

Carcass Acquisition and Consumption by Carnivores and Hominins in Middle Pleistocene Sites of Casablanca (Morocco)

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Study of faunal series resulting from recent excavations in two caves in North Atlantic Morocco (*Grotte à Hominidés* - GH - and *Grotte des Rhinocéros* - GDR - at Thomas I and Oulad Hamida I quarries, Casablanca) has yielded new evidence concerning the gathering and processing of ungulates carcasses during the Middle Pleistocene in this part of North Africa. Preliminary taphonomic analysis of the macrofauna indicates that the carcasses were mainly introduced in the caves by carnivores. Additionally, marks generated by porcupines also occur. Dimensions and morphologies of tooth-marks and coprolites suggest that carnivores of different sizes (mainly middle-sized canids, hyenids and felids), as well as porcupines, used the cave. Cut-marks on the bones are absent at GH and scarce at GDR, despite their association with lithic artefacts and human fossils. This raises the question of the relationship between hominins and other competitors in these caves. The recurring question is to determine the modalities of niche partitioning by the various predators and/or carrion-eaters as well as the mode of introduction of artefacts and human remains.

Keywords: HOMININS, CARNIVORES, MOROCCO, MIDDLE PLEISTOCENE, SUBSISTENCE, COMPETITION, BONE ACCUMULATORS

Introduction

The purportedly oldest cut-marks on bone in North Africa have been reported for Algeria, at Aïn Hanech in Lower Pleistocene units (Sahnouni *et al.*, 2011, 2013) but none are clearly known from other ancient sites. On the contrary, during the Middle Pleistocene, cave assemblages with mixed accumulations derived from materials modified by humans and a diverse array of carnivores are common in the Mediterranean basin (Blasco *et al.*, 2011; Gaudzinski, 2004; Huguet Pamies *et al.*, 2001; Rosell & Blasco, 2009; Raynal *et al.*, 2010; Sam & Moigne, 2011; among many others). Sharing the same landscape, shelters and resources, both hominins and animal predators might have benefited alternately from occupying the living spaces and exploiting the hunting or scavenging remains collected and brought to the cave by each other.

Since the beginning of the last century in Morocco, several quarries South-West of Casablanca have exposed Lower and Middle Pleistocene sites, the most famous being Sidi Abderrahmane Quarry (Figure 1). The faunal series studied in this report result from recent excavations in two caves at Thomas I and Oulad Hamida 1 quarries: the *Grotte à Hominidés* (GH) and the *Grotte des Rhinocéros* (GDR). In Thomas Quarry I, Unit 4 of GH has a minimum age of 500 ky and yielded an assemblage containing core, flakes and rare bifaces, many faunal remains and several human fossils (Raynal *et al.*, 2010, 2011). In the nearby Oulad Hamida 1 Quarry, a rich lithic assemblage containing bifaces and rare cleavers has been excavated from GDR and it is dated to a similar or slightly younger minimum age (Raynal *et al.*, 1993; Rhodes *et al.*, 1994, 2006).

In both sites carnivores were considered as the first agent for bone accumulations and

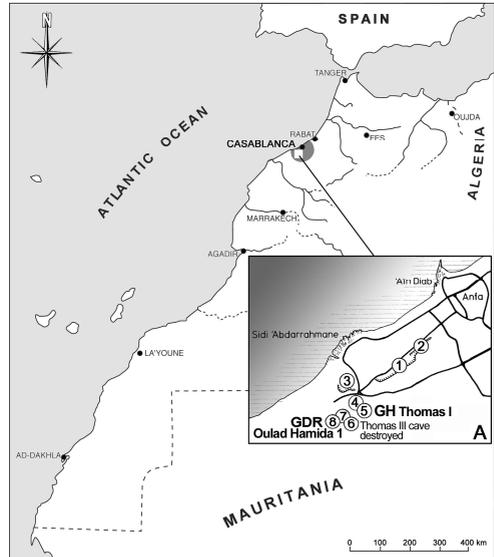


Figure 1. Location map and focus on the main Middle Pleistocene sites excavated at Casablanca (A). 1, Sidi Abderrahmane Grande Exploitation. 2, Sidi Abderrahmane Cunette with Cap Châtelier and Grotte des Ours. 3, Sidi Abderrahmane-Extension. 4, STIC Quarry. 5, Thomas Quarry I with Grotte à Hominidés. 6, Thomas III Cave. 7, Thomas III “fissures”. 8, Oulad Hamida 1 Grotte des Rhinocéros. (© J.P. Raynal).

their modifications (Bernoussi, 1997). However, recent excavations yield new evidence concerning the hominin way of life and the strong competition for resources and niches during the Middle Pleistocene in this part of North Africa.

Presentation of the sites

The Thomas Quarry I locality was made famous with the discovery of a human half-mandible in a cave (Ennouchi, 1969) that we subsequently named *Grotte à Hominidés* (GH). In the western part of Oulad Hamida 1 Quarry, a cave we named *Grotte des*

Rhinocéros (GDR) was discovered in 1991. It belongs to the same fossil cliff as Thomas III cave, now destroyed, in which human fossils were also discovered (Ennouchi, 1972, 1975, 1976) associated with lithic artefacts and fauna (Geraads, 1980; Geraads *et al.*, 1980). From 1991 onwards, modern controlled excavations took place in these caves within the framework of the Franco-Moroccan co-operative project "Casablanca" (Raynal *et al.*, 1995, 2001). Lithic objects both unmodified and knapped and faunal and human remains were georeferenced using a Total Station and special attention was given to the microstratigraphic context. Preliminary horizontal and vertical distribution patterns were analyzed using Geographical Information System (GIS) technology (Gallotti *et al.*, 2011).

In Thomas Quarry I, stratigraphic Unit 4 of GH (Raynal *et al.*, 2010, 2011) contains artefacts, fauna and hominin fossils. It rests on collapsed eolianite blocks imbedded in coarse sands that form an old intertidal marine Unit which fossilized a notch of a polyphase shoreline (Figure 2A). The lithic assemblage recovered by recent excavations in GH stratigraphic Unit 4 is similar to the series collected at the time of the discovery of the first *Homo* fossil in 1969 (Geraads *et al.*, 1980). It is manufactured mainly on various quartzites available close to the site as cobbles of small to medium size and some blocks as well as a few flint nodules collected in secondary position from beach deposits. The assemblage consists of chopper-cores (mainly unifacial unidirectional cores with a retouched cutting edge) and cores, semi-cortical flakes obtained by direct and bipolar flaking, along with rare handaxes made from large flakes or from flat cobbles, handaxe-like cores, hammerstones and anvils. Stone flaking was mainly oriented towards flake production and

