



## Two sides of the same coin—rocks, bones and site function of Picareiro Cave, central Portugal

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### Abstract

The issue of site function rarely has been a main focus in the study of Portuguese Upper Paleolithic. This fact may be related to a lack of interest in this research area. More likely, however, it is due to the fact that there are relatively few Paleolithic sites with data that allow a serious study of site function. At Picareiro Cave, central Portugal, there are various data sets from level F/G dated to the latter Magdalenian that are adequate for this type of research. These are habitat structures, lithic artifacts, macro- and mesofauna, as well as 3D location of all artifacts and fauna larger than 1 cm. Based on the interpretation of the analytical results of each data set, it is possible to reconstruct site function of this particular level of Picareiro Cave. The morphology of one of the hearths, being very large in size, with the base prepared and a pavement surrounding it, as well as the condition and diversity of fauna, indicates that it was used for processing the meat of rabbits, red deer, and wild boar, probably through smoking and grilling. All of the evidence from the different types of data (lithic artifacts, habitat structures, use of space, and fauna) indicate that Layers F/G of Picareiro Cave are the result of a specific task, that of processing animal carcasses of rabbits, red deer, and wild boar.

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Without question site function is an important topic in the study of Paleolithic archaeology. Unfortunately, adequate data for this type of research is not that common. Though, there are exceptions in Western Europe for the same period focused here (e.g., the French Magdalenian sites of Pincevent and Verberie sur Oise), Iberian studies, like so many others from

the Mediterranean basin that have been published on this topic focus only on one of the existing data sets: the lithic artifacts, the faunal elements, the habitation features, or the use of space based on one of those data sets. This is probably one of the reasons why ethnoarchaeological studies have given so much relevance to site function based on the type of artifacts and fauna present at the contemporary hunter-gatherer sites (e.g., Binford, 1978; Gamble and Boismier, 1991; Kroll and Price, 1991; Yellen, 1977).

The case study presented here to examine site function is an exception in the Upper Paleolithic of

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Portugal and Spain because all three data sets mentioned above are well preserved, in primary context, display clear intra-site patterns of organization of space, and are supported by multiple radiocarbon dates. Interestingly, all data, although still preliminary, point in the same direction, indicating a single pattern of the use of Picareiro Cave during the period in question, that is, around 12,000 years BP.

Picareiro Cave is located near the city of Fátima in Serra d’Aire, a limestone mountain range north-east of Lisbon and the Tagus estuary (Fig. 1). The closest town, some 2 km southwest of the cave, is named Covão do Coelho, which translated to English means “the great cave of rabbits.” The cave is at 540 m a.s.l., and its mouth opens to the west-northwest. It measures about 10 m in length by 8 m in width, presenting a general triangular shape, and

a high ceiling (Fig. 2). There is a cone below the drip line, marked by the presence of very large limestone blocks. These formed a 3–5 m wide open corridor between the drip line and the mouth of the cave. The entrance is slightly over 5 m in width with a maximum of 1.2 m in height (Bicho et al., 2003a).

Archaeological excavations started in 1994, with the cleaning of an old cut left by Gustavo Marques in the mid 1950s (Marques and Andrade, 1974). The last year of the current field work was in 2001, after 37 m<sup>2</sup> of excavation that reached a maximum depth of about 4.5 m.

Our excavations used a 1 m<sup>2</sup> unit grid. Vertical control followed the geological layers, which were each subdivided into artificial 5 cm thick spits. All artifacts, bones and shells larger than 1 cm were 3D plotted. All sediment was screened through 6 mm

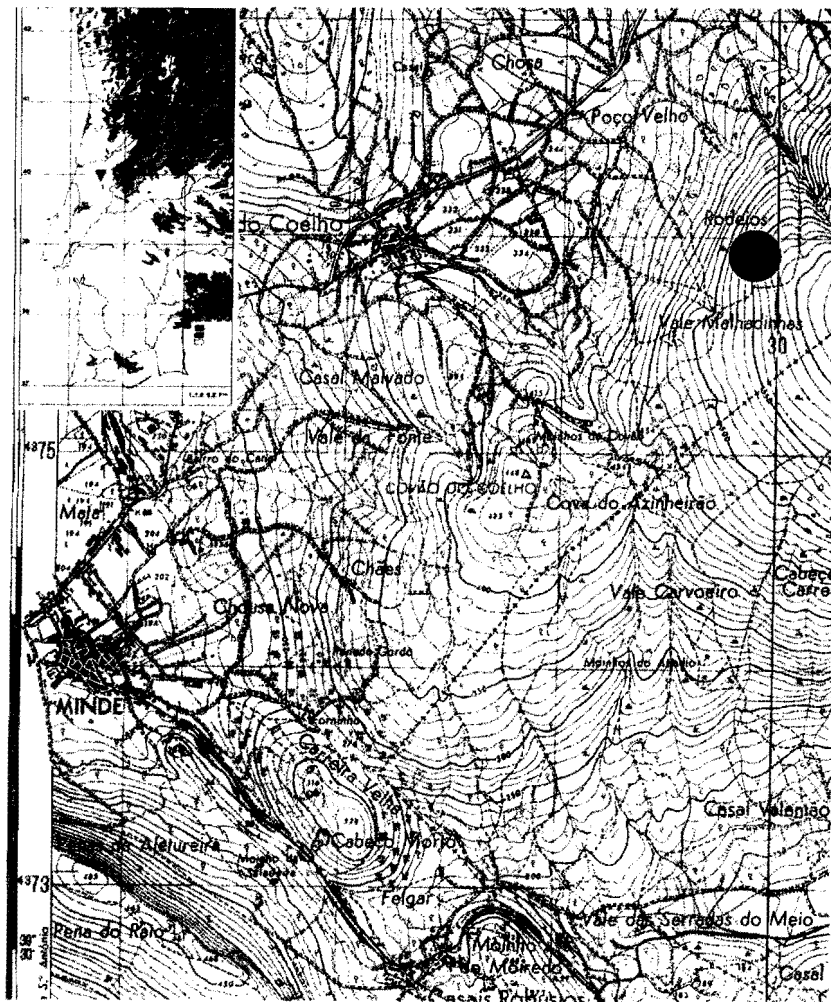


Fig. 1. Location of Picareiro Cave in the Carta Militar Portuguesa, scale 1:25,000 (n° 319).

