

Caldeirão cave (Central Portugal) – whose home? Hyaena, man, bearded vulture...

With 8 figs, 10 tabs

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A b s t r a c t

Caldeirão cave, 140 kilometres north east of Lisbon, was excavated by João ZILHÃO during the 1980s. The cave contains a sequence of Late Pleistocene-Holocene levels with associated cultural remains belonging to the Mousterian, early Late Palaeolithic, Solutrean, Magdalenian and Neolithic cultures. The associated faunal remains, all recovered by sieving, include ungulates (most are red deer, equids and goat), carnivores and rabbits. The problem we address here is who accumulated the animal bones – man, animal or both? Several criteria including those originally recommended by KLEIN (1975) are applied to the succession of assemblages. They indicate a change in the course of the cave's occupation. Several large carnivores – spotted hyaena, bear, wolf, leopard, and lion – were relatively common in the older periods, but subsequently became scarcer. Similarly coprolites, partially digested bones, and the presence of juvenile ungulates are more abundant in the earlier levels. Burn marks on bones are more common in the later levels as are the ratio lithics-to-bones and the relative abundance of unidentifiable bone fragments. We interpret these changes in terms of a replacement of large carnivores by man as the dominant occupant of the cave in the course of time. We caution that the Bearded vulture may also have played a small but significant role in the earlier levels.

Key words: hyaena, taphonomy, bone modification, zoo-archaeology, Bearded vulture

“If a cavern has remained open to the surface during long periods up to the present time, it may have been tenanted first by creatures now extinct, and subsequently by those now existing; and hence their various remains may be detected in it, sometimes mixed, at others in beds above each other. Consequently, the remains of Man and his works may be discovered in such places, as has been the case, particularly in the South of France.” Richard OWEN (1846: 160)

Introduction

The association between man-made artefacts and extinct animal remains helped to convince scientists in the 19th century that our ancestors lived before Sunday October the 23rd 4004 BC. This was the date originally calculated by Archbishop James USSHER of Armagh (TEGG 1811: 217). In his “Geological evidences of the antiquity of man”, published in 1863, Charles LYELL wrote “the occasional occurrence, in various parts of Europe, of the bones of man or the works of his hands, in cave-brecias... associated with the remains of the extinct hyæna, bear, elephant, or rhinoceros, has given rise to a suspicion that the date of man must be carried further back than we

had heretofore imagined.” This, then, was the first contribution that animal bones made to archaeology. Since those pioneering days, zoo-archaeology has become an integral part of archaeology.

Archaeological remains of animals help us to understand a site's use, the nature of the environment, species' evolution, and the relation between people and animals in the past. Zoo-archaeology is the study of faunal remains from archaeological sites and zoo-archaeologists generally assume that most archaeological remains of animals represent the food debris of our ancestors. This assumption is often reinforced by the presence on the bones themselves of butchery and burn marks. Here we present the results of a study where we do not believe

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Fig. 1: Map of Portugal to show the location of Caldeirão cave.

that this assumption is entirely correct. It would appear that man was not the only bone-collector. We discuss the animal remains from Caldeirão cave in Portugal and ask was Caldeirão inhabited solely by carnivores or solely by man or by both?

Location and excavation

Caldeirão cave (fig. 1) is in the Valley of the river Nabão, about 140 kilometers north east of Lisbon near Tomar and was excavated in the 1980s by João ZILHÃO (1992, 1997) of the University of Lisbon. He uncovered levels with cultural remains extending from the Mousterian to the Neolithic (tab. 1). Further excavations are planned in the future. Although the Caldeirão faunal collection is small, it is the largest Late Pleistocene one in Portugal and the site is the only one occupied for such a long extent of time.

A few words about the fauna

Like in many Late Pleistocene sites in the Iberian Peninsula, the ungulate fauna at Caldeirão (tabs 2 and 3)

Table 1: The layers in Caldeirão cave with their archaeological cultures and dates.

Layers	Culture	Dates Before Present
Ea	Neolithic	6,400 BP – 5,700 BP
Eb	Magdalenian	16,000 BP – 10,000 BP
Fa, Fb, Fc, H, I	Solutrean	22,000 BP – 18,000 BP
Ja, Jb	Early Upper Palaeolithic	27,000 BP – 22,000 BP
K, L, M, N	Mousterian	> 27,000 BP

is dominated by red deer, goat and two species of equid (horse and probably the extinct “Otranto ass” *Equus hydruntinus*). The sheep in the Neolithic are presumably introduced domesticates. Present in smaller quantities are chamois, wild boar and roe deer. Bones of birds, rodents, amphibians and even a fish were also uncovered and the numerous rabbit remains are currently under study. The carnivore fauna (tab. 2) comprises a wide spectrum of species – lion, leopard, lynx, wildcat, hyaena, wolf, badger, and fox, as well as several species of avian predators and scavengers (see also DAVIS 2002). Unfortunately most of the bones are covered by calcrete which made observations of gnawing and cut marks difficult. All fauna at Caldeirão was recovered by dry-sieving through a mesh of 2 mm aperture.

Perhaps of greatest relevance to this discussion is the presence of the spotted hyaena. This animal became widely distributed across the Palaearctic during the Cromerian, and in Europe it became extinct at the end of the last glacial (around 12,000 years ago; KURTÉN 1968, BONIFAY 1971, KAHLKE 1999). According to FERNÁNDEZ RODRÍGUEZ et al. (1995) hyaenas are only poorly documented in archaeological sites in Iberia and they “disappeared almost completely in the later phases” of the Upper Palaeolithic. ALTUNA & MARIEZKURRENA (1988) found that *Crocota* in northern Spain did not survive after the Solutrean some 20 or so thousand years ago. However, more recent records are known from the Magdalenian of south-western France (see KAHLKE 1999).

Who accumulated the bones?

