0	13	21,7	36,1	3	3,4	3	4,5	6,1
Indet. Teeth	7	4,3	4	2,9	5,3	4	3,4	4	4,2	6,7	6	6,7	6	4,5	6,1
Hyoid	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	0	0,0	0		0,0
Cervical vertebra	1	0,6	1	3,6	5,7	0	0,0	0	0,0	0,0	2	2,2	2	9,5	12,7
Thoracic vertebra	2	1,2	2	3,8	6,2	1	0,8	1	2,6	3,8	0	0,0	0	0,0	0,0
Lumbar vertebra	2	1,2	2	8,3	13,3	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Sacral vertebra	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Caudal vertebra	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Rib	0	0,0	0	0,0	0,0	1	0,8	1	1,3	1,9	4	4,5	4	3,7	4,9
Sternum	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Scapula	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	1	1,1	1	16,7	22,2
Humerus	7	4,3	3	37,5	60,0	4	3,4	2	33,3	50,0	7	7,9	2	33,3	44,4
Radio	6	3,7	2	25,0	40,0	11	9,3	4	66,7	100,0	2	2,2	2	33,3	44,4
Ulna	9	5,5	2	25,0	40,0	6	5,1	4	66,7	100,0	4	4,5	3	50,0	66,7
Radio/Ulna	0	0,0	0		0,0	2	1,7	2	33,3	50,0	0	0,0	0	0,0	0,0
Metacarpus	4	2,5	1	12,5	20,0	5	4,2	2	33,3	50,0	1	1,1	1	5,6	7,4
Carpal	1	0,6	1	1,8	3,3	1	0,8	1	2,4	4,2	2	2,2	2	5,6	7,4
Coxal	3	1,8	1	25,0	40,0	3	2,5	1	33,3	50,0	1	1,1	1	33,3	44,4
Femur	8	4,9	2	25,0	40,0	10	8,5	3	50,0	75,0	2	2,2	2	33,3	44,4
Tibia	15	9,2	3	37,5	60,0	11	9,3	4	66,7	100,0	1	1,1	1	16,7	22,2
Fibula	8	4,9	2	25,0	40,0	0	0,0	0	0,0	0,0	0	0,0	0		0,0
Metatarsus	16	9,8	2	25,0	40,0	6	5,1	2	33,3	50,0	5	5,9	4	22,2	29,0
Malleolus	0	0,0	0	0,0	0,0	2	1,7	2	33,3	50,0	-	-	-	-	-
Patella	0	0,0	0	0,0	0,0	1	0,8	1	16,7	25,0	1	1,1	1	16,7	22,2
Astragalus	1	0,6	1	12,5	20,0	0	0,0	0	0,0	0,0	1	1,1	1	16,7	22,2
Calcaneus	1	0,6	1	12,5	20,0	0	0,0	0	0,0	0,0	1	1,1	1	16,7	22,2
Tarsal	6	3,7	6	18,8	40,0	3	2,5	3	12,5	25,0	10	11,2	10	41,7	55,6
Indet. Metapodial	6	3,7	3	18,8	30,0	3	2,5	1	8,3	12,5	2	2,2	2	5,6	7,2
Phalanx I	15	9,2	15	46,9	75,0	7	5,9	7	29,2	43,8	9	10,1	9	75,0	100,0
Phalanx II	22	13,5	20	62,5	100,0	5	4,2	5	20,8	31,3	3	3,4	3	25,0	33,3
Phalanx III	7	4,3	7	21,9	35,0	1	0,8	1	4,2	6,3	2	2,2	2	16,7	22,2
Sesamoid	9	5,5	9	9,4	15,0	8	6,8	8	11,1	16,7	11	12,4	11	30,6	40,7
Total	163		100			118		77			89		82		

SUPPLEMENTARY TABLE 3A

Main taxa XIII.

