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Large mammals from the Upper Pleistocene at Tamaris I 'Grotte des gazelles' (Casablanca, Morocco): paleoecological and biochronological implications

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Gazelle Cave at Tamaris I in the region of Casablanca was discovered as a result of construction work. The cave is a dissolution pocket in marine calcarenite and contains an Upper Pleistocene deposit. Paleontological examination of the large mammal remains of this deposit revealed the presence of 15 species dominated by herbivores. There are also some human remains along with lithic artefacts and a rich collection of non-mammalian vertebrates (amphibians, reptiles and birds), as well as micromammals (Chiroptera, insectivores, lagomorphes and rodents). As yet only the large mammal remains have been studied in detail. The mammalian fauna indicates a semi-arid savannah-type environment. Because the sediments were deposited by natural rather than anthropogenic processes, the taxa in the cave are representative of the faunal spectrum in the region during the time of deposition.

Keywords: Tamaris I 'Grotte des gazelles'; large mammals; Upper Pleistocene; Morocco

Introduction

The Moroccan coast, and particularly the part located between Kenitra and Casablanca, is well-known internationally for the numerous prehistoric sites discovered there since the middle of the last century. The coastal zone in this area is distinguished by a pattern of large terraces of marine and eolian origin that are roughly parallel to the coastline (Lefèvre and Raynal 2002). These marine terraces are associated with intertidal, supratidal and dune deposits, characterising regressive sequences (karsts and paleosols) and stratified reshuffling from 180 to 0 m (niveau général de la mer en français) NGM. Similar terraces constitute the long, well-known Casablanca Quaternary sequence (Biberson 1961).

Unlike the Temara region, Casablanca yielded only one Upper Pleistocene site, the 'Grotte des Félins' (Raynal et al. 2008), despite the fact that numerous geological and prehistoric surveys took place in this region. Gazelle Cave or 'Grotte des gazelles' is a new site of the Upper Pleistocene recently discovered in the region of Tamaris I. This site was discovered when a construction project dug through the most recent marine terrace in the sequence. This terrace forms the paleo-cliff that dominates the Oulja from Sidi Abderrahmane to Dar Bou Azza and is the most recent morphosedimentary system of the Casablanca terraces. It is correlated with marine isotope stage 5e (Lefèvre and Raynal 2002), which was proposed as a neo-stratotype of the Ouljian (Biberson 1961).

The cave is located near the village of Makrat in Tamaris I, near the town of Dar Bou Azza about 20 km southwest of Casablanca (Figure 1). It is divided into three dissolution pockets cut in the calcarenite and assigned to the marine Ain Roummana Member of the Dar Bou Azza Formation (Lefèvre and Raynal 2002). This marine deposit is formed by consolidated intertidal and dune deposits (Lefèvre and Raynal 2002), which are about 1.5 m thick and show variable stratification (Texier et al. 2002).

It is an interesting site due to the presence of human remains, lithic materials and particularly rich fauna. The study of the large mammals fossils found here provides new data on the fauna of the Upper Pleistocene on the Casablanca coast, including new information on some taxa such as barbary sheep, *Canis* sp. and gazelle.

The formation of the three pockets in the cave probably resulted from the dissolution of the calcarenite by infiltrating water as evidenced by a small pocket without sedimentary deposit. The 'middle' cave which was excavated is filled with sandy-clay deposits introduced through an opening. These deposits belong to the Lahlalfa Member, a continental member of the Dar Bouazza formation and correspond to isotopic stages 4 to 2e (Lefèvre and Raynal 2002), the Soltanian according to Biberson's chronostratigraphy (1961).