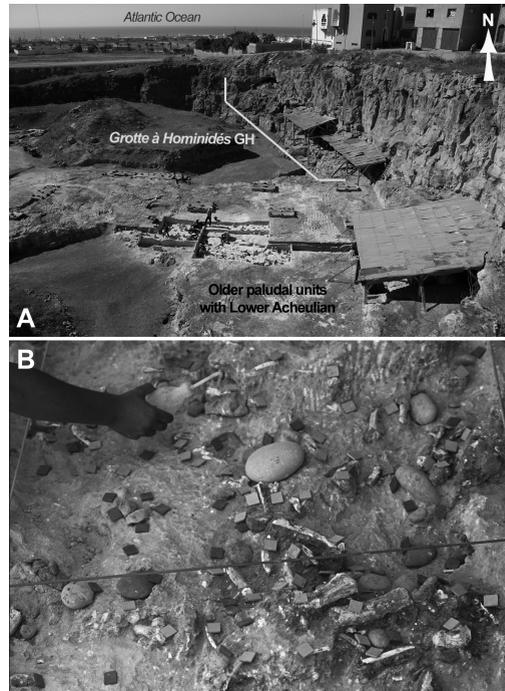


Figure 2. Thomas Quarry I, GH: large view of the cave (A) and close view of the excavation surface in Unit 4 (B). (© J.P. Raynal).

a few handaxes have probably been imported into this part of the site for specific subsistence tasks. A rich mammalian macrofauna together with a few reptiles and birds is associated with the lithics in Unit 4 and there is no evidences of fire use (Figure 2B). Geological studies have demonstrated that Unit 4 resulted from several sedimentary processes that probably mixed artefacts with bones previously accumulated by predators. Forty square meters have been excavated from Unit 4 which slightly slopes from north to south (Figure 3). Although analyzed for single categories, the spatial distribution trends in this part of Unit 4 do not differ significantly from a random model. However, the co-existence of lithic

heavy and light finds and the presence of refittings seem to attest to at least some lithic production *in situ*. Given the aforementioned hypotheses about the site formation processes, this reflects an anthropogenic composition of the lithic assemblage which is probably not too intensely altered. Similarly, the lack of some components of the *chaines opératoires* seems attributable to a spatial and/or temporal fragmentation of the activities undertaken in the site rather than to differential sorting by (post)depositional processes. These preliminary hypotheses will be tested during the excavation of the northern part of the cave and by further detailed spatial analyses. This multidisciplinary approach will certainly help to better determine the sedimentation mechanisms and the mixed human-carnivore status of Unit 4.

Between 1994 and 2011, several new *Homo* fossils were recovered in Unit 4. Laser ablation ICP-MS dating combining ESR and U-series data for modelling U-uptake has given an US/ESR age of 501^{+94}_{-76} ka for a human premolar (Raynal *et al.*, 2010) while OSL measurements indicate an age between 360 and 470 ky for sediments in which it was found (Rhodes *et al.*, 2006). Nevertheless, biostratigraphy and lithostratigraphy point to a greater antiquity, probably towards the lower Middle Pleistocene.

In Oulad Hamida 1 Quarry, archaeological units of GDR (Raynal *et al.*, 1993) gave evidence of human occupation that occurred during a global low sea level (Figure 4A). Lithic raw materials recovered from these units include Cambrian quartzites and

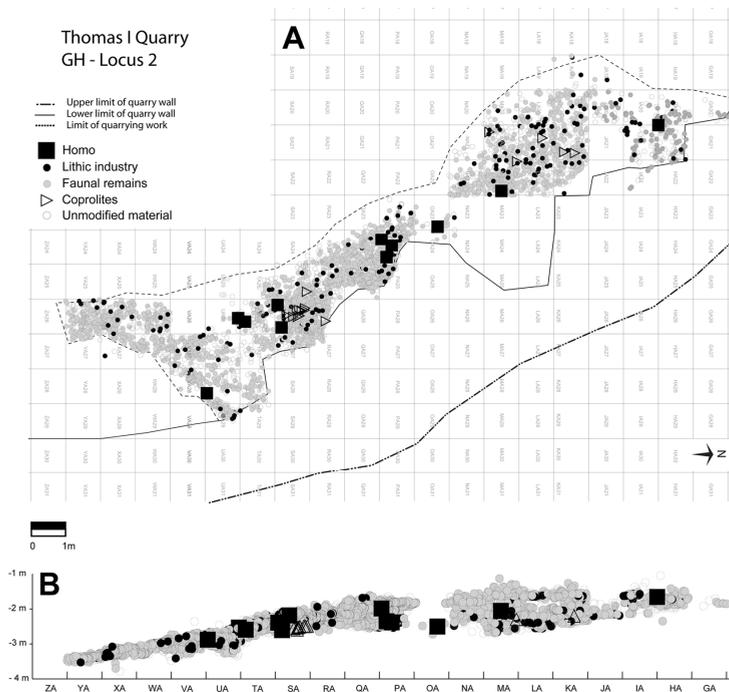


Figure 3. Thomas Quarry I. GH: map (A) and vertical distribution of findings (B) in Unit 4 (© R. Gallotti).

feldspathic sandstones, available as pebbles and cobbles from outcrops and paleo-beaches between Casablanca and Dar Bouazza. Containing flakes, cores, a few retouched tools, rare cleavers and numerous bifaces of various shapes and sizes, this assemblage was referred to a facies of the Acheulean complex in which various methods were used to produce stone flakes. Several refittings attest to a lithic *in situ* production in the upper archaeological units. There is no evidence of fire use. The associated macrofauna (with a huge proportion of rhinoceros remains) (Figure 4B) and microfauna (Geraads, 1993, 1994) are the richest known for this period in North Africa. From an ecological point of view, rodents from arid environments and large mammals indicate an open and dry landscape. On bio-stratigraphical criteria deduced from the study of the rodent assemblage, GDR is probably slightly more recent than GH. Samples from the enamel of four large and well-preserved teeth of *Ceratotherium mauritanicum* (Pomel) were used for ESR measurements (Rhodes et al., 1994, 2006). The mean ages calculated are 435 ± 85 ka for early uptake of U, and 737 ± 129 ka for linear uptake and the true age probably lies between these two estimations and confirms their position within the first half of the Middle Pleistocene.

Methods

Taxonomic and anatomic identities and the type of damage evident were recorded for each specimen. For each faunal assemblage, we determined the total remains (NR), the number of identified specimens (NISP), the minimum number of elements (MNE) and the minimum number of individuals (MNI) (Binford, 1984; Lyman, 1994). Parameters

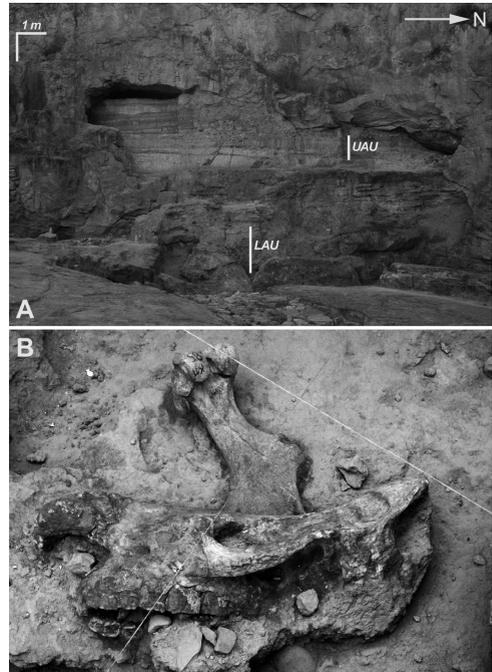


Figure 4. Oulad Hamida 1 Quarry. GDR: large view of the cave (A) and close view of rhinoceros fossils and quartzites artefacts in lower archaeological Unit (B) (© J.P. Raynal).

recorded for the bone samples included the number of remains, the area of excavation from which they were recovered, the impact of differential preservation (MAU percentages of each anatomical element compared with its bone bulk density) and the anatomical elements yielding similar MNI values.