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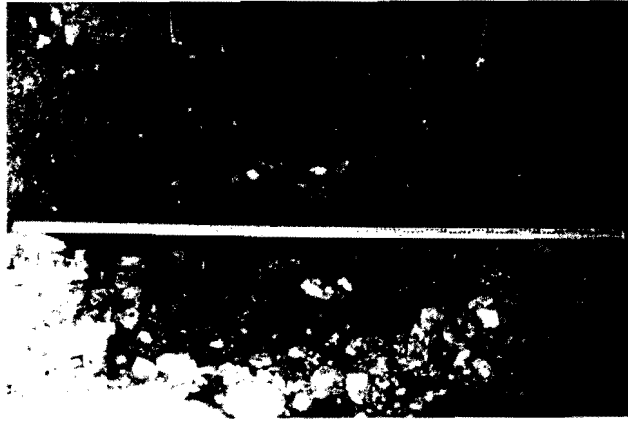


Fig. 2. Plan view of the excavation, showing the limits of both Layer G and of the large hearth in Layer F.

and 1 mm mesh screens. The material resting on the top screen was picked up at the field, while everything that stayed in the bottom screen was bagged and transported to the laboratory, where it was water screened and floated.

#### Stratigraphy and chronology

The excavation of Picareiro Cave revealed some 20 natural layers. Bedrock, however, has not yet been reached. These layers were named A through S, with the upper half containing evidence of human occupation. Some of these have been dated and the results are presented in Table 1 (Bicho et al., 2000, 2003a).

The sediment filling the cave is mostly *éboulis*, resulting from the chemical and physical erosion of the walls and ceiling of the cavity (Bicho et al., 2003a). The geologic sequence is also marked by the

presence of various thin travertine layers. The *éboulis* is characterized by a diversity of clast sizes and compaction, resulting in different interstitial spaces. Sometimes this is the element that individualizes the geologic layers.

The spaces among the limestone clasts are frequently packed with fine sediment, that is, silts and clays, of natural (eolic) and anthropogenic origins.

There are different phases of sedimentation in Picareiro, corresponding to important climatic episodes. The oldest phase documented so far comprises Layers S through K, and was accumulated during the Last Glacial Maximum. These layers are composed mostly of *éboulis*, without any fine sediment. Only a few artifacts and bones were found here, but unfortunately there were no diagnostic materials pointing to a more precise chronology. In Layers J and I artifacts seem to indicate Early Magdalenian occupations, though radiocarbon dates

Table 1  
Radiocarbon dates from Lapa do Picareiro

Lab.#	Layer	Material	Date BP	Notes	Evaluation <sup>a</sup>
Wk-7439	C	Charcoal	6580 ± 90		A
Wk-7440	Ca	Charcoal	6970 ± 80		A
Wk-6676	D	Charcoal	8310 ± 130		A
Wk-4217	E top	Charcoal	10,070 ± 80		A
Wk-5431	E middle	Charcoal	11,700 ± 120		A
Wk-10434	E middle	Charcoal	12,500 ± 160	Hearth	R <sup>b</sup>
Wk-4218	E lower	Charcoal	11,550 ± 120		A
Wk-4219	F	Charcoal	11,780 ± 90		A
Wk-6677	F	Charcoal	12,210 ± 100	Hearth	A
OxA-5527	G	Charcoal	12,320 ± 90		A
Wk-10433	J	Charcoal	10,490 ± 110	Hearth	R <sup>c</sup>
Wk-6678	J	Charcoal	11,880 ± 80		A

<sup>a</sup> A, accepted; R, rejected.

<sup>b</sup> The sample was likely contaminated with charcoal coming from Layer G.

<sup>c</sup> The sample was likely contaminated with charcoal coming overlaying levels through the *éboulis* interstices.

point to Late Magdalenian. These layers were sealed with the formation of a travertine Layer (H).

The deposition of Layers G through D took place during the Tardiglacial and early Holocene. They include a group of six archaeological levels, dated between c. 12,000 and 8000 BP (Table 1).

The last phase (Layers C–A) corresponds to the Middle Holocene, when the cave was occupied by Early Neolithic and Bronze Age people. These are better represented outside the cave, between the entrance and the dejection cone.

The focus of this paper is the occupation found in Layers F and G. The former is composed of brown silts (2.5 Y 5/2) that in certain areas fill the *éboulis* interstices. It is 40 cm thick in the southern section, thinning out to the north area of the cave, where there are only small sized clasts. There is some charcoal, as well as lithic artifacts, and medium to large sized fauna represented, including nearly 10,000 specimens of rabbit (*Oryctolagus cuniculus*). In addition, there are two hearths, described in detail in the following section.

Layer G is very compact. It is composed of a very dark gray (2.5 Y 5/0) silt and clay and a few clasts all of small size, measuring 25 cm in maximum thickness. There are about 3000 rabbit bones, large fauna, and a few shells and lithic artifacts. It seems that this layer is directly related to one of the hearths from Layer F, since it rests directly against the thickest part of that feature. Layer G is restricted in its thickest area to the diameter of the hearth, thinning out in the opposite directions away from the center of the feature. In fact, it seems that Layer G is the result of the periodical cleaning of the very large hearth found in F. The top of F seals both Layer G and the large hearth found in the bottom of F. There are dates for the top of F, G, and the large hearth in F, indicating that the human occupation took place between 11,800 and 12,300 BP, probably forming an archaeological palimpsest.

**The use of space in Picareiro Cave**

The use of space in Picareiro Cave is partially related to the depositional conditions inside the cavity. Most layers present a dip and strike towards the back and the east side of the cave, though this tendency is seen more clearly in the top layers dated to the Tardiglacial, or after the depositional hiatus that probably dates to the Last Glacial Maximum. It seems that a large part of the sedimentary fill of the cave took place during the Final Pleistocene and Early Holocene.

Nearly all of the human Paleolithic and Mesolithic occupations are located in the back of the cave, while a high degree of ‘natural’ sedimentation took place toward the entrance, creating the dip and strike mentioned above. Unlike the hunter–gatherer evidence, the Neolithic and Bronze Age peoples used the front of the cave, or alternatively directly outside of the entrance where the lip over the cone created a shaded and protected area.