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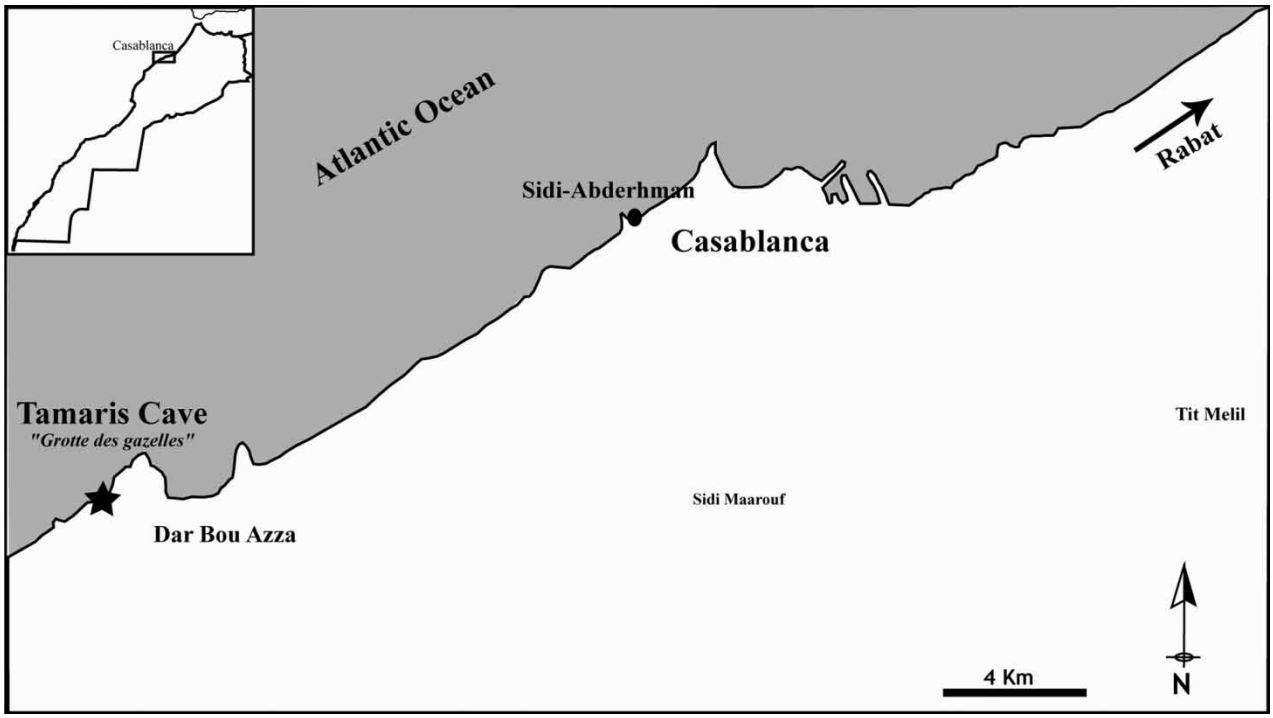


Figure 1. Geographical location of the Tamaris I deposit in the Casablanca region.

Given that the deposits accumulated through natural processes, the faunal spectrum could represent the biotic community in the region. However, because only part of the deposits were recovered (rescue excavations), it is possible that the list of fauna from Gazelle Cave only represents a portion of the fauna in the region.

The fossils come from two different levels: a lower level with fine red and dark sediments and an upper level with blocks and pebbles embedded in lighter-coloured and coarser sediment, particularly rich in vertebrate bones and gastropod shells.

The rescue excavations carried out in the large pocket yielded bones of various vertebrates, including human remains and some stone tools. The human remains consist of two right metacarpals, two right hand phalanges and two medium phalanges of the right foot, all attributed to *Homo sapiens*.

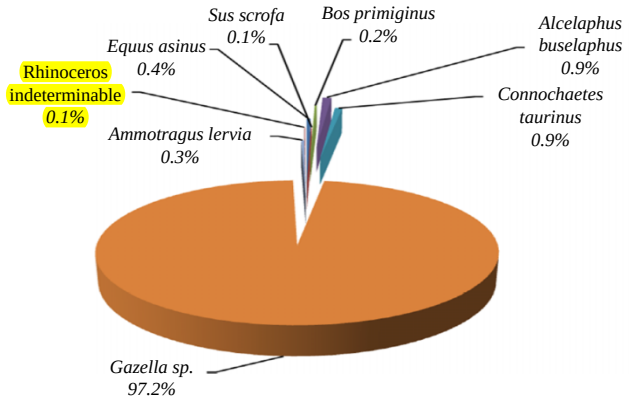
The stone tool industry is scarce in both levels. It consists of some poorly characterised cores and some debris, while retouched tools are very rare. The upper level yielded a retouched edge and a blade fragment. The majority of the artefacts are made from limestone pebbles, but some sandstone and, exceptionally, quartzite or silex are present as well.