Some of the taxa identified are known accumulators of animal bones. Hence we are confronted with an interesting zoo-archaeological puzzle: who was responsible for collecting the Caldeirão animal bones – man or animal or both? One possibility is that both people and carnivores used the cave. For example hyaenas, as Charles BRAIN (1981) has pointed out, will tolerate the presence of other species in their dens such as warthogs. However mutual avoidance seems more probable. People may have used the cave for some years or even decades and then carnivores used it. Can we determine the extent of carnivore versus human responsibility for the

Table 2: Counts and percentages of the mammal, bird and fish bones in the five main layers at Caldeirão cave. A + in the numbers columns signifies the presence of a bone not included in the list of parts of the skeleton counted (see DAVIS 2002). * Fewer parts of the rabbit skeleton were recorded, they are: mandible, scapula (glenoid), distal humerus, distal tibia, calcaneum (sustentaculum) and astragalus. The “large carnivores %” is calculated by dividing the number of hyaena + bear + lion + leopard + wolf bones by the total number of ungulate + large carnivore bones. The “Rabbit versus ungulates” are the numbers of recorded rabbit bones divided by the total number of bones (i.e. both rabbit plus ungulate). The presence of lion in the Solutrean is uncertain. Some artiodactyl counts include “halves” – these are broken metapodial condyles. EUP – Early Upper Palaeolithic.

	Mousterian		EUP		Solutrean		Magdalenian		Neolithic	
	n	%	n	%	n	%	n	%	n	%
Aurochs/cattle	1	1	–	–	1	+	3	1	10.5	13
Goat	12	9	23.5	18	24	7	2	1	1	1
Goat/Chamois/Sheep	3	2	8	7	14	5	3	1	8	10
Chamois	5	4	4	3	14	4	1	+	–	–
Sheep		–	–	–	–	–	–	–	4	5
Red deer	50	39	40.5	33	150.5	52	65	32	1	1
Roe deer	1	1	1	1	2	1	2.5	1	–	–
Wild boar/pig	3	2	–	–	0.5	+	10	5	34	43
Equids	24	19	17	14	25	9	6	3	1	1
Hare	–	–	2	2	–	–	17	8	–	–
Rabbit *	(171)		(220)		(2209)		(2275)		(345)	
Beaver	+	+	–	–	–	–	1	+	–	–
Hyaena	6	5	4	3	–	–	–	–	–	–
Bear	1	1	9	7	1	+	–	–	–	–
Badger	–	–	–	–	5	2	19	9	1	1
Lion	–	–	2	2	?1	?+	–	–	–	–
Leopard	1	1	–	–	3	1	3	1	–	–
Lynx	11	9	4	3	22	8	30	15	1	1
Wildcat	–	–	–	–	2	1	5	2	4	5
Wolf	3	2	–	–	1	+	–	–	–	–
Fox	1	1	1	1	1	+	9	4	8	10
Birds	9		10		36		28		5	
Fish	–		–		–		1		–	
Large carnivores %		(10)		(14)		(3)		(3)		(0)
Rabbit versus ungulates		0.63		0.70		0.90		0.95		0.85
Total (excluding rabbits)	131		126		303		205.5		78.5	

Table 3: Percentages of large herbivores at Caldeirão cave. Taxa present in small numbers are shown as +.

	Mousterian	EUP	Solutrean	Magdalenian	Neolithic
<i>Bos</i> (Aurochs/cattle)	1	–	+	3	18
<i>Rupicapra/Ovis/Capra</i> (Chamois/sheep/goat)	20	38	21	6	22
<i>Cervus elaphus</i> (Red deer)	51	44	66	70	2
<i>Capreolus</i> (Roe deer)	–	–	–	3	–
<i>Sus</i> (Wild boar/pig)	3	–	+	11	57
Equids	24	18	11	6	2
Total N (teeth + bones)	98	93	229	93	60

bones in the course of the cave’s occupation? Richard KLEIN (1975) and Kathryn CRUZ-URIBE (KLEIN & CRUZ-URIBE 1984) were among the first to recommend a number of criteria to aid in recognising who accumulated an assemblage of large mammal bones. What we shall now do is to consider

the following criteria to answer this question in the case of the Caldeirão fauna. They are as follows:

- The presence/absence of remains of large carnivore species known to collect bones