There are a series of hearths, spread both vertically and horizontally in the back of the cave to the east wall, exactly where the sediments tend to dip downward. These habitation features present diverse morphologies, described in detail elsewhere (Bicho et al., 2003a). These hearths are probably related to a variety of activities. One of the hearth types, probably used for light and heat, is characterized by an inverted cone shape with a circular design that is usually slightly scarred, and filled with burnt sediments, charcoal, ashes, burnt fauna, and a few lithic artifacts. Around these hearths there are more lithic artifacts than within the feature itself, and the fauna is generally not burnt. This type of hearth is known from other Portuguese Upper Paleolithic sites, including Cabeço do Porto Marinho in Rio Maior (Bicho, 1992; Marks et al., 1994), Lapa dos Coelhos (Almeida et al., 2004) and Lapa do Anecrial (Zilhão, 1995) (two caves near Picareiro), and Salto do Boi in the Côa valley, located some 350 km north as the crow flies (Zilhão, 1997). It is common in Picareiro and present in all levels dated to the Late Upper Paleolithic.

The second type of hearth, perhaps unique in Portugal, is present in Layer F in Picareiro (Fig. 3). It is characterized by an uncommon large size of 2.5 m in diameter and some 40 cm deep. It was likely prepared with the removal of materials from the underlying layers, forming a concavity. The removed clasts formed a thick lip around the concavity, which resulted in the central depression. Both the lip and an area of about 1 m around it were covered by large flat slabs of limestone, producing a nice pavement that was slightly inclined toward the hearth. Smaller slabs were also used to finish the interior of the hearth, where wood was placed to burn. There were thousands of rabbit bones, hundreds of bones of medium and large ungulates, burnt lithic artifacts, and hundreds of pieces of charcoal representing a diversity of species over these interior slabs. In addition, in Layer G, corresponding to the cleaning and maintenance of the hearth, there were the same type of bones and lithic

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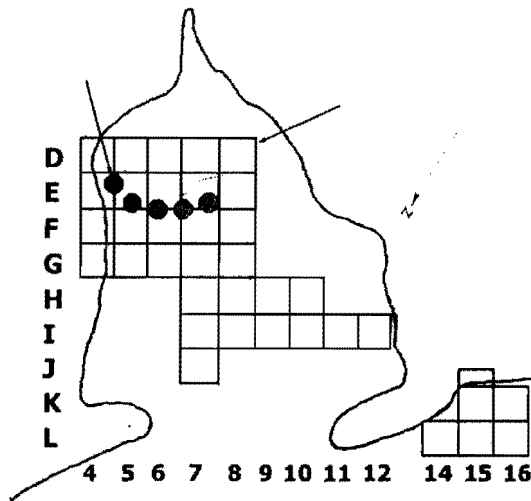


Fig. 3. General view of the large hearth from Layer F. It should be noted that the stadium rod is 3 m in length.

artifacts, as well as a high number of fish vertebrae from either sardine or shad (Bicho et al., 2000, 2003a). The type and amount of fauna, as well as the burning patterns found in some of the species described below suggest that this hearth was used for food preparation, likely through smoking and roasting.

The interpretation of the hearth function helps to explain its location and, consequently, the use of space in the back of the cave during the Paleolithic occupations. The back of the cave would retain smoke for a greater period of time and, thus, be more efficient in smoking the meat hunted near the cave. Unfortunately, there is no direct evidence, such as post holes from meat racks, present in the cave. Two other factors may have decided the organization of space during the Pleistocene occupation of Picareiro. One is the area accessible, at present, to sunlight. In fact, it is at the end of the day that sunlight illuminates the back cave, leaving the rest of the space in the darkness. The importance of the sun illuminating the back of the cave was likely not related to heating because the hearths would have been more effective for this purpose, as the sunset temperature is always low. Simple illumination from sunlight was probably more important.

The other possible explanation for the location of the hearths and the main activities to take place in the back and toward the east side of the cavity is that in the central and front areas there is clear evidence for instability of the ceiling and high walls of the cave. Here, increased erosion, weathering, and

fragmentation took place, as seen in the presence of large limestone blocks and bigger sized clasts that form the *éboulis* in those areas.

In summary, during the formation of Layers F/G it is mostly the rear of the cave, where it was more protected from wind and rain, that was used intensively. It was also the safer area of the cavity where stable high walls and ceiling were located. The sun probably illuminated the cave at the end of each day and, finally, it was a convenient place for both roasting and smoking meat.

#### Fauna from Layer F/G

The fauna from Picareiro Cave is very diverse and amounts to nearly 15,000 specimens (Tables 2 and 3). They include red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), wild boar (*Sus scropha*), aurochs (*Bos primigenius*), ibex (*Capra*), chamois (*Rupicapra rupicapra*), rabbit (*Oryctolagus cuniculus*), fox (*Vulpes vulpes*), microfauna including rodents and bats, fish (most from the family of *Clupeidae*, but also from *Ciprinoidea*), birds, terrestrial and marine gastropods, and marine bivalves.

The most important species, from the numerical point of view, is the rabbit, with over 13,000 specimens recovered (Table 2). The macrofauna NISP consists of almost 2000 fragments (Table 3), of which about 25% was identifiable to species (Bicho et al., 2003a; Haws, 2003). The most important large game species is red deer with about 65% of the identified specimens, followed by the wild boar (30%), aurochs (3%), and goat and chamois (less than 1% each).

Rabbit was the most common animal consumed by humans inside Picareiro Cave throughout the Upper Paleolithic. Table 2 also displays the rabbit minimum number of elements (MNE) and

Table 2  
Rabbit remains from Picareiro Cave

Layer	Rabbit (NISP)	Rabbit (MNE)	Rabbit (MAU)
D	50	36	4
E u.	717	385	18
E m.	982	456	14
E l.	594	314	11
F	6645	4290	133
G	2993	1829	66
I	348	254	5
J	540	325	13
K	86	48	1
L-Q	96	77	6
Total	13,051	8014	271

Table 3  
Medium and large size species from Lapa do Picareiro

Layer	Red deer	Wild boar	Aurochs	Chamois	Ibex	Ind.	Fox	Total
D	9	2	2			37		50
E u.	20	11	3			149		183
E m.	26	15	5			180		226
E l.	19	7	1	1		79		107
F	161	67		1		481		710
G	27	20				241		288
FA	5	2				24		31
I	10	5	1		4	31	1	52
J	15	5	1			94		115
K		1				3		4
Total	292	135	13	2	4	1319	1	1766

minimum animal units (MAU). A large percentage of the 13,051 rabbit specimens (9638 or 73%) was recovered from the Magdalenian hearth zones represented by strata F and G. MAU, based on the minimum number of rabbit elements recovered, are used here to estimate the minimum number of rabbit carcasses represented by 8014 estimated elements. At least 271 individual rabbits are represented, of which 199 (73%) came from the F and G hearth levels.