Absolute radiocarbon dating of gastropod shells provides ages of 23,500 years BP (Rabat 256) for the lower level and 13,500 years BP (Rabat 258) for the upper level. These dates may be younger than the sedimentary filling as gastropods are burrowing animals and may be more recent than the deposit. It is therefore highly likely that the fossils are older than the dates given by the gastropods.

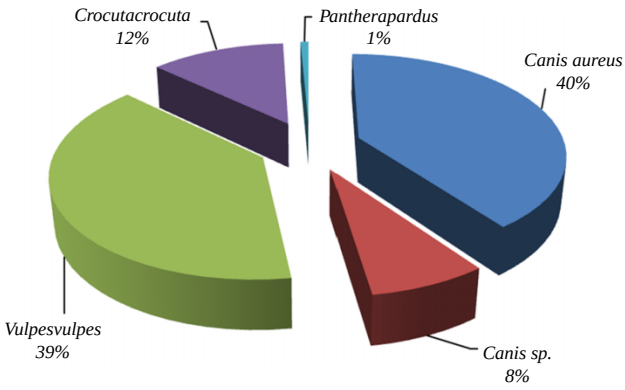
The fossil material of Tamaris I is retained in the Laboratory of Geoscience, Faculty of Sciences Ain Chock of Casablanca, Morocco.

Table 1. Number of remains of large mammals in both levels and MNI in the site.

Taxon	Lower level	Upper level	MNI
C. aureus	2	107	2
Canis sp.	3	18	5
V. vulpes	4	103	4
C. crocuta	1	33	3
P. pardus	–	2	1
Equus cf. *asinus*	1	8	2
S. scrofa	–	2	1
B. primiginus	–	5	1
A. buselaphus	3	19	2
C. taurinus	–	17	2
G. atlantica, *G. cuvieri* and *G. dorcas*	124	2153	30
A. lervia	–	6	2
Rhinoceros	–	3	1
indeterminable			
Number of remains identified	138	2476	–
Total number of remains	175	2838	–
Number of undetermined remains	37	362	–
Rate of determination	78%	87%	–



Percentage of skeletal remains of herbivores.



Percentage of skeletal remains of carnivores.

Figure 2. Percentage distribution of skeletal remains in NRD (number of remains determinable) site Tamaris I.

Fauna

The site of Tamaris I contained a wealth of material including large mammals, which are represented by 15 taxa (Table 1). This fauna is dominated by bovids (94%) of which most are gazelles (97%) (hence the name), Alcelaphinae (2%), *Bovini* (0.2%) and a Caprinae (0.3%) identified as *Ammotragus lervia*. Other herbivores are very rare, including representatives of Suidae (0.1%), Equidae (0.5%) and a Rhinocerotidae (0.1%) (Figure 2). Herbivores dominate the fauna while carnivores represent only 6% of the specimens. The carnivores can be divided into three families, Canidae (87%), Hyaenidae (12%) and Felidae (1%) (Figure 2).

The upper level contains a greater number of taxa and faunal remains. Six taxa present in the upper level are absent in the lower level (Table 1).

Other groups were also identified, such as Leporidae, ostrich (bones and egg shell fragments), amphibians and reptiles.

The carnivores

Three families of the order Carnivora are represented (Figure 2). Canids are quite abundant, while hyaenids and felids are rare.

Canidae

Canis aureus LINNAEUS, 1758. The jackal is the most abundant carnivore in terms of number of specimens; they are more abundant in the upper level than in the lower one (Table 1). The cranial bones are represented by a maxilla and a fragment of mandible preserving m3–m2. Some isolated teeth are also present, predominantly representing mandibular teeth. The degree of tooth wear varies but most of the teeth belong to young individuals.