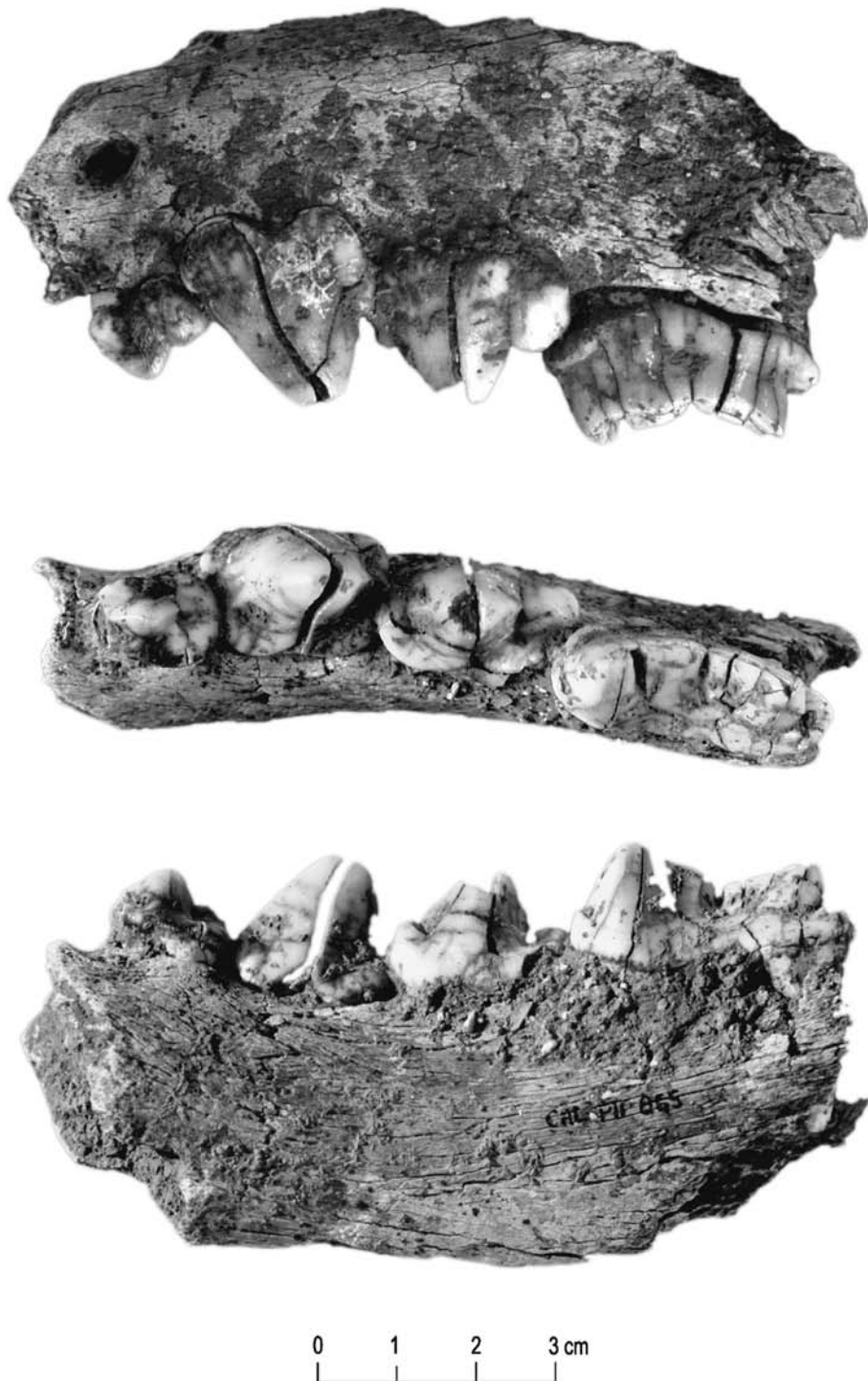


Fig. 2: Hyaena (*Crocute*) mandible from Caldeirão P11 865 K Mousterian. Above – buccal, centre – occlusal and below – lingual views.

- The presence/absence of coprolites
- The presence/absence of partially digested bones
- Carnivore to ungulate ratios
- Juvenile to adult ratios of the ungulate remains
- Body-part frequencies
- Cut and burn marks
- The ratio fauna to stone tools
- The ratio of small unidentifiable fragments to identified bone

Some of these indicate considerable carnivore influence, while others indicate clear human occupation of the cave. At this stage, and until further excavations uncover more fauna from Caldeirão, we suggest large carnivores, whose bones and teeth are found in abundance in the Mousterian and early Upper Palaeolithic, were only using Caldeirão in the two earlier levels, and that either they avoided the cave in Solutrean and Magdalenian times or they then became locally extinct – after c. 22,000 years ago.

Table 4: Survival and extinction of carnivores at Caldeirão – a working hypothesis. EUP – Early Upper Palaeolithic.

	Mousterian	EUP	Solutrean	Magdalenian	Neolithic
Bear	+	+			
Lion		+			
Hyaena	+	+			
Leopard	+	+	+		
Wolf	+	+	+		
Lynx	+	+	+	+	+
Fox	+	+	+	+	+
Wild cat			+	+	+
Badger			+	+	+
Nº of carnivore taxa	6	7	6	4	4

Presence of carnivore remains

One of the most remarkable carnivore finds from Caldeirão is a mandible of hyaena (fig. 2). Given the relative size of the carnassial tooth, it clearly belonged to a spotted hyaena, *Crocota crocuta*. Included among the finds of carnivores (tab. 2) are lion, leopard, lynx, wildcat and bear, as well as wolf, fox, badger, and several predatory and scavenging birds – the most important being the Bearded vulture, *Gypaetus barbatus*.

What is most interesting however (see tab. 4) is that the three large species of carnivores, bear, lion and hyaena, appear to have been present only in the two earliest levels of the cave. Both leopard and wolf were present in those two levels and lingered on into the Solutrean, but by Magdalenian times only the smaller species of carnivores are present.

These carnivore faunal changes are paralleled, if perhaps a little earlier, in the Spanish Mediterranean region where AURA TORTOSA et al. (2002) note that large carnivores such as leopards and hyaenas disappeared at the beginning of the late Pleniglacial during the transition between MIS 3 and 2 – the time of the extinction of the last Neanderthals some 30,000 years ago. They also note that large carnivore remains persisted into the early Upper Palaeolithic. Other carnivores like wolf, dhole (*Cuon alpinus*), lynx and wildcat maintained their numbers, but, they suggest, carnivores ceased to be the principal agent of bone deposition in the sites they consider.

Coprolites (tab. 5 and fig. 3)

Further evidence for the presence of hyaenas comes in the form of coprolites. Many are broken segments. Some are very large – too large to have belonged to wolf. 40 were found in Mousterian levels and another 3 in the Solutrean. The lengths of those that could be measured range from 29 mm to 51 mm and widths range from 18 to 52 mm. Two of the small Solutrean fragments had widths of 18 mm and 19 mm. They are yellow, with smooth sur-

faces and the ends are either pointed or exhibit a central depression, similar to those described by FERNÁNDEZ RODRIGUEZ et al. (1995) from La Valiña in northwest Spain (dated to 35,000 BP and which they identify as spotted hyaena coprolites). The Caldeirão pieces closely match the 12 coprolites from La Valiña in size and shape. The description that OWEN (1846: 146) gives of the fossilised faeces of spotted hyaena, once used in medicine and known as album graecum, from a site in England could equally apply to the Caldeirão specimens:

“...its external form is that of a sphere irregularly compressed as in the faeces of sheep, and varying from half an inch to an inch and half in diameter; its colour is yellowish white; its fracture is usually earthy and compact, resembling steatite, and sometimes granular; when compact, it is interspersed with small cellular cavities, and, in some of the balls, there are undigested minute fragments of the enamel of teeth.”

The three small coprolites found in the Solutrean are a possible indication of a lingering presence of hyaena after the early Upper Palaeolithic, though being small these may have belonged to a smaller carnivore.