Bone surfaces were studied with the naked eye and under low power magnification with a binocular microscope. We recorded types and locations of relevant modifications observed on surfaces including those made by rodents, carnivores or hominins as well as chemical and mechanical modifications. Identification of these was based mainly on the criteria defined by Maguire *et al.* (1980),

Brain (1981), Binford (1981), Haynes (1983), Lyman (1994) and Blumenshine *et al.* (1996).

We distinguished trampling marks from butchering marks using the works of Binford (1981), Shipman & Rose (1983, 1984), Behrensmeier *et al.* (1986), Olsen and Shipman (1988), Blasco *et al.* (2008) and Dominguez-Rodrigo *et al.* (2009). Two kinds of butchering marks were recorded distinguished by the type of force applied and the manner in which the cutting-edge of the lithics has been applied (Lyman, 2008). Sawing and slicing marks or incisions involve application of force parallel to the long axis of the cutting edge of the tool. Scraping marks are produced when force is applied perpendicular to the long axis of the implement's working edge, resulting in numerous shallow marks oriented in a single direction. This type of marking is often related to periosteum removal or to extraction of meat remnants attached to the bone (see Blumenshine *et al.*, 1996; Dominguez-Rodrigo, 2002; Saladié *et al.*, 2011). Third kind of butchering mark listed by Lyman (2008) as 'chopping marks' with percussion marks because of the dynamic loading evidenced by them. Once the types of cut-marks were recorded, their location and morphology may indicate the butchering activity related to them including evisceration; skinning; dismemberment; disarticulation; periosteum removal; cutting tendons and defleshing (Binford, 1981; Nilssen, 2000; Pobiner *et al.*, 2008).

We classified carnivore marks as follows: pits (shallow depressions whose bottom is compact bone), punctures (deep holes whose bottom is cancellous bone), scores (longitudinal and parallel shallow scratches that usually run perpendicular to the longitudinal axis, and whose bottom is compact bone), furrows (deep and wide grooves with irregular margins whose bottom is cancellous bone

tissue), notches (semi-circular removal due to the puncturing of the bone), corrosion by gastric acids (corroded and polished surfaces and edges). Pits and punctures are circular, or elongated (at least twice longer than wide) (adapted from Binford, 1981; Campmas & Beauval, 2008; Haynes, 1983a).

We took measurements of the dimensions of pits, punctures, scores and notches (maximal length and breadth) into account, as well as tissue location (cancellous bone or articular portions; cortical or median diaphysis; thin cortical bone or diaphysis extremity). While insufficient is taken alone, measuring the tooth-marks (especially maximal dimensions) is the most accurate method for establishing the body size of the predator (Campmas & Beauval, 2008; Coard, 2007; Delaney-Rivera *et al.*, 2009; Domínguez-Rodrigo & Piqueras, 2003; Faith, 2007; Pickering *et al.*, 2004; Selvaggio & Wilder, 2001). We also measured the coprolites (length, breadth and thickness).

The dimensions of broken elements were recorded and an identification of what had produced them was made based on the fracture shape, feature, angle and associated marks (Villa & Mahieu, 1991; Blumenshine & Selvaggio, 1988, 1991).

Ontogenic age of prey specimens is based on dental eruption/replacement patterns and wear. We established four age groups: juveniles (with deciduous teeth), young adult (with erupted P4 and M3), prime adults (with moderately worn P4 and M3) and old (with heavily worn teeth) (Grant, 1982; Klein & Cruz-Uribe, 1984; Bénatia, 1998; Munro *et al.*, 2009).

We distinguished four mammal size classes (Table 1) (modified from Bunn, 1982, 1986; Brain, 1981; Brugal *et al.*, 1997; Rodríguez, 1997; Huguet *et al.*, 1999).

In order to represent anatomical segments in terms of their "nutritious value"

and following the first stages of carcass dismemberment, they were sorted according to percentage of Minimal Number of Animal Unit (% MAU, Binford, 1984) using seven main divisions: head (skull, mandibles, isolated teeth excepted); axial elements (vertebrae, ribs); forequarter (scapula, humerus, radio-ulna); forefoot (carpal, metacarpal); hindquarter (pelvis, femur, tibia, patella); hindfoot (tarsal, metatarsal); indeterminate foot (phalanges, sesamoidal, metapodials) (after Wilson, 1989, modified).

To discuss the processes of accumulation whether from hunting, scavenging or natural actions, the following studies were used: Hill (1980), Binford (1984), Klein & Cruz-Uribe (1984), Blumenshine (1986, 1988), Cruz-Uribe (1991), Brugal *et al.* (1997), Fosse *et al.* (1999), Pickering (2002) and Coumont (2006).

Data

All the faunal data resulted from our own analysis of the material extracted during the recent excavations. The taphonomical analysis of the assemblages of the two sites is in

progress so the data are preliminary. The sieved remains have not been studied yet but identified specimens and coprolites have been taken into account. At GH, the taphonomical study of the macrofauna is that from Unit 4, excavated since 2005. This series, unearthed between 2005 and 2009, has been reported on previously (Raynal *et al.*, 2010, 2011) and includes 921 identified remains. In the present study we analysed a total of 764 recorded faunal remains from GDR, but we focused on those excavated in 2009, from a surface of 16 square metres, in the lower part of the sequence from which came 567 identifiable remains.

The Grotte à Hominidés (GH)

In the faunal spectrum, gazelles (*Gazella cf. atlantica*) and Alcelaphini (including the extinct genus *Parmularius*, and the wildebeest, *Connochaetes*) are dominant among bovids and a middle-size jackal, *Lupulella mohibi* (see Geraads, 2011), dominates the carnivore group. Several other mammals complete the faunal list, such as the Bovini (*Bos* or *Pelorovis*); white rhinoceros (*Ceratotherium*);

Size classes (GH-GDR)	Weight (kg)	Brain, 1981 (Bovids)	Brugal <i>et al.</i> , 1997 (Ungulates)	Taxa (GH-GDR) (mammals)
Size 1	0-114 kg	Bovids sizes 1-2	Size 1: Small bovids	<i>Gazella</i> , <i>Redunca</i> , <i>Phacochoerus</i> , juvenile bovids indet. and equids, hyenids, canids, mustelids, <i>Felis</i> , <i>Theropithecus</i> , hominins
Size 2	114-300 kg	Bovids size 3	Size 2: Medium bovids+small equids	<i>Oryx</i> , <i>Connochaetes</i> , <i>Parmularius</i> , <i>Equus</i> , <i>Ursus</i> , <i>Monachus</i> , <i>Panthera</i>
Size 3	300-1000 kg	Bovids size 4	Size 4: Large bovids	<i>Bos</i> , <i>Pelorovis</i> , <i>Camelus</i> , juvenile <i>Ceratotherium</i>
Size 4	> 1000 kg		Size 5: very large ungulates	<i>Adult Ceratotherium</i>

Table 1. Mammal weight categories used at GH and GDR.

zebras; suids; bears; hyenids; panthers; cats; seals and honey badgers. The largest rodents are the porcupines and the largest primates are humans and giant baboons (*Theropithecus*). The high percentage of carnivores remains (NISP and MNI) and the numerous coprolites are characteristic of a den accumulation (Table 2) (Klein & Cruz-Uribe, 1984; Cruz-Uribe, 1991; Fosse, 1999; Pickering, 2002).