As discussed in Hockett and Bicho (2000), all of the rabbit bones from strata D to J appear to have been deposited in the cave by humans. In these levels, there are no bones with carnivore or raptor puncture marks (Table 4), unlike the modern rabbit bones from the surface of the cave, which were accumulated primarily by small carnivores (see also

Table 4  
Comparison of relative frequency values of leporid head, hind limb, and front limb portions amongst eagle nests, small carnivore accumulations, and Magdalenian foragers at Picareiro Cave (see also Hockett and Haws, 2002)

	Leporid bone assemblage		
	Eagle nests	Small carnivores	Picareiro Cave
<i>Head</i>			
Mandible	.23	.48	.66
Maxilla	.14	.58	.51
<i>Hind limb</i>			
Innominate	.60	.73	.99
Femur	.51	.67	.64
Tibia	1.0	1.0	.63
Calcaneus	.95	.60	1.0
<i>Front limb</i>			
Scapula	.06	.19	.71
Humerus	.18	.33	.59
Radius	.22	.25	.85
Ulna	.19	.31	.81
% Punctured	.02	.24	.00

Hockett, 1999). Table 5 shows the number of individual rabbit elements recovered from the cave. In general, all bones of the rabbit body are well represented except for the sacrum and vertebrae, especially in levels D–J. In these levels, head, front limb, hind limb, and fore/hind feet elements appeared to have been discarded together inside the cave (see Table 4), either within the hearth zone or next to it. Hockett and Bicho (2000) suggested that the vertebral column may have been mashed with milling stones into bone meal. This possibility cannot be discounted, although it is also possible that vertebral columns were tossed outside of the cave, tossed in a corner of the cave that remains unexcavated, or carried from the cave to be processed later at a residential site.

Large numbers of humeri, femora, and tibiae cylinders were recovered from the cave (Fig. 4). Table 6 displays the distribution of the 674 cylinders recovered from Picareiro Cave. Of these, 85% came from levels F and G. Hockett and Bicho (2000) and Hockett and Haws (2002) discussed the dietary implications of recovering large numbers of rabbit long bone cylinders from Paleolithic contexts. We noted that large numbers of these bones have been recovered from Upper Paleolithic levels in many caves throughout Iberia (e.g., see also Pérez Ripoll, 2001). The ends of rabbit femora, tibiae, and humeri were broken or bitten off by Paleolithic foragers inside Picareiro Cave to obtain additional fat calories within the medullary cavities of these bones. The ends of these marrow-bearing long bones were snapped or bitten off, discarded to the side, and then the bone marrow was pushed or sucked out of the tubes after the carcasses were roasted. The interpretation that these cylinders represent "waste tubes" derived from exploiting bone marrow is bolstered by the numbers of detached epiphyses that were

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Table 5  
Minimum number of rabbit elements (MNE) recovered from Picareiro Cave

	D	E.u.	E.m.	E.l.	F	G	I	J	K	L	M	N	O	P	Q	Total
Mandible	3	6	4	4	178	78	8	3	1	0	0	0	0	0	0	285
Maxilla	0	0	0	1	151	53	5	9	0	0	0	0	1	0	0	220
Innominate	3	8	11	2	266	109	6	16	1	0	0	1	1	0	1	425
Patella	0	9	13	14	66	26	10	10	2	0	0	0	0	0	0	150
Femur	2	12	15	8	130	85	5	12	1	1	0	1	1	1	0	274
Tibia	4	15	12	5	150	65	5	13	1	0	0	1	0	0	0	271
Calcaneus	7	35	26	22	180	132	8	15	1	0	0	2	0	2	0	430
Astragalus	1	33	27	13	143	76	9	25	0	0	0	0	0	0	0	327
Scapula	0	5	6	5	186	91	6	6	1	0	0	0	0	0	0	306
Humerus	1	12	9	6	134	73	6	10	1	0	0	1	0	0	0	253
Radius	2	24	28	15	183	99	9	3	1	0	0	0	0	0	0	364
Ulna	2	10	9	9	202	97	8	10	0	2	0	0	0	0	0	349
Carpal/tarsal	0	10	14	18	132	68	7	9	2	0	0	0	0	0	0	260
Metapodial	5	47	59	46	680	203	34	49	10	4	1	10	1	9	0	1158
Phalange	5	148	214	129	1170	439	115	108	26	1	0	8	5	6	0	2374
Rib	1	7	7	10	180	95	11	18	0	0	0	0	0	13	0	342
Vertebra	0	4	2	7	153	40	2	8	0	0	0	0	0	2	0	218
Sacrum	0	0	0	0	6	0	0	1	0	0	0	1	0	0	0	8
Total	36	385	456	314	4290	1829	254	325	48	8	1	25	9	33	1	8014

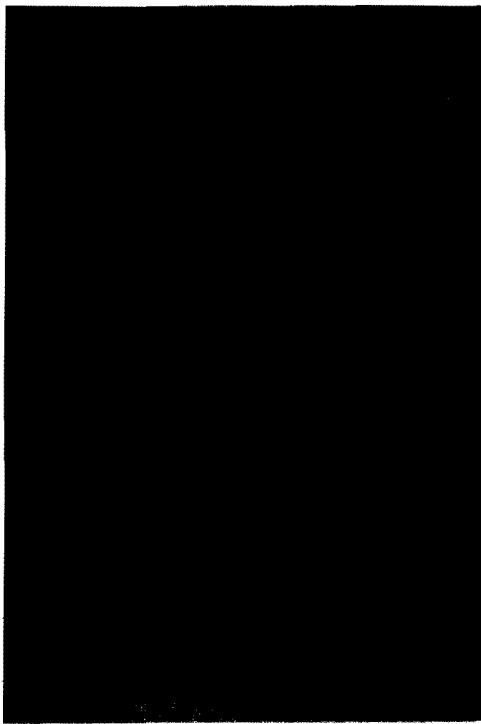


Fig. 4. Rabbit long bone cylinders from levels F and G, Picareiro Cave. Top row, femora; middle row, tibiae; bottom row, humeri.

discarded alongside the cylinders (Table 7), as well as a comparison of the frequency of complete marrow and non-marrow bearing long bones recovered from the cave (Table 8). A total of 67 complete long

Table 6  
Total number of rabbit long bone cylinders recovered from Picareiro Cave

	D	E	F	G	I	J	K	Total
Femur	0	20	127	84	3	4	1	239
Tibia	0	33	150	65	2	13	1	264
Humerus	0	12	78	68	2	10	1	171
Total	0	65	355	217	7	27	3	674

bones were recovered, 54 (81%) of which consisted of the non-marrow bearing radii and ulnae. The bone marrow probably was removed after the rabbit carcasses were cooked. Raw rabbit bone marrow may be in liquid form and is easily lost if the ends of the long bones are broken before cooking. During heating, the marrow solidifies into a soft core of fat, and stays inside the medullary cavity until removed.