Partially digested bones (tab. 5)

Many carnivores swallow complete bones, or parts of bones. These may be subsequently regurgitated or survive passage through the gut as PAYNE & MUNSON (1985) have demonstrated in dogs. Dogs for example will not swallow fragments whose diameter exceeds about 2.5 cm. These bones may survive their stay in the stomach, but suffer varying degrees of digestive alteration and present a characteristic eroded appearance. Etched surfaces of partially digested bones are often shiny, and any broken edges wafer-thin and razor sharp. The absence of this sort of corrosion on larger bones rules out soil acids as the cause, as soil corrosion would affect both small and large fragments alike. Hyaenas regularly regurgitate indigestible residues of their recent meals (KRUUK 1972: 244, BRAIN 1981, KLEIN et al. 1999).



Fig. 3: Coprolites from Caldeirão (P11 sc 907, layer M M1; Mousterian). In view of their large size these are probably derived from hyaena. Scale bar: 10 cm.

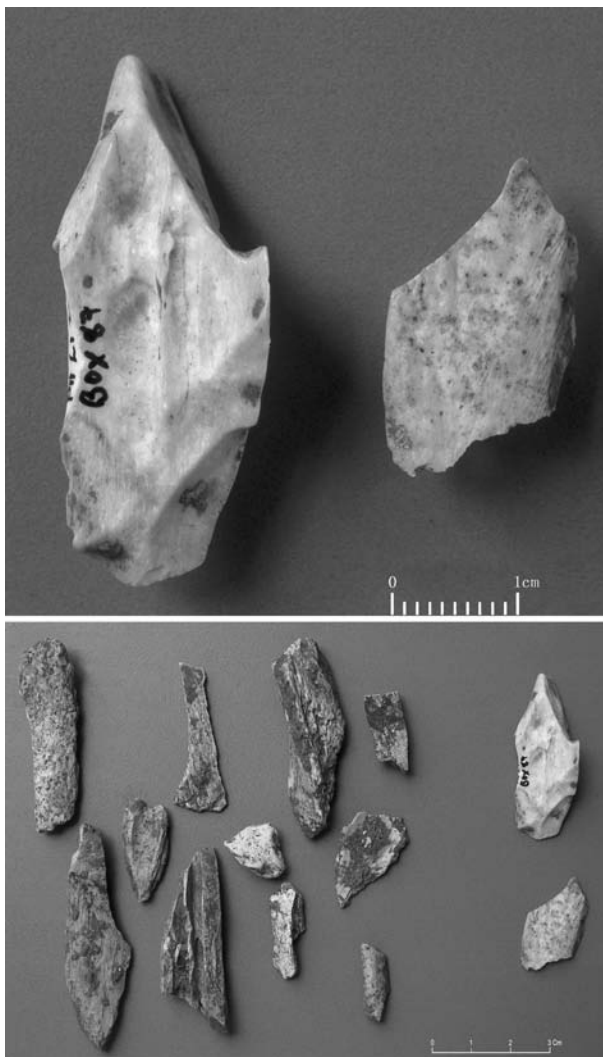


Fig. 4: Above: Two partially-digested fragments of large mammal bone. Note their shiny surfaces and sharp broken edges. Below: these two fragments, on the right hand side, with 11 ordinary fragments. All are from P11 L1 sc 894 (Mousterian).

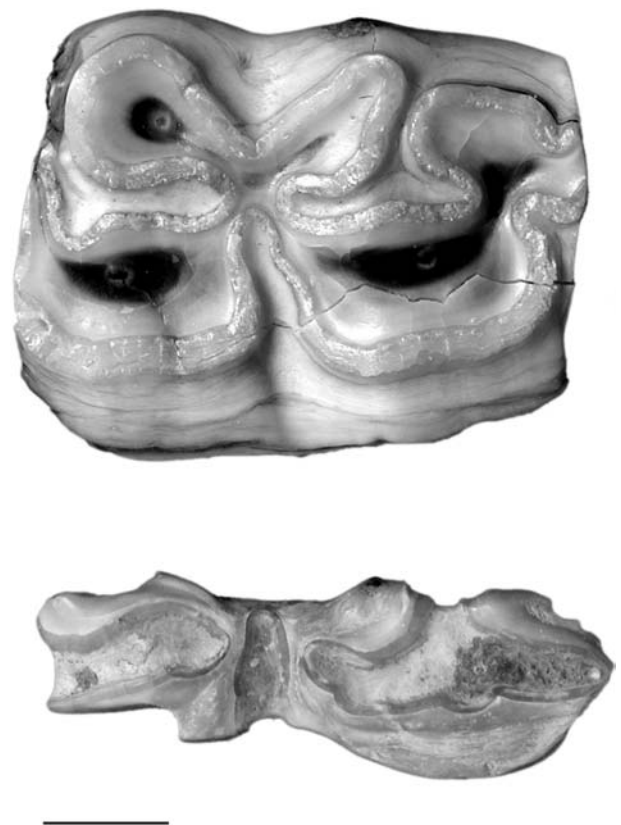


Fig. 5: Occlusal views of a partially-digested equid (possibly *E. hydruntinus*) lower cheek tooth from the Mousterian shown below a modern (undigested) horse lower second molar to show the extent of gastric erosion. Scale bar: 5 mm.

Large amounts of small chips and fragments of bone were found throughout the Caldeirão sequence. These include many corroded fragments. The pattern of corrosion is similar to that produced by immersion in acid, which suggests they

Table 5: Human versus carnivore activity at Caldeirão. This table provides various counts that indicate the relative activity of man and carnivores at different times. They are as follows from top to bottom: a) Counts made of identified bones and teeth, coprolites and observations made on these recorded bones. b) Percentages of burnt and partially digested rabbit bones. c) Observations recorded on the unidentified bone fragments and chips. All categories of observation appear to show the same trends. Clearly hyaenas were present in the Mousterian and early Upper Palaeolithic as evidenced by their bones and teeth. The coprolites too are assumed to have belonged to this animal. Other evidence for carnivore activity, presumably hyaena but possibly other species too, includes semi-digested bone, and the low ratio “chips to identified bones” (most chips may have become completely digested by large carnivores such as hyaenas). This ratio, rounded to the nearest whole number, is calculated by dividing the number of unidentified chips + number of ungulate bones and teeth by the number of ungulate bones and teeth. Evidence for human activity takes the form of stone tools and burnt bones. Overall, these data suggest the cave was predominantly a large carnivore den in the Mousterian but subsequently humans exploited the cave more intensively and presumably caused the demise of hyaenas and the other large carnivores before or during the Solutrean. The increased human activity, at least in the Solutrean, is also indicated by the high ratio of fauna to lithics. * Faunal and lithic density data are from ZILHÃO (1997: vol. 2, 114, tab. 9.2). EUP – Early Upper Palaeolithic.