Apart from encrusted remains, the majority of bone surfaces and edges have been preserved from post-depositional alteration and allow an identification of marks. The number of isolated teeth implies a high bone destruction index. Fragmentation of the assemblage is intensive. The completeness index is high, but this is mainly due to the presence of small joint bones (Table 2). Very few ungulate long bones are complete. Most of the diaphyses retain less than a half of their length preserved, but almost one third retain their complete circumference, which is also consistent with an accumulation by carnivores (Table 3) (see references above). Green bone fractures are numerous (19.1% of the number of georeferenced remains excluding isolated teeth) and are mostly associated with carnivore tooth-marks. The articular portions of long bones have been mostly spared from gnawing (Table 2). The epiphysis/diaphysis rate is high and *a priori* inconsistent with those of hyena dens (Blumenschine, 1988; Fosse, 1999). However, in some European Pleistocene dens that were recently excavated and studied, the long bone articular portions appear well represented (Villa *et al.*, 2004; Discamps, 2011). Nevertheless, at GH the predominance of the middle-sized canid among carnivores, whose masticatory power is less than that of the hyena could be partly responsible for the preservation of these bone parts.

Regarding the skeletal profiles, for small bovids (sizes 1 and 2 according to

Brain, 1981), heads and upper limb elements are best represented, whereas for larger bovids (size 3), axial and limb elements are dominant (Figure 5). The regular transportation of heads for smaller animals is consistent with fossil carnivore accumulations (Klein & Cruz-Uribe, 1984 and see methods). Among ungulates, gazelles and Alcelaphini every age class is represented (Table 4). For those bovids, data tend to confirm a predation and transportation of either whole carcasses or some selected elements. Other ungulates, such as Bovini, rhinocerotids, equids or suids, are mostly represented by elements of the autopod and by some isolated teeth, which is indicative of gathering activities over scavenged carcasses. These remains include juveniles or aged specimens, either derived from selective hunting (among the most vulnerable individuals) or from natural death (Stiner, 1990; Cruz-Uribe, 1991).

Of the recorded bones, 19.5% bear carnivore tooth marks (Table 5). This proportion is similar to that obtained in fossil hyena dens and is higher than in sites that are just visited by canids (Cruz-Uribe, 1991; Coumont, 2006). The virtual absence of carnivore deciduous teeth does not support the den hypothesis, but it is impossible to determine the exact cause of this underrepresentation that may be due to *in situ* differential preservation. On the other hand, if we use data from actualistic approaches, the great variability observed in accumulation patterns among modern hyena dens may temper the previous interpretations (Brugal *et al.*, 1997; Egeland *et al.*, 2008; Lansing *et al.*, 2009).

The distribution of the bite marks on the long bones is homogeneous, which indicates the primary action of carnivores on carcasses (Table 6) (Blumenschine, 1988). Although the wide diversity of tooth marks measurements could indicate involvement of a multiplicity

Table 2. Relative abundance and bone indices for the large fauna at GH (NISP; Number of Identified Specimens. NISP_a; Number of anatomically Identified Specimens. NR; Number of total Remains. MNI; Minimum Number of Individuals per taxon; Bone destruction index= isolated teeth/NISP_a).

Taxa (GH - THI)	MNI	%MNI	NISP	%NISP
<i>Hystrix</i> sp.	3	5.8	30	4.8
RODENTIA	3	5.8	30	4.8
<i>Felis</i> cf. <i>libyca</i>	1	1.9	1	0.2
<i>Panthera</i> sp.	1	1.9	1	0.2
Hyaenidae	2	3.8	7	1.1
<i>Lupulella mohibi</i>	8	15.4	179	28.6
<i>Ursus bibersoni</i>	2	3.8	12	1.9
<i>Mellivora capensis</i>	1	1.9	1	0.2
<i>Monachus</i> sp.	1	1.9	1	0.2
CARNIVORA	16	30.8	202	32.3
PROBOSCIDEA	1	1.9	1	0.2
<i>Ceratotherium</i> sp.	1	1.9	6	1.0
<i>Equus</i> sp.	1	1.9	4	0.6
PERISSODACTYLA	2	3.8	10	1.6
<i>Kolpochoerus</i> sp.	1	1.9	1	0.2
<i>Phacochoerus africanus</i>	1	1.9	1	0.2
Bovini	5	9.6	39	6.2
Hippotragini	1	1.9	1	0.2
Reduncini	1	1.9	1	0.2
Alcelaphini	7	13.5	123	19.6
<i>Gazella</i> cf. <i>atlantica</i>	11	21.2	210	33.5
ARTIODACTYLA	27	51.9	376	60.1
<i>Homo</i> sp.	2	3.8	4	0.6
<i>Theropithecus oswaldi</i>	1	1.9	3	0.5
PRIMATES	3	5.8	7	1.1
Total	52	100.0	626	100.0
NISP _a	921			
NR coordinated	1296			
Isolated teeth	349			
Bone destruction Index	37.9%			
Illegibility	8.3%			
Epiph./Diaph.	0.4			
Completeness Index	31.7%			
Coprolites	78			

Table 3. Long bone fragmentation at GH (L1<1/4 Li; 1/4<L2<1/2 Li; 1/2<L3<3/4 Li; L4>3/4 Li; Li: initial diaphyseal length).

Length	L1	L2	L3	L4
%	52.4	31.0	7.7	8.9
Circumference	C1	C2	C3	
%	67.1	5.2	27.6	

of carnivores involved at GH, figure 7 indicates that a single carnivore group such as hyenas alone can produce such variability (Figures 6 and 7). Nevertheless the means and standard deviations of these measurements are close to those derived from jackals but slightly higher, highlighting the actions of the small canid *Lupulella mohibi* while not ignoring the bigger carnivores like hyenas or to a lesser extent, large felids (see references above). The dimensions of the coprolites confirm that bone-eaters of different sizes were using the cave, large (hyenas) and middle-sized carnivores (other canids) and porcupines (Figures 8 and 9) (Brugal, 2010; Chame, 2003; Gaudzinski, 2004; Horwitz & Goldberg, 1989). Porcupine tooth marks can be observed on 5.1% of recorded bones. Some of them are completely gnawed and reduced to an unidentified compact piece (Figure 10). To date, no cut-marks have been found, which raises the question of the role played by humans in the bone accumulations. A human femoral diaphysis with gnawing of both articular portions yields new data on the presence of human remains in this cavity.