	Cervus elaphus					Capra pyrenaica					Equus sp./E. hydruntinus				
	NISP	%NISP	MNE	%Isu	%MAU	NISP	%NISP	MNE	%Isu	%MAU	NISP	%NISP	MNE	%Isu	%MAU
Antler	1	1,0	1	16,7	25,0	0	0,0	0	0,0	0,0	-	-	-	-	-
Cranium	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	1	5,9	1	100,0	100,0
Maxilla	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Mandible	5	5,0	3	50,0	75,0	1	3,7	1	25,0	50,0	0	0,0	0	0,0	0,0
Upper teeth	2	2,0	2	4,8	7,1	3	11,1	3	12,5	25,0	1	5,9	1	4,5	4,5
Lower teeth	2	2,0	2	3,7	5,6	1	3,7	1	2,8	5,6	2	11,8	2	9,1	9,1
Indet. Teeth	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Hyoid	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Cervical vertebra	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Thoracic vertebra	0	0,0	0	0,0	0,0	2	7,4	2	7,7	15,4	3	17,6	3	16,7	16,7
Lumbar vertebra	1	1,0	1	5,6	8,3	0	0,0	0	0,0	0,0	1	5,9	1	16,7	16,7
Sacral vertebra	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Caudal vertebra	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Rib	0	0,0	0	0,0	0,0	2	7,4	2	3,8	7,7	1	5,9	1	2,8	2,8
Sternum	0	0,0	0	0,0	0,0	1	3,7	1	50,0	100,0	0	0,0	0	0,0	0,0
Scapula	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Humerus	3	3,0	2	33,3	50,0	2	7,4	1	25,0	50,0	0	0,0	0	0,0	0,0
Radio	5	5,0	2	33,3	50,0	2	7,4	1	25,0	50,0	0	0,0	0	0,0	0,0
Ulna	4	4,0	4	66,7	100,0	1	3,7	1	25,0	50,0	0	0,0	0	0,0	0,0
Radio/Ulna	1	1,0	1	16,7	25,0	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Metacarpus	3	3,0	2	33,3	50,0	1	3,7	1	25,0	50,0	0	0,0	0	0,0	0,0
Carpal	2	2,0	2	5,6	8,3	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Coxal	0	0,0	0	0,0	0,0	2	7,4	1	50,0	100,0	0	0,0	0	0,0	0,0
Femur	5	5,0	3	50,0	75,0	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Tibia	8	8,0	3	50,0	75,0	2	7,4	1	25,0	50,0	2	11,8	1	50,0	50,0
Fibula	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Metatarsus	8	8,0	3	50,0	75,0	0	0,0	0	0,0	0,0	2	50,0	2	33,3	33,3
Malleolus	1	1,0	1	16,7	25,0	0	0,0	0	0,0	0,0	-	-	-	-	-
Patella	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Astragalus	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Calcaneus	2	2,0	2	33,3	50,0	0	0,0	0	0,0	0,0	0	0,0	0	0,0	0,0
Tarsal	2	2,0	2	11,1	16,7	0	0,0	0	0,0	0,0	2	11,8	2	25,0	25,0
Indet. Metapodial	12	12,0	4	33,3	50,0	0	0,0	0	0,0	0,0	1	5,9	1	8,3	8,3
Phalanx I	13	13,0	10	41,7	62,5	3	11,1	3	18,8	37,5	0	0,0	0	0,0	0,0
Phalanx II	10	10,0	10	41,7	62,5	2	7,4	2	12,5	25,0	0	0,0	0	0,0	0,0
Phalanx III	8	8,0	8	33,3	50,0	2	7,4	2	12,5	25,0	0	0,0	0	0,0	0,0
Sesamoid	2	2,0	2	2,8	4,2	0	0,0	0	0,0	0,0	1	5,9	1	8,3	8,3
Total	100		70			27		23			17		16		

SUPPLEMENTARY TABLE 3B
Main taxa XIV.