	Mousterian	EUP	Solutrean	Magdalenian	Neolithic
a) IDENTIFIED BONES					
Ungulate bones & teeth	98	93	229	93	60
Rabbit bones	171	220	2209	2275	345
Felid bones & teeth	12	6	28	38	5
Canid bones & teeth	4	1	2	9	8
Badger bones & teeth	0	0	5	19	1
Bear bones & teeth	1	9	1	0	0
Hyaena bones	1+?1	2?	0	0	0
Hyaena teeth	4	2	0	0	0
Coprolites	40	0	3	0	0
Semi-digested bones	11	3	0	0	0
Gnawed bones	0	0	0	1	1
Burnt bones	0	0	4	3	2
b) RABBIT BONES					
% burnt	1	3	4	3	
% semi-digested	20	11	4	< 1	
c) UNIDENTIFIED CHIPS					
Total Number	648	780	2288	2071	
Number gnawed	6	4	7	2	
Number with cut marks	2	0	4	5	
Number burnt	11	14	177	183	
Number semi-digested	108	53	17	8	
% gnawed	0.9	0.5	0.3	0.1	
% cut	0.3	0	0.3	0.2	
% burnt	1.7	1.8	7.7	8.8	
% semi-digested	16.7	6.8	0.7	0.4	
Ratio “chips” to “identified”	8	9	11	23	
Average faunal density (g/m ² /millennium)*	440	225	470	?	
Average lithic density (g/m ² /millennium)*	175	76	91	?	
Ratio fauna to lithics*	2.5	3.0	5.2	?	
Presence of scavenging birds	+	+	+	-	-
Presence of Bearded vulture	+	-	?	-	-

had been partially digested and fig. 4 shows some randomly selected fragments. Note the two on the right which appear to show these characteristics. Figure 5 shows a partially digested equid tooth. These and numerous other similarly corroded bones and chips of bones were found mainly in Mousterian and early Upper Palaeolithic levels. Their presence, as well as

the abundance of large carnivores and the coprolites already discussed, are all good evidence for the presence of a bone-eating carnivore(s) in the earlier two periods at Caldeirão (see also fig. 6). However, to make matters more complicated, we shall see below what happens to ungulate bones after being regurgitated by the Bearded vulture!

Table 6: Caldeirão cave red deer and equids – juveniles versus adults. This table provides separate counts of teeth and bones from young and adult animals, and the percentages of juveniles calculated separately from teeth and bones (very small samples are excluded). For teeth of red deer, the numbers of deciduous and adult fourth premolars (dP_4 and P_4 respectively) are given. Since the exact location within the jaw of equid teeth is generally difficult to determine, equid teeth counts are pooled as deciduous premolars ($dP_2 + dP_3 + dP_4$) and adult premolars + molars ($P + M$). For bones of both taxa, UE and UM are the unfused epiphyses and unfused metaphyses respectively of the following bones: scapula, distal humerus, distal radius, distal metapodials, distal femur, distal tibia, calcaneum, proximal first phalanx, and proximal second phalanx. Unfused scapulae and unfused calcanea are counted as UM. In order to compute the percentage of juveniles via the limb bones, the higher of the UM or UE counts was used in the numerator. These figures indicate that in the Mousterian and early Late Palaeolithic most of the red deer and equids brought into the cave were juveniles. Subsequently the percentages of juveniles were much lower. (NB: some red deer counts include “halves” – these are broken metapodial condyles). EUP – Early Upper Palaeolithic.

Taxon	Teeth/bones	Juv/adult	Mousterian		EUP		Solutrean		Magdalenian		Neolithic
			n	% juv	n	% juv	n	% juv	n	% juv	
Red deer	teeth	dP_4	1		5		8		2		0
Red deer	teeth	P_4	2		0		5		3		0
Red deer	bones	UE	9		6.5		13.5		5		0
Red deer	bones	UM	9.5		11		23		2		0
Red deer	bones	F	4.5		5		49		27		1
				68		69		32		16	
Equids	teeth	dP	7		6		0		0		0
Equids	teeth	$P+M$	5		3		16		3		0
				58		67		0			
Equids	bones	UE	3		2		2		0		0
Equids	bones	UM	7		4		3		0		1
Equids	bones	F	1		0		3		3		0
				88		100		50			

Carnivore to ungulate ratio

KLEIN (1975) and KLEIN & CRUZ-URIBE (1984) suggested that human food remains could be distinguished from those of carnivores by the proportion of carnivore remains. This is because carnivores like hyaenas have a tendency to feed on the carcasses of other carnivores, even of their own species, and to an extent greater than people did. Using this argument, BRAIN (1981) concluded that large carnivores collected many of the accumulated animal and hominid bones in South African caves. At Caldeirão it is quite clear that the percentage of large carnivores decreases quite drastically from around 10 or 14 % in the early two levels to a mere 3 % in the later levels (calculations based on the numbers of bones; see tab. 2). This criterion too corroborates our conclusion that carnivores played a major role in the two early levels of the cave.

Juvenile to adult ratio

Zoo-archaeologists generally consider the age-at-death of the animals represented in the sites they study. An estimate of the mortality pattern of animals culled in antiquity can reveal important information about man-animal relations. At Caldeirão samples are too small to draw

Table 7: Percentages of young and adult wildebeest in Ngorongoro (KRUUK 1972: tab. 24) and waterbuck (PIENAAR 1969) preyed by spotted hyaena and leopard in East Africa today. (Note that 60 of the 62 % young wildebeest were aged between 0 and 12 months old.)

	infants & juveniles	adults
Hyaena v wildebeest	62	38
Leopard v waterbuck	90	10

secure conclusions, though the data (tab. 6) do suggest that most of the red deer and equids in the earlier levels were juveniles, while more or most of these animals in the subsequent periods were adult. One could argue that people were improving their hunting capabilities in the course of time and that it was not until later that people were able to cull the adult (larger) horses and red deer.