Table 9 shows that 305 rabbit bone specimens were charred, the majority of which are limbs and feet. The lack of burned cranial fragments suggests the heads might have been removed prior to cooking or smoking. The pattern of burning, in which approximately 5–10% of limb and feet bones were charred, suggests the roasting or near-fire smoking of whole carcasses minus the heads.

Level F is by far the richest deposit in Picareiro Cave. In addition to the nearly 7000 specimens of rabbit, this level contained some of the best preserved specimens and larger fragments of ungulate remains. Ungulate MNI for this layer is four red

Table 7  
Marrow-bearing rabbit limb bone portions recovered from Picareiro Cave

	Complete	Proximal	Distal	Midshaft
<i>Stratum F</i>				
Femur	3	97	80	127
Tibia	0	75	111	150
Humerus	8	35	126	78
<i>Stratum G</i>				
Femur	1	46	27	84
Tibia	0	27	46	65
Humerus	1	16	72	68
<i>Stratum I</i>				
Femur	0	5	5	3
Tibia	0	1	5	2
Humerus	0	3	6	2
<i>Stratum J</i>				
Femur	0	12	9	4
Tibia	0	2	5	13
Humerus	0	5	8	10

Table 8  
Number of complete rabbit limb bones from strata F and G, Picareiro Cave

	# complete
<i>Stratum F</i>	
Femur	3
Tibia	0
Humerus	8
Radius	24
Ulna	21
<i>Stratum G</i>	
Femur	1
Tibia	0
Humerus	1
Radius	7
Ulna	2

deer, two wild boar, and one chamois. The red deer are represented by three adults and one juvenile and the wild boar by one adult and one juvenile (Tables 10 and 11). In contrast, MNI for both red deer and wild boar is one each in Level G.

One of the most debated topics in zooarchaeology centers on the bones left behind by prehistoric hunters at kill sites and carried away and discarded at base camps. Bunn (1991) traces the origins of this problem to the work of the early prehistorians Lartet and Christy (1865–75) who first suggested that the skeletal part frequencies of the French Paleolithic sites reflected the transport decisions of prehistoric hunters. In Americanist zooarchaeology the issue was renewed by White (1953) who considered anatomical part frequency in determining whether a site represented a kill or a residential site. Perkins

Table 9  
Number and type of burned rabbit bones from strata F and G, Picareiro Cave

	# specimens burned	% elements burned
<i>Head</i>		
Mandible	0	.00
Maxilla	1	<.01
Subtotal	1	<.01
<i>Limbs</i>		
Innominate	3	.01
Femur	12	.05
Tibia	11	.05
Scapula	16	.06
Humerus	13	.06
Radius	29	.11
Ulna	6	.02
Subtotal	90	.05
<i>Feet</i>		
Calcaneus	47	.15
Astragalus	19	.09
Carpal/tarsal	15	.08
Metapodial	36	.04
Phalange	97	.06
Subtotal	214	.07
Total	305	.06

Table 10  
Wild boar from layer F—Lapa do Picareiro

	NISP	MNE
Cranial	13	5
Mandible	9	5
Vertebra	0	0
Rib	0	0
Scapula	1	1
Humerus	1	1
Radius	0	0
Ulna	1	1
Carpals	0	0
Metacarpals	4	4
Pelvis	1	1
Femur	0	0
Tibia	1	1
Patella	0	0
Tarsal	0	0
Calcaneus	0	0
Astragalus	0	0
Metatarsals	0	0
Phalanges	15	15

and Daly (1968) argued that an overrepresentation of foot bones in a site occurred because hunters stripped the meat off the limbs, presumably to reduce the weight, and carried it back to the residence in the skin of the animal with the feet still attached for use as handles. The bulky limb bones

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Table 11  
Red deer, Layer F—Lapa do Picareiro

	NISP	MNE	MAU	%MAU
Cranial	8	2	2	67
Mandible	3	3	1.5	50
V. cervical	4	2	.22	7
V. thoracic	4	2	.14	5
V. lumbar	2	2	.4	13
Rib	2	2	.07	2
Scapula	2	2	1	33
Humerus	8	5	2.5	83
Radius	8	5	2.5	83
Ulna	0	0	0	0
Carpals	11	11	.54	18
Metacarpals	6	3	1.5	50
Pelvis	3	2	1	33
Femur	2	2	1	33
Tibia	12	6	3	100
Fibula	1	1	.5	17
Patella	1	1	.5	17
Tarsal	1	1	.5	17
Calcaneus	2	2	1	33
Astragalus	3	3	1.5	50
Metatarsals	5	4	2	67
Phalanges	41	35	1.46	49

were left behind. In the decades since, zooarchaeologists have realized there is a great deal of variability in bone assemblages and numerous causes for their composition. There is no longer a simple dichotomy between kill sites and residential sites (Binford, 1978, 1980, 1981).

Ethnoarchaeological research has shown many factors determine which parts of the skeleton are transported from kills and which ultimately arrive in camps and/or villages (Bartram, 1993; Binford, 1978; Bunn, 1986, 1991; Bunn et al., 1988, 2003; Emerson, 1993; O'Connell et al., 1988, 1990; O'Connell and Marshall, 1989; Oliver, 1993). Binford (1978) quantitatively modeled transport decisions by devising body part utility indices for caribou and sheep. These indices were simplified into a single measure, food utility index (FUI) by Metcalfe and Jones (1988). Generally, high utility skeletal parts will be missing from kill sites because hunters would have processed the carcass and left behind low-utility parts. This model of discarding low-utility axial parts and transport of high-utility appendicular parts has been challenged recently by O'Connell and colleagues who used ethnographic observations of Hadza hunters to argue that for many large game animals, appendicular parts are left behind more often than axial parts, which are transported away (Emerson, 1993; O'Connell et al., 1988, 1990). The

reasoning behind their argument is that limb bones are heavy and hunters will strip the meat off them and discard the bones, taking the axial parts back to camp because the effort to remove the meat from them would be uneconomical. Thus, the decision to transport a skeletal part is guided by the ratio of edible to inedible tissue. Bones with a low ratio are likely to be processed to remove meat and marrow and the bulky, heavy inedible fraction, bone, will be discarded. Elements with high ratios would be transported because the cost to remove the inedible fraction would lower the economic value of the edible part. O'Connell et al. (1988) argued that transport decisions are based on carcass size and distance to camp. Bunn (1993) countered this interpretation of Hadza transport by contending that Hadza hunters try to transport entire carcasses when possible, with the exception of very large animals (e.g., giraffe).