	Lynx sp.				cf. Bos	Sus	Artiodactyla	Felis	Panthera	Phocidae	Vulpes
	NISP	%NISP	MNE	%Isu							
Cranium	1	2,7	1	50,0			3				
Maxilla	0	0,0	0	0,0							
Mandible	1	2,7	1	25,0	1						
Upper teeth	2	5,4	2	6,3						1	
Lower teeth	2	5,4	2	7,1							1
Indet. Teeth	0	0,0	0	0,0			15				
Hyoid	0	0,0	0	0,0							
Cervical vertebra	1	2,7	1	7,1							
Thoracic vertebra	0	0,0	0	0,0							
Lumbar vertebra	0	0,0	0	0,0		1					
Sacral vertebra	0	0,0	0	0,0							
Caudal vertebra	0	0,0	0	0,0			1				
Rib	0	0,0	0	0,0							
Sternum	0	0,0	0	0,0							
Scapula	0	0,0	0	0,0	1						
Humerus	2	5,4	2	50,0			1	1	1		
Radio	2	5,4	2	50,0			1				1
Ulna	0	0,0	0	0,0			1	1			
Metacarpus	3	8,1	3	15,0			1				
Carpal	2	5,4	2	7,1			1				
Coxal	1	2,7	1	50,0			1				
Femur	2	5,4	1	25,0			2	1			
Tibia	2	5,4	1	25,0			1	1			1
Fibula	2	5,4	2	50,0				1			
Metatarsus	2	5,4	2	10,0							
Malleolus	0	0,0	0	0,0							
Patella	0	0,0	0	0,0							
Astragalus	2	5,4	2	50,0							
Calcaneus	0	0,0	0	0,0	1			1			
Tarsal	2	5,4	2	10,0							
Indet. Metapodial	0	0,0	0	0,0							
Phalanx I	4	10,8	4	10,0			1	2	1	2	
Phalanx II	3	8,1	3	7,5			1	1			
Phalanx III	1	2,7	1	2,5							
Sesamoid	0	0,0	0	0,0							
Total	37		34		3	1	34	9	2		3

SUPPLEMENTARY TABLE 4A

Minor taxa XIII.

	Artiodactyla	*Lynx*	*Vulpes*	Carnivora
Cranium				
Maxilla				
Mandible	1			
Upper teeth				
Lower teeth				
Indet. Teeth	2			
Hyoid				
Cervical vertebra				
Thoracic vertebra				
Lumbar vertebra				
Sacral vertebra				
Caudal vertebra				1
Indet. vertebra	1			
Rib	1			
Sternum				
Scapula	1			
Humerus	1	1		
Radio	1			
Ulna	1			
Metacarpus				
Carpal				
Coxal				
Femur				
Tibia	3		1	
Fibula				
Metatarsus		1		
Malleolus				
Patella				
Astragalus				
Calcaneus				
Tarsal				
Indet. Metapodial				
Phalanx I	1	1		
Phalanx II	2	1		
Phalanx III				
Sesamoid	2			
Total	17	4	1	1

SUPPLEMENTARY TABLE 4B
Minor taxa XIV.

XIII	Breakage pattern					Modern fracture	Complete element	NISP
	Fresh	Dry	Mixed	Indet.	Total			
Cervus elaphus	71	6	2	59	138	7	18	163
Capra pyrenaica	34	8	3	41	86	10	22	118
Equus sp.	10	8	0	49	67	5	17	89
Other ungulates	6	1	0	27	34	3	1	38
Lynx sp.	5	3	0	14	22	7	8	37
Other carnivores	3	4	0	9	16	6	4	26
Small size	12	5	2	70	89	17	0	106
Middle size	244	171	11	658	1084	113	1	1198
Large size	10	9	0	13	32	7	0	39
Total level XIII	**395**	**215**	**18**	**940**	**1568**	**175**	**71**	**1814**
%	21,8	11,9	1,0	51,8	86,4	9,6	3,9	100,0

XIV	Breakage pattern					Modern fracture	Complete element	NISP
	Fresh	Dry	Mixed	Indet.	Total			
Cervus elaphus	43	0	0	48	91	2	6	100
Capra pyrenaica	8	1	0	15	24	3	1	27
Equus sp.	2	0	0	13	15	1	1	17
Artiodactyla	2	0	0	10	12	1	1	17
Carnivores	0	1	0	3	4	1	2	6
Small size	3	0	0	16	19	0	0	19
Middle size	134	161	0	897	1192	93	6	1311
Large size	3	0	0	14	17	1	0	18
Total level XIV	**195**	**163**	**0**	**1016**	**1374**	**102**	**17**	**1515**
%	12,9	10,8	0,0	67,1	90,7	6,7	1,1	100,0

SUPPLEMENTARY TABLE 5

Breakage pattern.