Among the teeth, the M2 have a triangular shape divided into two parts, a sectorial part formed by the metacone and paracone and an internal part formed by the paraconule and protocone. The metaconule is reduced while the protocone is well developed.

The M2 from Gazelle Cave ($L_{moy} = 7.4$ mm and $B_{moy} = 11.7$ mm) (L, length and B, breadth) are in size close to those of El Harhoura I (Aouraghe 2001), Bouknadel and Doukkala II (Michel 1990). The post-cranial remains are mostly fragmentary, with the exception of the phalanges and metapodials.

Canis sp. The site has yielded a few isolated teeth and two post-cranial remains whose measurements exceed those of *C. aureus*. It is probably a specimen of the large *Canis* (*Canis* sp.), which exists in other deposits of the Late Pleistocene such as at Doukkala I (Laquay et al. 1986), Bouknadel (Michel 1990), Dar es Soltan and Jbel Irhoud (Amani 1991), El Harhoura I (Aouraghe 2001), in layer 2 of El Mnasra (Nespoulet et al. 2008) and in layer 1 of El Harhoura II (Campmas et al. 2008). In the Holocene, examples are reported in Mugharet es Saifiya (Arambourg in Gilman 1975) and Hassi Ouenzga (Ouchaou and Amani 2002).

The upper teeth are represented by P4 and M1. The P4 are robust and a little worn. They are characterised by a well-pronounced heel, a paracone that is sharp in its posterior part and they have a well-pronounced anterior crest.

The lower teeth include p2 or p3, m1 and m3. The m1 of this large *Canis*, in contrast with the jackal, has a talonid with a hypoconid that is significantly larger than the entoconid, both are more or less merged. The cingulum is pronounced and arises from the hypoconid.

The robustness of the teeth, the metatarsal 3 and the calcaneum of Tamaris I are much larger than those of *C. aureus*. We therefore attribute these remains to a large *Canis* sp.

Vulpes vulpes LINNAEUS, 1758. Fox is the third most abundant carnivore species from Tamaris I, represented by