Bartram (1993), reporting ethnoarchaeological observations of carcass transport by Kua hunters, showed an important correlation between assemblage composition at kill/butchery sites and time spent field processing. Large game limb elements were left at kill/butchery sites after meat was stripped off and sun-dried. This occurred because of decisions to reduce transport costs based on factors such as the number of carriers, distance to camp, and size of the animal.

The statistical correlations between carcass size, distance to kill, and proportion of elements transported were argued by O'Connell et al. (1990) to explain 40–57% of the variation. The remaining variation is significant and just as important in determining carcass transport as Bartram showed. The additional problems of sample size and length of observation time was raised by Bunn (1993) who provided a substantially larger data set. The transport pattern shows that over 90% of the carcass was transported with the exception of heads and ribs which were carried over 80% of the time.

Not all of the interpretive aspects resulting from Hadza and Kua carcass transport can be applied directly to the large mammal assemblage from Picareiro F, since it is dominated by two medium ungulates, red deer, and wild boar. Still, those studies do provide useful frames of reference in the interpretation of carcass utilization and transport at Picareiro. For both species, economic utility and bone density were considered against skeletal element representation patterns (Haws, 2003).

Rowley-Conwy et al. (2002) have recently published a food utility index (FUI) for European wild

boar. Using the revised methodology proposed by Metcalfe and Jones (1988), they found the highest utility parts were the entire thorax (vertebrae, ribs, and sternum combined), lumbar vertebrae, pelvis, and femur. Of secondary importance were the skull, mandible, cervical vertebrae, and scapula. The humerus, tibia, and lower limb elements ranked lowest. This contrasts with the values Binford (1978) reported for sheep and caribou. Rowley-Conwy et al. (2002) show that wild boar femora, scapulae, humeri, and tibiae generally have a much lower food utility than caribou especially.

The skeletal element representation for level F red deer and wild boar at Picareiro shows some interesting patterns. Tables 10 and 11 show NISP and MNE for wild boar and red deer, respectively. It is immediately apparent that red deer has a much better overall skeletal representation than wild boar. While level F has evidence for at least two wild boar and maybe three, the NISP and MNE show an extremely high degree of underrepresentation for most elements. In level F, wild boar crania and mandibles are the most common parts, followed by phalanges, and metapodials. The vertebrae, ribs, and upper limbs are least represented. The tibia, humerus, and ulna are the only upper limbs present. This suggests removal of the bulky heads and transport of nearly intact carcasses away from the cave. Some wild boar was consumed on site as evidenced by the few limb remains. It is unlikely that meat was removed to reduce transport costs. Drying and smoking of limb quarters may have taken place, but likely with the bones in. This pattern matches that of the rabbit remains. Based on the wild boar FUI, it would appear that the Picareiro wild boar exhibit a classic reverse utility curve for kill/butchery sites where the lowest utility parts are most commonly left behind. This interpretation would stand in contrast to the rabbit data, which suggest most of the rabbit meat was consumed on site, or perhaps the meat was stripped from the bones and then the bones discarded in and around the hearth zone.

Interestingly, the red deer carcasses were treated differently than wild boar. Haws (2003) contrasted red deer MNE estimates for limb based on counting long bone portions with MNE estimates for limbs using epiphyses only. This highlights the methodological debate in zooarchaeology begun by Bunn and Binford and recently taken up by Pickering, Marean, and Stiner. Element representation would be much different had limb shafts not been taken into consideration. In fact, counting MNE by only

using epiphyses leads to a classic reverse utility curve for Picareiro (Binford, 1978; Haws, 2003; Metcalfe and Jones, 1988). This could lead to an erroneous conclusion that Picareiro itself was a kill site, dominated by low-utility skeletal parts with most of the limbs transported away, or that carnivores had ravaged the assemblage. Meaty limb elements are in fact present and mostly identified by shaft fragments with few surviving epiphyses. Only dense epiphyses of lower limbs are well represented. The missing epiphyses are from the proximal humerus, proximal radius and ulna, proximal and distal femur, and proximal tibia. These are precisely the low density but greasy parts most likely to disappear due to natural attrition or carnivore consumption. With limb shafts counted, the overall representation shows a different pattern. %MAU shows a high percentage of upper limbs except the ulna and femur. Lower limbs are moderately represented by comparison with the exception of smaller dense carpals and tarsals. The most abundant elements are limbs while ribs, vertebrae, and pelvis are scanty. Even counting fragments from the indeterminate species fraction, ribs and vertebrae are very much underrepresented. This could be due to some density-mediated attrition or carnivore-ravaging, though none of these show evidence for carnivore-gnawing. As with the indeterminate fraction, the identifiable assemblage from Layer F/G at Picareiro shows a high degree of fragmentation.

Patterns of ungulate long bone fragmentation have been used to interpret faunal assemblages and infer human behavior for several decades (Binford, 1978, 1981; Brain, 1981; Bunn, 1983, 1986; Bunn and Kroll, 1986; Todd and Rapson, 1988). In Picareiro, the long bones show evidence of intentional cracking for marrow extraction (Fig. 5). They are highly fragmented with many percussion scars and impact



Fig. 5. Example of red deer bones broken for the extraction of marrow and grease from the spongy parts.

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fractures. None of the long bones are complete. The only whole elements are 3rd phalanges, carpals, tarsals, calcanei, astragali, and sesamoids. Every limb element including 1st and 2nd phalanges of red deer are cracked open for marrow. The frequency of small (<2 cm) fragments suggests dry bone breakage due to postdepositional trampling of sediment, mostly *éboulis*. Cutmarks are difficult to assess due to the chemical erosion on many of the bone surfaces. Given the absence of carnivore remains, paucity of carnivore-gnaw marks and low impact of density-mediated attrition, absence of limb epiphyses and vertebrae suggests grease extraction. Again, marrow extraction matches an activity also seen in the rabbit bone assemblage.