At GH, the state of bone fragmentation, the abundance of carnivores remains and of their marks on the long bones prompts us to attribute the major part of the bone accumulation and its modification, including those made to human remains, to different sized carnivores,

and a small part to the activity of porcupines. However, as the studied assemblage comes from deep inside the cave, any human occupation of the site may well have been concentrated closer to the entrance in a zone at the western end which has not been excavated yet.

The Grotte des Rhinocéros (GDR)

More than 50 vertebrate taxa are present, similar to those present at GH, and they also indicate a surrounding open environment. Among herbivores, Alcelaphini dominate the spectrum, followed by gazelles and rhinoceros (*Ceratotherium*), and by equids and Bovini (Table 7). Carnivores, which represent 25.6% of the MNI but only 9.6% of the NISP, are diverse and include the middle-sized canid *Lupulella mohibi*, less common than at GH, and hyenas, bears, panthers, cats and honey badgers. Porcupines are present. Humans are represented by an isolated tooth only and the giant baboon is present. Only four coprolites have been recovered.

The bone destruction index and the unreadable condition of bone surfaces are much lower than in GH, which is consistent with its overall better preservation (Table 7).

Fragmentation state differs significantly from that of GH. Small unidentified fragments (L1) are less numerous but the completeness indexes (entire bones and complete shaft circumferences) are lower (Tables 7 and 8). Almost half of the bones have green bone fractures. Among them only 3% show percussion marks, while 9% have carnivore bite marks and 5% modification by porcupine. Marrow extraction by carnivores (but also to a lesser extent by humans), was a common occurrence in carcass consumption.

For all bovid taxa sizes 1 to 3, heads and upper limb elements are the most represented.

Figure 5. Skeletal elements distribution (MAU) for different Bovid sizes at GH and GDR (see Methods and material for categories).

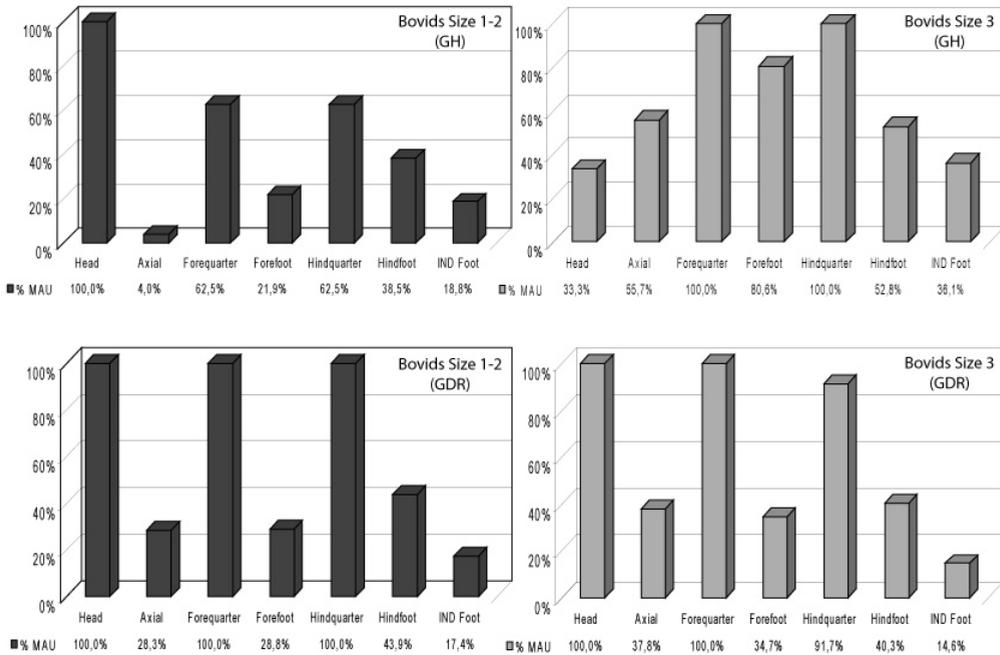


Table 4. MNI for every age category of the main ungulates at GH.

GH - THI	Juvenile	Young adult	Prime adult	Old adult	Senile	Total MNI
<i>Gazella</i>	3	2	3	2	1	11
Bovini	2	1	1	1		5
Alcelaphini	2	1	2	1	1	7
Reduncini			1			1
<i>Ceratotherium</i>					1	1
<i>Equus</i>				1		1
<i>Kolpochoerus</i>		1			1	2

GH - THI	%NRc	%NRp	NR
<i>Lupulella</i>	6.2	1.2	81
Bovidae S4	40.7	7.4	27
Bovidae S3	25.9	7.4	81
Bovidae S1-2	23.8	4.0	126
Total NR	19.5	3.8	816

Table 5. Percentages of bone remains with carnivore marks (NRc) or porcupine marks (NRp) (NR; Number of coordinated and readable remains).

Some axial and distal limb elements are present. The transportation of heads for size 3 bovids, unlike the situation at GH, may indicate some human input into the accumulation (Klein & Cruz-Uribe, 1984).

Gazelles and Alcelaphini are represented by almost every age class (Table 9), indicating predation and the transportation of heads and at least some portion of the rest of the carcass attached or of some whole carcasses. Rhinoceros and Bovini are represented by a majority of either juveniles or old specimens. Some long bones and axial elements of these were recovered but there are very few of them, especially for rhinoceroses, taking into account that there are three complete or nearly complete skulls (15 for the whole site) (Figure 11). For those big animals, data suggest *in situ* scavenging of animals with the possible export of some limb elements.

Carnivore marks are less common than at GH, appearing on 16% of recorded bones (Table 10; Figure 12). Measurements of tooth marks closely match those of GH, being marginally lower. Perhaps this situation indicates the combined action of carnivores of various sizes (Figures 6 and 7). Some ingested bones and large coprolites indicate the presence and activity of big carnivores

(Figure 8). Porcupines gnaw marks are much more common than at GH appearing on 13% of the samples. Cut marks are present at a rate of 5% of the samples (Table 10). Future experimental and characterization studies of these butchery marks will provide us with more data on subsistence strategies and type of raw material used. All ungulate have bones modified by cut marks but size 3 bovids seem to have been the most favoured by humans. Some elements have a variety of differing marks (Figure 13). Butchery marks are widespread along diaphyses, a characteristic of an early access to the carcasses, whereas porcupine and carnivore tooth marks are present both on diaphyses and articular portions suggesting some secondary actions (Tables 11, 12 and 13). Only two bones with overlapping marks were documented. In these two instances pits appear to have been made prior to the other marks (Blasco & Rosell, 2009). Evidence for numerous steps in the butchery process are evident, such as defleshing, dismembering of the hind feet, cutting of the tendons and muscle attachments.

For GDR, our current data are insufficient to clarify the accumulation processes for the bones but we can assume that the accumulations and processing of carcasses was undertaken by various carnivores, humans

Table 6. Distribution of carnivore toothmarked zones (NZc) along the bovids shafts at GH.