	Cervus elaphus			*Capra pyrenaica*			*Equus* sp.			Other ungulates		*Lynx* sp.		Other carnivores	
	Fragmented	Fresh frac.	%Fresh frac.	Fragmented	Fresh frac.	%Fresh frac.	Fragmented	Fresh frac.	%Fresh frac.	Fragmented	Fresh frac.	Fragmented	Fresh frac.	Fragmented	Fresh frac.
Antler	-	-	-	1	0	0,0	-	-	-	-	-	-	-	-	-
Cranium	2	0	0,0	1	0	0,0	2	0	0,0	3	0	1	0	-	-
Maxilla	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mandible	6	1	16,7	6	0	0,0	4	0	0,0	1	0	-	-	1	0
Upper teeth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lower teeth	-	-	-	-	-	-	1	0	0,0	-	-	-	-	-	-
Indet. Teeth	9	0	0,0	1	0	0,0	5	0	0,0	13	0	1	0	1	0
Hyoid	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-
Cervical vertebra	1	0	0,0	-	-	-	2	1	50,0	-	-	1	0	-	-
Thoracic vertebra	1	0	0,0	1	0	0,0	-	-	-	-	-	-	-	-	-
Lumbar vertebra	2	1	50,0	-	-	-	-	-	-	1	0	-	-	-	-
Sacral vertebra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caudal vertebra	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0
Rib	-	-	-	1	0	0,0	4	1	25,0	-	-	-	-	3	0
Sternum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scapula	-	-	-	-	-	-	1	1	100,0	1	1	-	-	-	-
Humerus	7	7	100,0	4	3	75,0	6	1	16,7	1	0	2	1	1	0
Radio	6	3	50,0	11	6	54,5	2	2	100,0	1	1	1	0	1	0
Ulna	8	4	50,0	4	2	50,0	4	0	0,0	1	0	-	-	-	-
Radio/Ulna	-	-	-	2	0	0,0	-	-	-	-	-	-	-	-	-
Metacarpus	4	1	25,0	5	3	60,0	1	0	0,0	1	0	3	2	-	-
Carpal	-	-	-	-	-	-	1	0	0,0	1	0	-	-	-	-
Coxal	3	0	0,0	3	1	33,3	1	0	0,0	-	-	1	0	-	-
Femur	8	3	37,5	10	6	60,0	2	1	50,0	2	2	2	1	1	0
Tibia	15	9	60,0	11	5	45,5	1	1	100,0	1	1	1	0	3	2
Fibula	-	-	-	-	-	-	-	-	-	-	-	1	0	-	-
Metatarsus	15	13	86,7	6	4	66,7	4	1	25,0	-	-	2	1	-	-
Malleolus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Patella	-	-	-	-	-	-	1	0	0,0	-	-	-	-	-	-
Astragalus	1	0	0,0	1	0	0,0	1	0	0,0	-	-	2	0	-	-
Calcaneus	1	0	0,0	1	0	0,0	1	0	0,0	1	1	-	-	-	-
Tarsal	3	0	0,0	3	0	0,0	3	0	0,0	-	-	1	0	-	-
Indet. Metapodial	6	3	50,0	3	2	66,7	2	0	0,0	-	-	-	-	1	0
Phalanx 1	15	12	80,0	5	1	20,0	9	1	11,1	4	0	3	0	3	0
Phalanx 2	20	12	60,0	4	1	25,0	3	0	0,0	1	0	-	-	-	-
Phalanx 3	5	2	40,0	1	0	0,0	2	0	0,0	-	-	-	-	-	-
Sesamoid	-	-	-	1	0	0,0	4	0	0,0	-	-	-	-	-	-
Total	138	71	51,4	86	34	39,5	67	10	14,9	34	6	22	5	16,0	2,0

SUPPLEMENTARY TABLE 6A

% Fresh fracture XIII.