An alternative explanation for the age-shift, and the one we prefer, is quite simply that the majority of the equids and red deer in the earlier times were not hunted by people but by carnivores such as hyaenas, leopards and wolves. Hyaenas are by no means the largest and most efficient of predators and were perhaps unable to take the faster and more ferocious adult horses and red deer. This may be further evidence for a change of predator between early Upper Palaeolithic and Solutrean

Table 8: Body-part counts of the common large and medium-size mammals at Caldeirão. The purpose of this table is to see whether the presence or absence of hyaena has had any effect on the parts of the skeleton present. The Mousterian and early Upper Palaeolithic layers in which bones of hyaena were found are compared to Solutrean and Magdalenian layers which have little or no evidence for hyaena. Data may be found in DAVIS (2002: tabs 1–5). RC includes both goat and chamois. “Bones” is the count of all girdle (scapulae and pelves), limb and foot bones. “Long bones” is the count of the main limb-bones, excluding scapulae and pelves. “Tarsals” includes both astragali and calcanea. The presence or absence of hyaena does not appear to have had any overall impact on the tooth to bone ratio or other body-part frequencies. The high proportion of red deer phalanges in the Solutrean is worth noting but difficult to explain. (NB: some artiodactyl bone counts include “halves” – these are broken metapodial condyles). EUP – Early Upper Palaeolithic.

	Mousterian + EUP			Solutrean + Magdalenian		
	Equids	Red deer	RC	Equids	Red deer	RC
Teeth	21	22	21	19	43	24
Bones	20	68.5	34.5	12	172.5	33
	Mousterian + EUP			Solutrean + Magdalenian		
	Equids	Red deer	RC	Equids	Red deer	RC
Teeth	21	22	21	19	43	24
Long-bones	5	18.5	6.5	7	25.5	9
Tarsals	2	9	5	0	17	7
Phalanges	12	40	22	4	127	12

times. Perhaps too, as ALBARELLA (pers. comm.) has suggested to us, the age structure of the deer and equids has something to do with their social organisation. Were the Caldeirão hyaenas concentrating upon herds of immature individuals during certain times of the year?

KRUUK (1972) observed that the three species of large mammals most commonly hunted by spotted hyaenas in Africa are wildebeest, zebra and Thompson’s gazelle. He recorded the ages of over 100 wildebeest killed by hyaenas. The majority of the wildebeest were juveniles (tab. 7). The age-at-death data for leopard kills of large mammals are also interesting. PIENAAR (1969) noted that while most of the impala, whose average weight is 45 kg, were adults, the waterbuck, whose average weight is 250 kg, predated by leopards were mostly juveniles and infants. This preference for the young of the really large animals, in the case of the hyaena and leopard, is, according to KRUUK (1972), quite different from what lions and wild dogs prefer to kill today in East Africa. They take a much smaller proportion of young prey. Again this criterion corroborates our interpretation that in the earlier levels bones were accumulated by hyaena although the leopard too cannot be excluded. Man and lion, both of which hunt in groups, would seem less likely candidates in the two early levels

What is known from the Iberian Pleistocene? At Cova Negra (Valencia), VILLAYERDE et al. (1996) noticed that levels with a predominance of carnivore marks on the bones show a greater representation of infant as well as old cervids. It is unclear to us at present why there are so few “old” cervid remains at Caldeirão in the early levels, though it may simply be a matter of sampling. ALTUNA & MARIEZKURRENA (2000) studied the animal remains from a pit in Labeko Koba, an Upper Palaeolithic cave in the Basque region of Spain, where they found abundant *Crocota* remains (30 % of the animal bones were of this

taxon) as well as numerous coprolites. They suggest that their preferred prey at that time were horses, most of which were juveniles. These hyaenas also took red deer and large bovids whose remains were mainly derived from juvenile animals.

Body-part frequencies

Zoo-archaeologists identify and record many or even most of the different bones of an animal’s skeleton such as teeth, leg bones, feet bones, and phalanges. Their frequencies in an archaeological site may reveal information about where the animals were slaughtered and what happened to their skeletons after death. However, the main factor causing discrepancies, as BRAIN (1967) pointed out, is differential post-mortem destruction. Some bones are more fragile than others and so in adverse conditions, suffer greater post-mortem loss. The hyaena with its powerful jaws and teeth is capable of causing great destruction to the bones of a mammal carcass. A study (SKINNER et al. 1980) of this destruction in relation to different parts of the skeleton and the size of the animal in question reveals that striped hyaenas will destroy all the limb bones of mammals the size of a goat, but tend to leave the teeth. However, in the case of larger animals, not only are the teeth left intact but so are many of the limb-bones. According to KRUUK (1972: 73) hyaenas feeding on wildebeest would leave the head for some time “which would be eaten in a few hours save the horns and teeth”. We apply the results from the SKINNER et al. (1980) study of striped hyaena bones to the Caldeirão fauna even though its behaviour with respect to parts of the skeleton consumed may be different from that of the spotted hyaena (we are unaware of a body-part study of spotted hyaena bone accumulations). The mammal fauna of Caldeirão

includes both large animals like red deer and equids, and smaller ones like goat and chamois. If *Crocota* had a major impact on the Caldeirão assemblage, we would expect the large animals to be represented by both teeth and bones and the smaller ones by teeth only. Furthermore, this discrepancy should disappear in the more recent levels from which hyaenas were absent. Table 8 pools the different parts of the skeleton in several ways, and includes a more detailed breakdown of the different parts of the skeleton. With so few remains any conclusions must be regarded with caution. The tooth-to-bone ratios show little overall variation between large and small animals and between early and later levels. The different parts of the skeleton also fail to reveal any substantial variation between periods and between species. It appears likely that all parts of the skeleton of the larger herbivores were introduced into the cave. Discrepancies are probably due to differential destruction of the different bones. PICKERING (2002) suggests that body-part discrepancies are not useful for recognising hyaena accumulations of bones.