GH -THI	Epiphyses			Shaft ends			Median diaphyses		
	NZc	NZ	%NZc	NZc	NZ	%NZc	NZc	NZ	%NZc
Bovidae S4	2	5	40.0	0	1	0.0	1	2	50.0
Bovidae S3	7	16	43.8	3	10	30.0	4	13	30.8
Bovidae S1-2	7	15	46.7	6	19	31.6	7	22	31.8
Total	16	36	44.4	9	30	30.0	12	37	32.4

Figure 6. Maximal length and breadth (mm) for pit marks on cortical bone at GDR (n=44 pits) and GH (n=23).

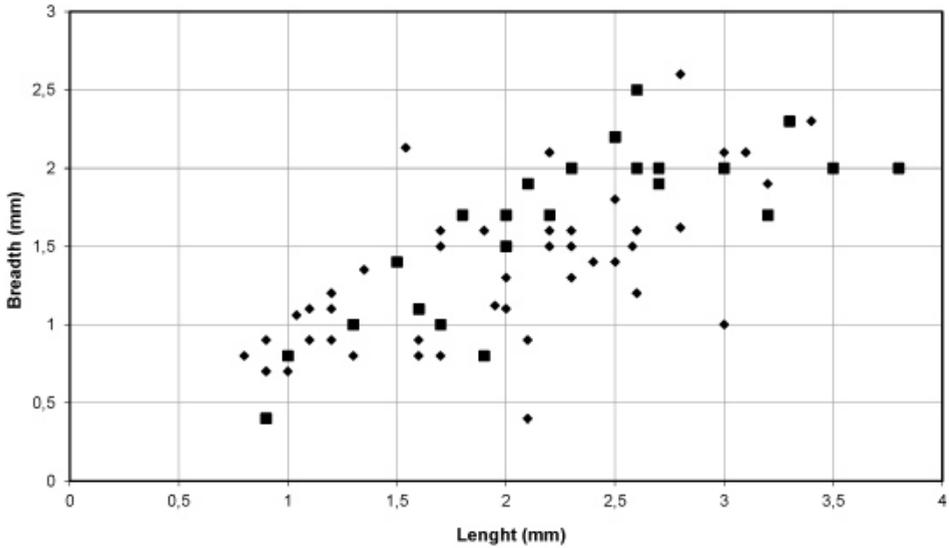


Figure 7. Mean percentages and S.D. of pit sizes on cortical bone. Samples with (*) have been taken from Selvaggio & Wilder (2001) and samples with (**) from Dominguez-Rodrigo & Piqueras (2003) for comparative purposes.

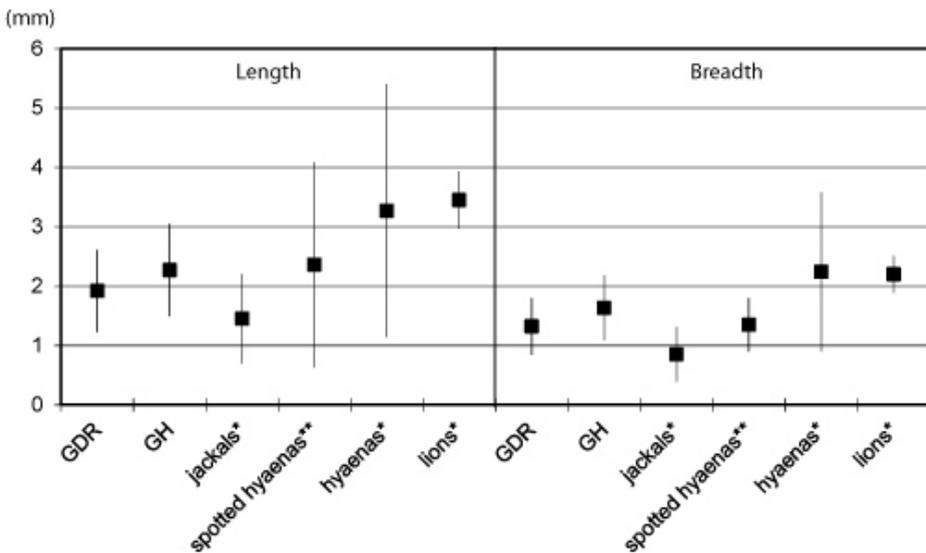
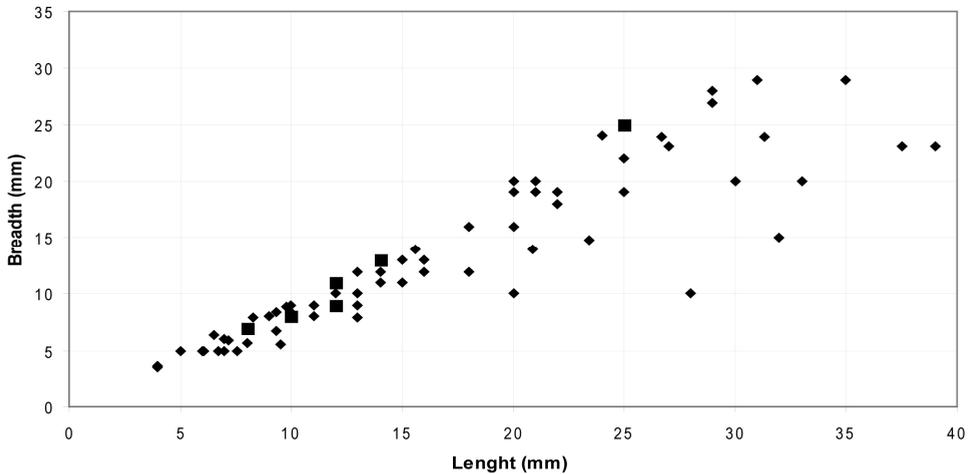


Figure 8. Maximal length and breadth (mm) for coprolites of GH (n=74) and GDR (n=9; squares).



and porcupines, perhaps in competition with each other but it may be that some animals (that perhaps fell through pitfalls) died in the cave.

Discussion

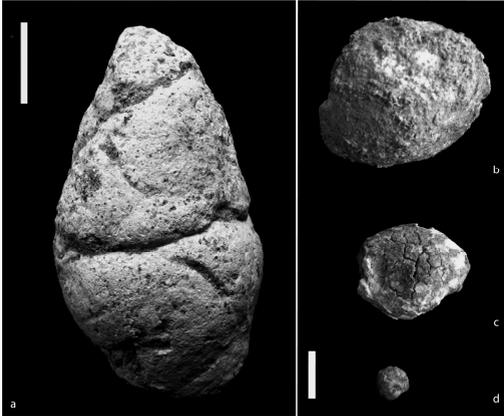
In the early Middle Pleistocene, hunting hyenas and hyper-carnivora (sabre cats) disappeared while the hyenids/canids complex became dominant on both sides of the Mediterranean. Effective carrion providers were replaced by carcass consumers so that competition for and access to resources became harsher and more difficult. This period is contemporaneous with the first indications for hunting of large ungulates by humans (see Garcia, 2001; Stiner, 2002; Brugal & Fosse, 2004; Rabinovitch *et al.*, 2008; Stiner *et al.*, 2009). Species subject to competition for scarce resources developed avoidance strategies and ecological movements that allowed their coexistence with their competitors. For instance, it is well-known that the

processing of an ungulate carcass can be partitioned between a top predator (like wolves, lions or leopards), confrontational scavengers (like spotted hyenas, which are also capable predators), non-confrontational scavengers (like brown and striped hyenas) and a hominin scavenger, reducing levels of inter-specific competition (Brantingham, 1998), and such partitioning may well have included more levels in the past (Geraads & Daujeard, 2011).