	Cervus elaphus			*Capra pyrenaica*			*Equus* sp.		Artiodactyla	
	Fragmented	Fresh frac.	%Fresh frac.	Fragmented	Fresh frac.	%Fresh frac.	Fragmented	Fresh frac.	Fragmented	Fresh frac.
Antler	1	0,0	0,0	-	-	-				
Cranium	-	-	-	-	-	-	1	0		
Maxilla	-	-	-	-	-	-				
Mandible	5	1	20,0	1	0	0,0			1	0
Upper teeth	-		-	3	0	0,0				
Lower teeth	2	0,0	0,0	1	0	0,0	1	0		
Indet. Teeth	-	-	-	-	-	-			2	0
Hyoid	-	-	-	-	-	-				
Cervical vertebra	-	-	-	-	-	-				
Thoracic vertebra	-	-	-	-	-	-	3	0	1	0
Lumbar vertebra	1	0	0,0	-	-	-	1	0		
Sacral vertebra	-	-	-	-	-	-				
Caudal vertebra	-	-	-	-	-	-				
Rib	-	-	-	2	0	0,0	1	0	1	0
Sternum	-	-	-	1	0	-				
Scapula	-	-	-	-	-	-			1	1
Humerus	3	2	66,7	2	1	50,0			1	0
Radio	5	3	60,0	2	1	50,0				
Ulna	4	2	50,0	1	1	100,0			1	0
Radio/Ulna	1	1	100,0	-	-	-				
Metacarpus	3	3	100,0	1	1	100,0				
Carpal	-	-	-	-	-	-				
Coxal	-	-	-	2	0	0,0				
Femur	5	3	60,0	-	-	-				
Tibia	8	7	87,5	2	1	50,0	2	1	2	1
Fibula	-	-	-	-	-	-				
Metatarsus	8	5	62,5	-	-	-	2	0		
Malleolus	-	-	-	-	-	-				
Patella	-	-	-	-	-	-				
Astragalus	-	-	-	-	-	-				
Calcaneus	2	0	0,0	-	-	-				
Tarsal	2	0	0,0	-	-	-	2	0		
Indet. Metapodial	11	3	27,3	-	-	-	1	1		
Phalanx 1	13	8	61,5	3	2	66,7			1	0
Phalanx 2	9	5	55,6	1	1	100,0			2	0
Phalanx 3	8	0	0,0	1	0	0,0				
Sesamoid	-	-	-	-	-	-	1	0	1	0
Total	91	43	47,3	23	8	34,8	15	2	14	2

SUPPLEMENTARY TABLE 6B

% Fresh fracture XIV.