Binford (1981, p. 177) discussed the relationship between long bone splinters and articular ends in ungulate remains. In carnivore-ravaged assemblages, splinters represent “what is no longer present,” which is the articular ends. In assemblages left by humans, splinters represent “what remains,” which again are the articular ends. The exception for humans is grease extraction whereby articular ends are destroyed thus mimicking a carnivore-ravaged assemblage. Preservation bias due to density-mediated attrition may have impacted ribs and vertebrae since they are present in very low proportion. However, given the above discussion of carnivore destruction, grease processing, and ethnographically observed carcass transport these elements may be absent for other reasons.

Transport of ungulate elements is difficult to assess given the extremely fragmentary nature of the bones. However, results indicate an equal representation of limbs with the possible exception of femora. It is possible that meat was filleted, dried or smoked in the cave, and transported away. However, since cutmarks are rare this is difficult to test. The remaining bones were then cracked open and the marrow consumed on site. This would appear to contrast with the Hadza model of carcass treatment if Picareiro is considered a butchery site. Obviously, it is not a kill site but a place to which animals were transported and processed. Given the size class of the animals hunted, all elements should be represented if entire carcasses were brought to the cave and consumed on site, as appears to be the case with the rabbits. The likelihood that the axial portions of animals of such size would have been left at kill sites is low (Bunn, 1991, 1993). However, Bartram’s study of Kua carcass treatment provides some interesting possibilities (Bartram, 1993; Bartram and Marean,

1999). The number of skeletal elements left behind at Kua kill and/or butchery sites correlated positively with time spent processing. Increased occupation time at Picareiro may have led to filleting and drying/smoking of meat from limb elements. Epiphyses and vertebrae may have been carried back to a base camp for grease extraction. The absence of femora and pelvis provides further evidence of transport. Binford (1978) noted low frequencies of femora at butchery sites or field camps. A similar pattern was observed by Noe-Nygaard (1977) for Star Carr. In addition to limb bones, the 1st and 2nd phalanges also show evidence for marrow extraction. They are all split open and exhibit impact fracturing, similar to ones documented at Erralla (Altuna et al., 1985) and La Riera (Altuna, 1986) in Cantabria, at Tossal de la Roca (Perez Ripoll, 1992) and Cova de les Cendres (Villaverde and Marti’nez Valle, 1995) in Valencia, at Cingle Vermell (Vila et al., 1985) in Catalunya, and at Vale Boi in Algarve, Southern Portugal (Bicho et al., 2003b).

In summary, then, the Magdalenian faunal assemblages from Levels F/G are numerically dominated by rabbit. Large numbers of rabbit carcasses were processed and consumed on site. Vertebral columns may have been transported for later processing. Entire carcasses of medium ungulates were brought to the cave for processing. Many red deer limb elements were stripped of flesh and the bones broken open to extract marrow. Epiphyses were either consumed by dogs or pounded and boiled to extract grease on site or at a base camp. Wild boar was probably brought to the cave where heads and some lower limb elements were consumed. The rest of the carcass was probably transported away. Therefore, it appears that wild boar was preferentially transported over red deer. This may have been due to nutritional differences (fat content) between the two.

Marine fish, representing sardine or shad, are also present in the Magdalenian levels (Bicho et al., 2000). These may have been smoked or dried and carried in as hunters’ snack food. Belcher’s analysis (Bicho et al., 2000) shows a pattern of small fish consumption analogous to that observed ethnoarchaeologically where heads are chewed up and the vertebrae removed and discarded. Thus, the extraordinarily high number of rabbit bones in the large hearth, as well as carcass butchery, and high degree of fragmentation of the large mammal limb elements all indicate that the cave was repeatedly used as a short-term hunting/carcass processing camp.

### The lithic materials

The lithic artifacts from Layers F/G present a set of interesting and clear patterns that allow an easy interpretation about site function and the type of human activity that took place in Picareiro Cave between 12,300 and 11,800 BP.

Different types of raw materials were brought to the site. The most important, in numerical terms as well as functional, is flint, followed by quartz and quartzite (Table 12). The flint artifacts amount to 65% of the total assemblage and 90% of the retouched tool collection. This pattern is common in other sites within Estremadura dated to the same period, such as Cabeço do Porto Marinho (Bicho, 1992, 1994).

The raw materials, by themselves, do not indicate the activity type at the cave. There are, however, other revealing patterns seen in the lithic assemblage of Picareiro. This is the case of technological and typological aspects present in the assemblage. As seen in Table 12, close to 80% of all artifacts from Layers F/G are chips. These have very small dimensions, usually less than 4 mm. This type of chip results more frequently from tool resharpening than from core preparation and maintenance, suggesting that little core shaping took place at the site. Added to this interpretation, there is the fact that there are very few cores (less than 1%) present at the site. Of those present, all of small dimensions with the flaking surface usually less than 2 cm long. There is rare evidence for the presence of core preparation and maintenance such as crested pieces, core fronts, core trimming flakes, and core tablets. Also, there are no complete cortical flakes present and partial cortical flakes are rare. These patterns confirm the idea that the chips are coming from tool preparation or

resharpening while people were at the cave, and not from production of blanks.

Those rare core shaping and maintenance elements present at the site, as well as the core size, seem to suggest that they were brought in to the site already shaped and prepared for the extraction of either small flakes or bladelets. The low number of both types of blanks seems to confirm that the cores were brought in exhausted condition, an aspect that is reflected by their small size. This core selection could be the result of a choice toward light, transportable pieces, reflecting the distance, and difficult access to the cave from lower elevations where most of the daily activities took place at other sites. It should be noted that Picareiro is at about 540 m of altitude, in a rough, mountainous region. There is no other Upper Paleolithic site in Portugal with this location, and in Estremadura the second highest site is located at only c. 200 m altitude.