In North Africa, at GH, artefacts and human remains were associated with a faunal assemblage which seems exclusively accumulated by carnivores. At GDR, numerous rhinoceros remains were closely associated with a rich Acheulean industry.

The Middle Pleistocene sites of Casablanca highlight the sharing of the ecological niches by carnivores (hyenids, felids, canids, ursids, mustelids), porcupines and hominids, which is also observed in early Plio-Pleistocene sites of South Africa (Sterkfontein, Swartkans, Makapansgat among others; Brain, 1981; Maguire *et al.*, 1980;

Figure 9. Different-sized coprolites in GH - Unit 4. a, b: of a big carnivore (hyenids?); c: of a middle-sized carnivore (canids?) and d: of a small mammal (porcupine?) (© C. Daujeard).



Pickering *et al.*, 2002, 2004a, 2004b, 2004c; Kuman *et al.*, 2005).

The modifications observed on the faunal remains indicate also the sharing of resources by the different actors. The impact of humans on the faunal remains seems to have been of lesser importance than the impact made by carnivores and porcupines, although the human impact is not congruent with both examples.

The spatial and taphonomical analyses and the cut-marks on almost 40 specimens at GDR provide evidence for a direct association between lithic artefacts and some of the faunal remains but were the bones bearing cut marks gathered as carrion (of either primary or secondary access) or were they derived from direct predation activities? Whatever the scenario was, the butchering marks reveal that early hominins in Atlantic Morocco carried out part of their subsistence activities within the caves, like other species that consumed bone marrow and meat. Subsistence activities of human clearly took place in the cave and these include production of lithic artifacts and their use on animal portions, whether gathered or derived from hunting.

In contrast at GH, the numerous human remains, with one modified by carnivores, indicate a locational proximity and likely close interaction between humans and large carnivores which probably competed for the same preys and used the same natural shelters. The modification of a human bone by a large carnivore shortly after death (when the bone was still fresh) indicates that humans were likely to have been an occasional food resource for other predators and so their

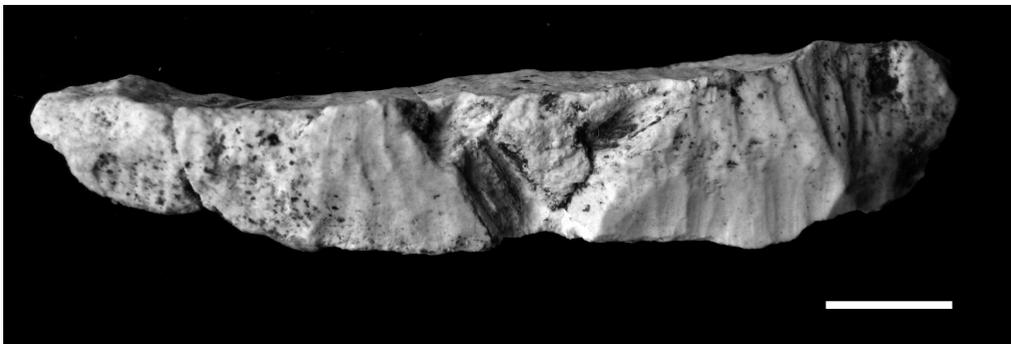


Figure 10. Unidentified compact bone damaged by porcupines at GH (scale=1 cm) (© C. Daujeard).

Table 7. Relative abundance and bone indices for the large fauna at GDR (see Table 2 for abbreviations).

Taxa (GDR)	MNI	%MNI	NISP	%NISP
<i>Hystrix</i> sp.	2	4.7	9	2.2
RODENTIA	2	4.7	9	2.2
<i>Felis</i> sp.	1	2.3	2	0.5
<i>Panthera</i> sp.	1	2.3	1	0.2
Hyaenidae	3	7.0	8	2.0
<i>Lupulella mohibi</i>	4	9.3	24	5.9
<i>Ursus bibersoni</i>	1	2.3	1	0.2
<i>Mellivora</i> sp.	1	2.3	3	0.7
CARNIVORA	11	25.6	39	9.6
<i>Ceratotherium</i> sp.	8	18.6	76	18.7
<i>Equus</i> sp.	1	2.3	6	1.5
PERISSODACTYLA	9	20.9	82	20.1
Bovini	2	4.7	12	2.9
Bovidae S4	–	–	6	1.5
Alcelaphini	10	23.3	73	17.9
Bovidae S3	–	–	67	16.5
<i>Gazella</i> cf. <i>atlantica</i>	8	18.6	86	21.1
Bovidae S1-2	–	–	32	7.9
ARTIODACTYLA	20	46.5	276	67.8
<i>Homo</i> sp.	1	2.3	1	0.2
PRIMATES	1	2.3	1	0.2
Total	43	100.0	407	100.0
NR coordinated	764			
Isolated teeth	94			
Bone destruction Index	16.6%			
Illegibility	7.5%			
Epiph./Diaph.	0.36			
Completeness Index	16.2%			
Coprolites	4			

Table 8. Long bone fragmentation at GDR (see Table 3 for abbreviations).

Length	L1	L2	L3	L4
%	38.2	44.6	8.8	8.3
Circumference	C1	C2	C3	
%	77.2	7.5	15.3	

Table 10. Percentages of bone remains with carnivore marks (NRc), porcupine marks (NRp) or butchering marks (NRb) (NR; Number of coordinated and readable remains).

GDR 09	%NRc	%NRp	%NRb	NR
<i>Ceratotherium</i>	35.3	29.4	2.9	34
<i>Equus</i>	1/6	2/6	2/6	6
Bovidae S4	23.5	29.4	5.9	17
Bovidae S3	24.1	18.1	15.5	116
Bovidae S1-2	15.1	14.2	5.7	106
Total NR	16.0	12.7	5.4	613

Table 9. MNI for every age category of the main ungulates at GDR.

GDR 09	Juvenile	Young Adult	Prime Adult	Old Adult	Senile	Total MNI
<i>Ceratotherium</i>	2	1	1	2	2	8
Bovini	0	0	0	1	0	1
<i>Gazella</i>	2	0	2	2	2	8
Alcelaphini	3	2	1	2	2	10

Figure 11. Skeletal elements distribution (MAU) for rhinocerotids at GDR (see Methods and material for categories).