	Skinning — Short incisions and deep striations with circular or longitudinal orientation	Evisceration — Deep striations, short and large incisions	Dismembering — Short and quite deep incisions	Disarticulation — Short incisions and deep striations with transverse/oblique orientation, frequently on the extremities of bone shafts	Filleting — Short incisions and scrapes in oblique-transverse direction; large cutmarks are rare and tend to be longitudinal	Tendon extraction — Short incisions transversely/obliquely oriented on the extremities of autopodial bones	Marrow extraction — Impact notches on long-bone shafts
(total)	15	3	2	18	23	5	12
Cervus	9	-	-	6	13	1	7
	Mandible diastema (buccal); Metcarpus prox. (posterior); Metatarsus prox., mid. & dist. (x4) (posterior; medial); Phalanx II prox. (x3)			Radio prox. (posterior/medial); Femur dist. (posterior/medial) & prox. (anterior); Tibia dist. (posterior); Tarsal (lateral)	Humerus mid. (x2) (posterior); Radio prox. (posterior/medial); Metacarpus prox. & dist.(x3) (posterior); Ilium (ventral); Tibia prox. & dist. (x4) (anterior; posterior; medial); Metatarsus (x2) (posterior; medial)	Palanx I dist. (posterior/medial)	Humerus mid. (posterior); Radio prox. (lateral); Ulna mid.; Femur prox. (posterior/medial); Metatarsus dist. & mid. (x2) (posterior medial); Phalanx II
Capra	3	2	1	6	8	2	4
	Mandible diastema and corpus (labial); Metatarsus prox. (posterior/lateral); Phalanx I mid. & dist.	Thoracic vertebra (spinouss process); Ischium (medial)	Rib prox. & mid. (dorsal)	Humerus dist. (posterior); Radio prox. (anterior) & dist. (medial); Ulna prox. (lateral); Femur lesser trochanter (posterior); Tarsal (posterior)	Humerus mid. & dist. (x3) (posterior; medial); Radio mid. (lateral); Femur prox. & mid. (x2) (posterior); Tibia prox. (posterior/lateral) & mid. (anterior) (x2)	Metacarpus prox. (posterior); Metatarsus prox. & dist. (medial/lateral)	Radio prox. & dist (posterior); Femur prox. (medial); Indet. metapodial mid. (lateral/medial)
Equus	1	1	-	3	2	2	1
	Mandible diastema (plantar)	Maxilla (medial); Rib (ventral?)*		Humerus dist. (posterior/medial); Ulna mid. (posterior); Tarsal (posterior)	Rib prox. (peeling); Femur mid. (posterior)	Metatarsus II/IV mid. (posterior); Phalanx I dist. (posterior/lateral)	Mandible corpus (buccal)
cf. *Bos*	-	-	1	1	-	-	-
			Scapular body & dist.	Clacaneus body			
Lynx	2	-	-	2	-	-	-
	Parietal bone (dorsal); Astragalus neck			Fibula prox., mid. & dist. (x2) (posterior)			

SUPPLEMENTARY TABLE 7

Butchery marks XIII.

Prox.= proximal shaft; mid.=middle-shaft; dist.=distal-shaft. *This cutmark is uncertain: if ventral side= evisceration/ if dorsal side=filletting.

	Skinning	Evisceration	Disarticulation	Filletting	Tendon extraction	Marrow extraction
	Short incisions with transversal orientation	Short scrapings and deep incision with transversal orientation	Short incisions of moderate intensity near the epiphyses and on carpals/tarsals	Short incisions and scrapes in oblique-transverse direction; large cutmarks are rare and tend to be longitudinal	Short incisions transversely/ obliquely oriented on the extremities of autopodial bones	Impact notches on long-bone shafts
Cervus	3 2 Upper canine (labial) Indet. metapodial prox. (anterior)	2 1 Mandibular ramus (lingual)	7 5 Mandibular ramus (buccal) Oleocraneon (posterior) Trapezoid (posterior) Tibia dist. (medial) Central tarsal	17 11 Humerus prox. (anterior/medial) Radio/Ulna prox. (lateral) Ulna prox. (x2) (medial) Metacarpus prox. (posterior) Femur mid. (posterior) Tibia prox. (x 1) (posterior), mid. (x 2) (medial) & dist. (x2) (anterior/medial)	6 6 Tibia dist. (posterior) Metatarsus prox. (anterior) Indet. metapodial prox. & dist. (x3) (anterior; posterior) Phalanx I dist. (posterior)	5 4 Radio dist. (anterior) Metacarpus prox & mid. (x2) (anterior/lateral) Metatarsus dist. (lateral/medial)
Capra	0	1 Rib mid. (ventral)	1 Tibial tuberosity (craneal)	3 Humerus dist. (plantar) Acetabulum (lateral) Tibia mid. (posterior/medial)	-	1 Phalanx II (lateral)
Equus	1 Premolar 3 (labial)	-	-	2 Thoracic vertebra (transverse process)	-	-
Lynx	-	-	1 Humerus dist. condyle (lateral)	- Tibia dist. (anterior)	-	-
Vulpes	-	-	-	1? Tibia prox. (lateral)	-	-

SUPPLEMENTARY TABLE 8

Butchery marks XIV.

Prox.= proximal shaft; mid.=middle-shaft; dist.=distal-shaft. *This cutmark is uncertain: if ventral side= evisceration/ if dorsal side=filletting.

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