Another relevant pattern is the number of retouched tools. There are over 120 formal tools. Within the total collection, these are only about 6% of the collection. But if one discards the numbers of chips, the percentage rises to 30%, corresponding to over 6 times the number of cores. It should be noted that these tools are marked by a very high number of weaponry tips—these represent more than 40% of the collection of retouched tools (Table 13). A different pattern also present in the retouched tools. Specifically, the microlithic weaponry and the backed bladelets are all, but one (Figs. 6 and 7), broken, showing clear evidence of impact fractures. This evidence could be the result of site formation processes such as lithic artifact breakage caused by sedimentological pressure from the sedimentary column or by collapse or exfoliation of the ceiling and cave walls. There is, however, a clear differential breakage

Table 12  
Lithic materials from layer F/G, Lapa do Picareiro

	Quartz	Quartzite	Flint	Rock crystal	Total
Fragments	12,50	37,50	50,00		16
Chips	21,52	9,54	68,94		1510
Flakes	6,74	31,46	60,67	1,12	89
Flake fragments	6,93	54,46	38,61		101
Blades and bladelets			100,00		19
Fragments of blades and bladelets	1,92	5,77	92,31		52
Burin spalls		5,88	94,12		17
Crests and tablets		25,00	75,00		8
Cores	31,58	26,32	42,11		19
Retouched tools	4,96	1,65	89,26	4,13	121
Total	353	246	1349	6	1954

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Table 13  
Retouched tools (%) from layer F/G, Lapa do Picareiro

Classes	Fragments	Complete	Total
Burins	60.0 (9)	40.0 (6)	15
Endscrapers	75.0 (6)	25.0 (2)	8
Truncations	100.0 (1)	—	1
Retouched flakes	83.3 (10)	16.7 (2)	12
Notches and denticulates	65.0 (13)	35.0 (7)	20
<b>Backed bladelets</b>	<b>100.0 (33)</b>	—	<b>33</b>
<b>Microlithic points</b>	<b>93.3 (14)</b>	<b>6.7 (1)</b>	<b>15</b>
Other retouched tools	73.3 (11)	26.7 (4)	15
Total	97	22	119



Fig. 6. Microlithic tools from Layer F.

between the other retouched tools (usually fairly small like the backed bladelets) and the microlithic retouched tool assemblage, as well as between non-retouched and retouched bladelets. Thus, these differences, together with the frequent impact fracture evidence, clearly indicate that this type of retouched tool was brought in to the site already broken, likely as the result of hunting. Probably, they arrived at the site either inside the carcasses of the hunted animals, whereby they were broken at the time of impact, or simply in broken condition to be replaced at Picareiro.

In summary, there is no evidence for a full reduction sequence for either flakes or bladelets, nor is there good support for the presence of core shaping, preparation, and maintenance. On the other hand, there is clear evidence for tool resharpening through the presence of high numbers of very small chips. It seems likely that some of the tools were brought in to the site with the final retouched tool morphology, and then used, resharpened and finally discarded. This is the reason why there is such a high number

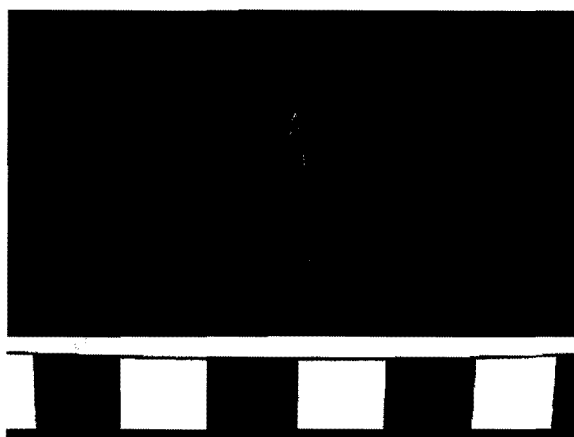


Fig. 7. Fusiform point from Layer F.

of retouched tools, more so when compared to the number of cores (fairly exhausted) present at Picareiro. Finally, the most important retouched tools in Layers F/G in Picareiro are the microlithic points and backed bladelets, of which almost all are broken, showing impact fractures.

The simplest interpretation of these patterns is related to the site function, where hunting took place around or nearby Picareiro, and carcasses were brought in to the cavity and there prepared and eaten. The microlithic points were used for hunting, and brought into the cave inside the animals or to be fixed and replaced as weapon tips for future hunting episodes.

### Conclusions

The present data from Picareiro on leporids, ungulates, habitat features, and lithic materials seem to indicate the same pattern of utilization of the cavity. The number of rabbit bones, the fragmentation and burning patterns, as well as the presence of most anatomical elements show that rabbit hunting took place near the cave, perhaps with the use of nets and snares. The prey was then brought to the site, where they were butchered and processed in the large hearth, probably by smoking or roasting. Some of those animals were consumed at Picareiro, while some others, and perhaps other carcass parts such as vertebral columns, were likely removed and taken to further sites.

As for red deer and wild boar, their anatomical diversity (teeth, cranial fragments, long bones, and vertebrae) suggest that they were also hunted close by. The kill sites, however, may have been further

afield than the rabbits hunting grounds, since the topography and vegetation cover in the vicinity of the site may have been inappropriate for these ungulate species. The anatomical diversity of the red deer indicates that these animals were also processed at the site, where they were butchered and cooked. Some of the meaty parts, and perhaps vertebrae, were taken to other sites.

Wild boar seems to have been used in a slightly different manner than the red deer. The wild boar carcass was probably butchered in the cavity, then the more valuable parts were removed to other sites, probably to residential camps in the lower plains. The heads and distal parts of the limbs were consumed at the cave. In sum, carcass butchery and the high degree of fragmentation of the large mammal limb elements all indicate the cave was repeatedly used as a hunting/carcass processing camp by groups of hunters from larger residential sites in the surrounding valleys.

In addition to the use of the meat, it seems that Picareiro has evidence of the exploitation of both marrow and grease rendering from the spongy parts of the bone, through both cold marrow as well as heat-in-liquid techniques. Thus, in general, it can be said that Picareiro was a specialized camp for butchering and processing animal foods, namely rabbit, red deer, and wild boar.

The lithic artifacts show very clear patterns that corroborate the interpretations of site function based on faunal analysis. The large majority of the artifacts are chips resulting from tool sharpening. Contrary to the numbers of cores, which are rare and tend to be exhausted, there are high numbers of retouched tools. These tend to be small in size, and marked by the presence of microlithic points. The weaponry is, with a single exception, broken, showing evidence of impact fractures, certainly resulting from hunting episodes. They were abandoned at the site, and probably removed from the animal carcasses where they were broken. Some replacement of broken points probably also occurred while the hunters were still at the cave.

From the point of view of intra-site patterning, it is clear that the space inside the cave was used differentially—the area against the back wall was more frequently used than the area near the entrance, as suggested by the presence of various hearths in the back. The morphology of one of the hearths, being very large in size, with the prepared base and a surrounding pavement, as well as the condition and diversity of fauna, indicates that it was used for pro-

cessing the meat of rabbits, red deer, and wild boar through smoking and roasting. All of the evidence from the different types of data (lithic artifacts, habitat structures, use of space, and fauna [both rabbits large ungulates]) indicate that Layers F/G of Picareiro Cave are the result of a special purpose occupation for processing animal carcasses of rabbits, red deer, and wild boar.

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