Cut and burn marks

The presence of cut marks on bones is generally considered to be conclusive evidence of an association between people and the animal in question. At Caldeirão cut marks were observed on a small number of the bones in all levels, although these are probably under-estimated as most of the Caldeirão bones were encrusted by calcrete which made observation of surface features difficult if not impossible. Clearly people accumulated some of the faunal remains at all times. Burning of bones too, is evidence for man's presence in the cave. Burn marks are relatively scarce in the earlier levels, and common in the more recent ones – almost one in ten bone fragments in the Magdalenian show signs of burning (tab. 5). The fourfold increase of burnt bones between early Upper Palaeolithic and Solutrean corroborates the notion of large carnivores being replaced by people as the main occupants of the cave.

The ratio fauna to stone tools

ZILHÃO (1997) studied various quantitative aspects of the Caldeirão deposits such as the densities of fauna and stone tools (tab. 5). The small size of the artefact assemblages (in the high tens or low hundreds, including chips) and the low bone-to-tools ratio in the Mousterian and early Upper Palaeolithic, suggests that people only used the cave intermittently. Moreover, the preponderance of barbs and points (these comprise 50 % of the retouched tools) in the small artefact assemblages contained in levels Ja (latest early Upper Palaeolithic) and I (earliest Solutrean) suggests a specialized use of the site by humans – perhaps for hunting forays only. The faunal density and the ratio

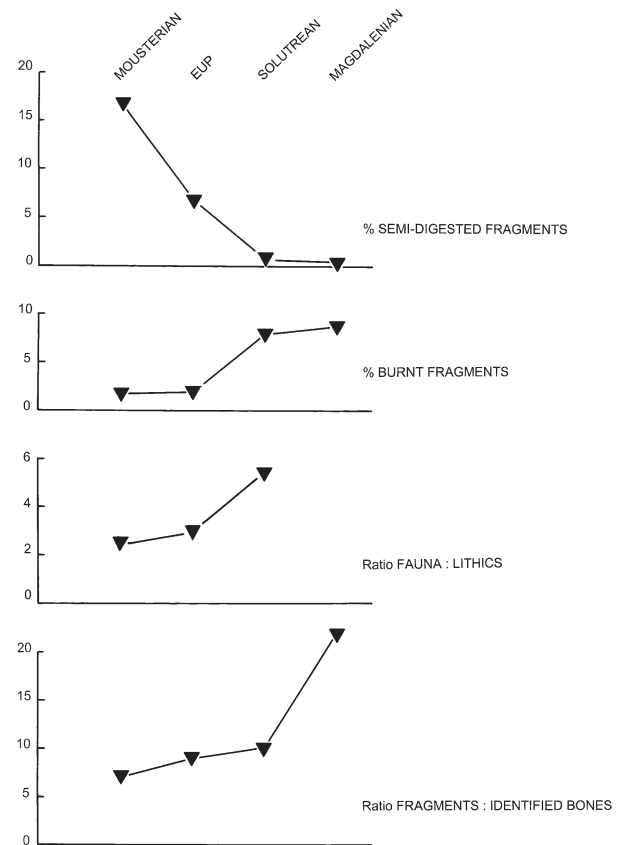


Fig. 6: Carnivores versus humans as bone accumulators. Plots to show a change in the pattern of occupation of Caldeirão cave in the course of time. From top to bottom: percentages of partially digested fragments of bone, percentages of burnt fragments of bone, the ratio 'fauna to stone tools' and the ratio 'fragments of unidentifiable bones to identifiable bones' (data in tab. 6). Note the decrease of partially-digested bones and increase of burnt bones, fauna versus stone tools (from ZILHÃO 1997: vol. 2, 114), and unidentified versus identified bones in the course of the succession. These changes may reflect a decrease in the use of the cave by carnivores, especially hyaenas, and its increasingly intense use by humans.

of tools-to-fauna are greater in the early Solutrean. Also, the different stages of lithic reduction systems are all represented in the abundant artefact assemblages recovered from Solutrean and Magdalenian levels, suggesting longer, perhaps seasonal occupations of a residential nature. This inference is consistent with the fact that human skeletal remains of adults, adolescents and children were found in the Solutrean deposits (TRINKAUS et al. 2001), suggesting that the adjacent territory was frequented by family groups, not just specialized hunting parties. ZILHÃO (1997) concluded that this change in the nature of the human use of the site, coupled with the decrease or even complete disappearance from the faunal assemblage of the large carnivores after circa 21,000 years ago indicates an intensification of the human use of the cave at that time. (This aspect of the study is incomplete as the Middle and Late Solutrean and Magdalenian levels have not



Fig. 7: An X-ray image of a living bearded vulture showing the presence of a metapodial (probably caprine), within the oesophagus. From TERRASSE, J.-F. (2001: 57).

yet been studied quantitatively in this way. Qualitative observations, however, are fully consistent with this view of the site's stratigraphic sequence.) In other words, while animal predators like hyaenas were significant bone accumulators in the Mousterian and early Upper Palaeolithic, their role declined subsequently when people occupied the cave more intensively.

The ratio of small unidentifiable fragments to identified bone

A count of the numbers of unidentified fragments of bone (most are fairly small and measure one or two centimetres) compared to the numbers of identified bones revealed an interesting trend (tab. 5, fig. 6). The relative numbers of fragments increased substantially in the Magdalenian. We wonder whether this trend has something to do with the feeding behaviour of the occupants of the cave. Both people and bone-eating carnivores such as hyaenas break long bones in order to gain access to the marrow. While the hyaena swallows and digests many of the resulting fragments, people do not.

Table 9: Identification of bones from 11 modern Corsican nests of Bearded vultures (modified from ROBERT & VIGNE 2002). NISP: the number of identified specimens; MNI: the minimum number of individual animals.

Taxon	NISP	% NISP	MNI	% MNI
<i>Bos taurus</i>	428	50	27	26
Caprines (sheep and goat)	319	37	59	56
<i>Sus scrofa</i>	60	7	10	10
<i>Vulpes vulpes</i>	40	5	4	4
<i>Canis familiaris</i>	5	1	2	2
<i>Felis</i> sp.	1	+	1	1
<i>Equus</i> sp.	1	+	1	1
<i>Lepus capensis</i>	1	+	1	1
Total	855		105	

Does the shift in this ratio at Caldeirão reflects the presence of hyaenas that caused the disappearance of many of the small chips of bone in the early levels but by Magdalenian times, with hyaenas absent, all bone chips remained as part of the faunal assemblage. We are unsure of the validity of this criterion and as far as we are aware it has not been studied in modern hyaena dens. Moreover, as mentioned above (see section 'body-part frequencies') there are no similar changes in the ratios of small to large identified parts of the skeleton.