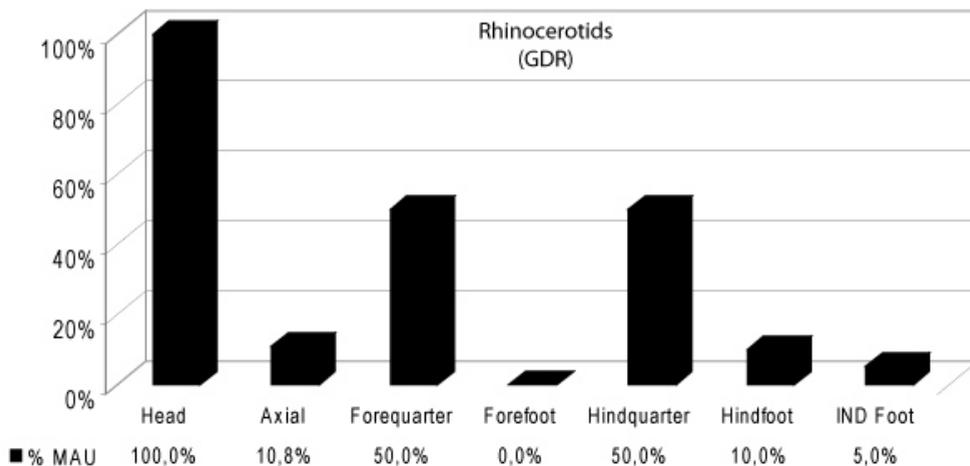


Figure 12. An Alcelaphini metacarpal with carnivore tooth-marks on its proximal diaphysis at GH (© C. Daujeard).



place within the food chain ranged between predator or scavenger and prey or carrion. Human presence in the cave, besides sheltering, consisted certainly of lithic artefacts production, while other subsistence activities still need to be deeper investigated.

Conclusion

These preliminary inferences on competition for resources and living areas by carnivores and humans in Atlantic Morocco during the Middle Pleistocene will certainly be enriched by excavations in progress and forthcoming detailed studies about lithic

production and use-wear analysis in these sites.

At GH, bones bearing cut-marks are absent from the sample despite the occurrence of lithic artefacts and human remains. Given the high proportion of carnivores and rodent marks on bones the question of the relationship between hominins and other competitors in this cave needs further examination. Hominins were occasionally preyed upon by carnivores and their place within the food chain ranged between predator or scavenger and prey or carrion. At GDR, the numerous artefacts associated with cut and tooth-marks demonstrate that this cave was shared by both humans and carnivores, and indicates clearly and for the first time, that early hominins

Table 11. Distribution of carnivore toothmarked zones (NZc) along the ungulate shafts at GDR.

GDR 09	Epiphyses			Shaft ends			Median diaphyses		
	NZc	NZtot	%NZc	NZc	NZtot	%NZc	NZc	NZtot	%NZc
Bovidae S4	0	5	0.0	2	6	33.3	1	5	20.0
Bovidae S3	6	18	33.3	8	32	25.0	13	47	27.7
Bovidae S1-2	6	19	31.6	4	26	15.4	3	23	13.0
Equidae	0	2	0.0	1	6	16.7	0	4	0.0
Rhinocerotidae	4	9	44.4	1	10	10.0	0	5	0.0
Total	12	42	28.6	14	64	21.9	17	75	22.7

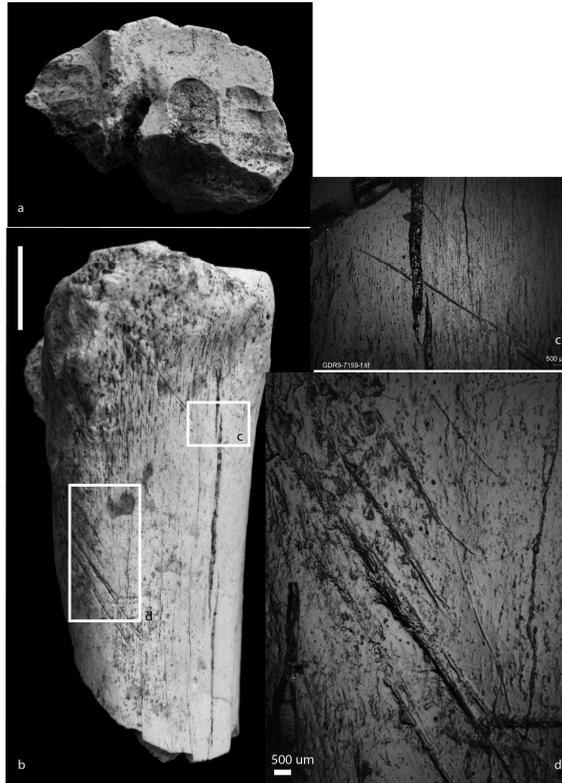
Table 12. Distribution of porcupine toothmarked zones (NZp) along the ungulate shafts at GDR.

GDR 09	Epiphyses			Shaft ends			Median diaphyses		
	NZp	NZtot	%NZh	NZp	NZtot	%NZc	NZp	NZtot	%NZc
Bovidae S4	2	5	40.0	0	6	0.0	2	5	40.0
Bovidae S3	1	18	5.6	7	32	21.9	9	47	19.1
Bovidae S1-2	3	19	15.8	3	26	11.5	3	23	13.0
Equidae	0	2	0.0	1	6	16.7	1	4	25.0
Rhinocerotidae	4	9	44.4	2	10	20.0	1	5	20.0
Total	10	42	23.8	13	64	20.3	16	75	21.3

Table 13. Distribution of cutmarked zones (NZb) along the ungulate shafts at GDR.

GDR 09	Epiphyses			Shaft ends			Median diaphyses		
	NZb	NZtot	%NZb	NZb	NZtot	%NZb	NZh	NZtot	%NZb
Bovidae S4	0	5	0.0	0	6	0.0	0	5	0.0
Bovidae S3	1	18	5.6	8	32	25.0	5	47	10.6
Bovidae S1-2	0	19	0.0	3	26	11.5	2	23	8.7
Equidae	0	2	0.0	1	6	16.7	1	4	25.0
Rhinocerotidae	0	9	0.0	0	10	0.0	0	5	0.
Total	1	42	2.4	12	64	18.8	8	75	10.7

Figure 13. An Alcelaphini (cf. Connochaetes) metacarpal with porcupine tooth-marks (a) and butchering marks (b, c and d) on its proximal end at GDR(© G. Merceron and C. Daujeard). On photo c, the gap between the striations on both sides of the crack attests to their antiquity. On the photo d, some cut-marks are fork-shaped marks, which are characteristic of marks produced by handaxes (De Juana et al., 2010).



have occupied the caves of Atlantic Morocco and carried out subsistence activities in them.

The occupation of these two sub-contemporaneous sites shines new light on the proximity between and the close interaction of humans and carnivores. Cases of bones accumulations with a mixt origin have already been described in the Plio-Pleistocene of the Mediterranean area, but the faunal series from the Moroccan sites of GH and GDR at Casablanca demonstrate the sharing of the caves by carnivores, rodents and humans

during the North African Middle Pleistocene. In these sites, absence or scarcity of butchery marks on the bones makes a human role in their accumulation appear less important than that of other competing carnivores. Ongoing excavations in the Middle Pleistocene of Atlantic Morocco and a spatial multidisciplinary analysis of the finds distributions in the caves will doubtless further substantiate these preliminary inferences on competition for resources and ecological niches by carnivores and humans.

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