Another possible agent!

Until recently it seemed most reasonable to assume that hyaenas were mainly responsible for many of the bones accumulated in the cave in the Mousterian and early Upper Palaeolithic. However, recent studies (ROBERT & VIGNE 2002) in Corsica indicate that partially digested ungulate bones in rock shelters and caves may also be derived from the feeding activities of the Bearded vulture – *Gypaetus barbatus*. This scavenging vulture is now extremely rare in Europe being confined to the Pyrenees, Corsica, Crete and parts of the Balkans and the Alps (HAGEMEIJER & BLAIR 1997). It has probably been scarce throughout most of the 20th century and this may explain why many zoo-archaeologists interested in the origin of bones in cave deposits have tended to ignore this bird. However, until the end of the 19th century it was widespread in the Iberian Peninsula (CANO & VALVERDE 1959, HEREDIA & HEREDIA 1991, DONÁZAR et al. 1993, HERNANDEZ & MORALES 1995, TERRASSE 2001). The Bearded vulture is known to feed on the bones of juvenile large mammals such as calves, and both juvenile and adult medium-sized mammals such as caprines like sheep, goat and wild mouflon (fig. 7, tab. 9). In the Late Pleistocene of Corsica, this bird almost certainly consumed bones of the endemic deer, *Megaloceros cazioti* (ROBERT & VIGNE

Table 10: Bearded vultures at Caldeirão? Counts of proximal (P1), central (P2) and terminal (P3) phalanges of equids (EQ), red deer (CEE) and *Rupicapra* + *Capra* (RC) in the five main periods at Caldeirão. The P1 and P2 counts are given as follows: $x + y$ where x = the number of adult specimens with fused proximal epiphyses and y = the number of juvenile specimens of either (whichever is the greater) unfused proximal epiphyses or metaphyses. For example in the Solutrean there are 31 red deer adult (epiphyses fused) P1s and another 9 juvenile with unfused epiphyses. More detailed counts are in DAVIS (2002).

	Mousterian			EUP			Solutrean			Magdalenian			Neolithic		
	EQ	CEE	RC	EQ	CEE	RC	EQ	CEE	RC	EQ	CEE	RC	EQ	CEE	RC
P1	0+3	1+5	2+0	0+2	1+5	5+0	0+2	31+9	3+1	0+0	9+2	0+0	0+0	1+0	1+1
P2	0+2	1+2	1+0	1+0	2+3	5+0	0+1	28+9	4+1	0+0	8+1	2+0	0+0	0+0	0+1
P3	1	10	4	1	5	5	1	25	1	0	15	0	0	0	0

2002). In order to gain access to the marrow, large bones and partial carcasses may be carried to some height by this bird and then dropped so that they break on impact. Moreover these birds are capable of swallowing bones as large as caprine metapodials (fig. 7)!

One of us (IR) has undertaken extensive studies of their nesting eyries in Corsica (ROBERT & VIGNE 2002). The Corsican data showed not only that these birds concentrate upon medium and large-sized ungulates, but that they leave a signature on the assemblage which is not too dissimilar from that left by mammalian carnivores such as hyaenas. For example short compact bones like carpals, tarsals and phalanges, are well represented in their accumulations. Terminal (hoof) phalanges are especially common, much more so than proximal and central phalanges, presumably because their partial covering by the hoof helps to protect these bones from the strong digestive juices of this bird. Digestion marks are also common especially on the proximal parts of the phalanges (fig. 8).

A recent re-examination by one of us (IR) of some of the Caldeirão bones suggests that this bird may have been present at Caldeirão at least occasionally. A second phalanx of Bearded vulture was identified in the Mousterian and a terminal phalanx from the Solutrean may have belonged to this species. Note also the fairly high counts of red deer terminal phalanges compared to proximal and central ones in the Mousterian and Magdalenian (tab. 10). The results are by no means as marked as in the bearded vulture nests in Corsica (see fig. 2 of ROBERT & VIGNE 2002), but we feel that the occasional presence of this bird at Caldeirão needs to be considered as a possibility.

Conclusion and further observation

We suggest that in the early stages of its occupation, Caldeirão functioned in part as a large carnivore den. We suspect that hyaenas were mainly responsible for accumulating the animal bones but leopards and bearded vultures may have played a role too. Then after the early Upper Palaeolithic the cave functioned primarily as a human ‘home’. The gradual usurping of the role of large



Fig. 8: Partially digested proximal phalanges from a modern bearded vulture nest in the Spanish Pyrenees. Photo: I. ROBERT.

mammalian carnivores by people in the course of the Late Pleistocene is a pattern which is now recognisable in other parts of the Iberian Peninsula (AURA TORTOSA et al. 2002).

Another intriguing trend in the Caldeirão faunal succession (tab. 5) is the increase from Mousterian to Magdalenian of rabbit remains. Like the large mammals, the rabbit remains also indicate reduced carnivore action – note the trend towards relatively fewer partially digested bones in the course of time. Does this too mean that the earlier rabbits were largely predated by carnivores such as the lynx, a well known specialist predator of rabbits, and in later times most were hunted by people? A taphonomic study of the Caldeirão rabbits is now underway, but the huge increase in their numbers relative to other species is worth noting. A similar increase of smaller animals in archaeological sites during the Mesolithic and just prior to the advent of domestication has been noted in many circum Mediterranean regions (see for example DAVIS et al. 1988, MORALES et al. 1998, BAR-ÖZ 2004, LUBELL 2004, MUNRO 2004, DAVIS 2005). AURA TORTOSA et al. (2002) also note the capture of large quantities of rabbits and small animals including birds, fish and shellfish in the Magdalenian. These shifts may reflect increasing pressure upon natural resources – the result

of an increase in human population. We wonder whether these changes reflect the growing human population of western Iberia during the course of the Late Pleistocene and Early Holocene.

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