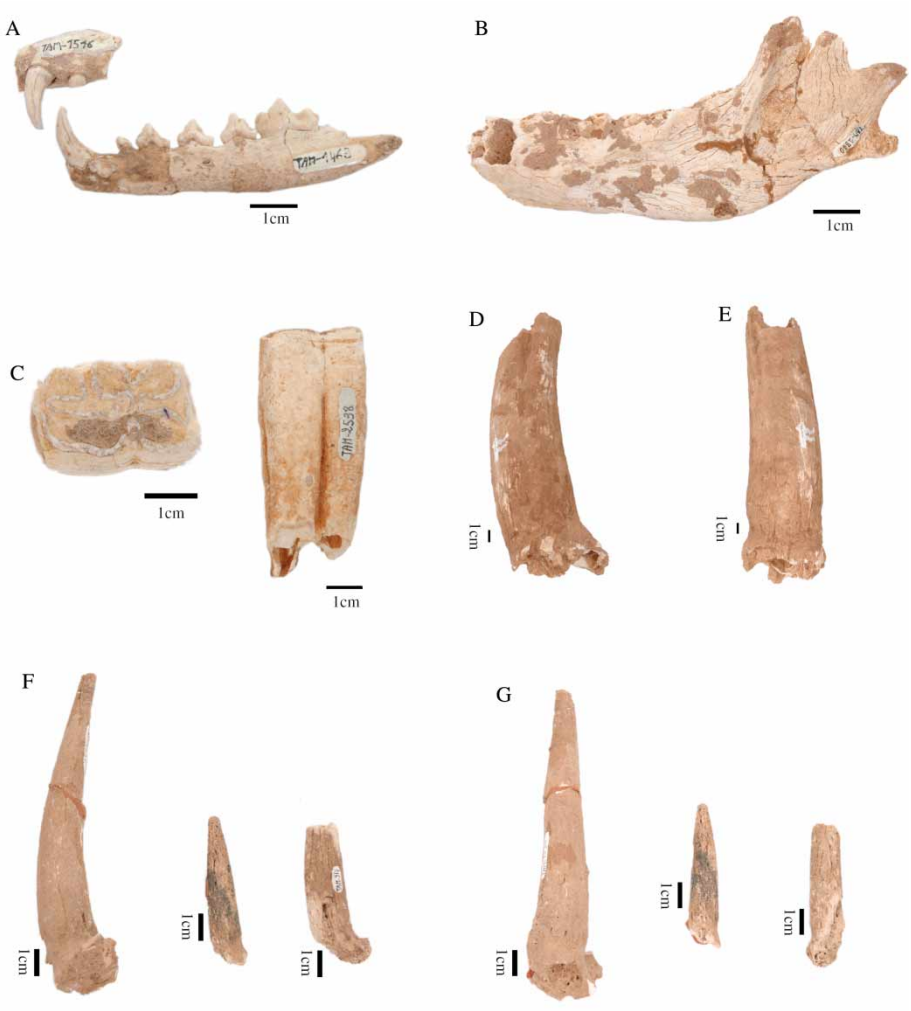


Figure 3. (A) *V. vulpes*. TAM-1516 and 1463 left Maxilla and hemi-mandible in lateral view; (B) *C. crocuta*. TAM-1647–1820 left hemi-mandible in lateral view; (C) *Equus* cf *asinus*. TAM-2538 right lower p3 or p4 occlusal and lingual views; (D–E) *A. lervia.* TAM-1517 Horn-core in lateral (D) and frontal (D) and (F–G) TAM-1536 *G. atlantica,* TAM-917 *G. cuvieri* and TAM- 914 *G. dorcas*. Horn-core in lateral (F) and frontal (G) views.

three fragments of premaxilla and three mandibular fragments including one containing c-p2-p3-p4-m1 (Figure 3). This specimen is characterised by a shallow horizontal branch (Table 2).

The m1 is characterised by a high and sharp paraconid and protoconid. Its length is 13.5 mm, which falls within the limits identified by Arambourg (1979) ranging from 12 to 14 mm. The presence of a metastylid between the

Table 2. Size (mm) comparison of the mandible of *V. vulpes* from different sites.

	Length p1–p4	Horizontal branch at p1	Height horizontal branch at p1	Length of m1
Tamaris I	29.1	10	11.1	14.0
Doukkala II (1)	27	10.2	12.5	13.5
Irhoud (2)	26		10.5	13
Dar es Soltan (3)	27	11		13
Contrebandiers (4)	28.7		11.8	
Kaf-taht-el Ghar (6)	30.9	11	13	14.2
Kehf-el-Baroud (6)	33.5	10	11	
El Harhoura I (7)	28.3–31.9 mean = 28.5	9.0–12.8 mean = 10.7	13.1–14.5 mean = 13.7	13.7–15.6 mean = 14.7

Notes: 1, Michel 1990; 2, Amani 1991; 3, Amani 1991; 4, Margaa 1995; 5, Ouchaou and Amani 1997; 6, Ouchaou 2000 and 7, Aouraghe 2001.

Table 3. Size ($L \times B$) comparison of the lower teeth of *C. crocuta* (in mm).

	Canine	p2	p3	p4	m1
Tamaris I	16.8 × 12.5			22.8 × 13.6	31.9 × 13.5
	20.5 × 15.4				
Ain Hanech (1)	18 × 13	Ain Brimba (Arambourg 1979): 16 × 10	22 × 15	23 × 14	32 × 13
Doukkala II (2)	14 × 12	14 × 9.2	20 × 14	21.5 × 16.6	28 × 12
	15 × 12.2	14.4 × 9.5	20.2 × 14.1	20.7 × 12	28.7 × 12.5
	16.3 × 12.5	14.9 × 9.9	20.3 × 14.5	20.5 × 12	29 × 13.5
El Harhoura I (3)	15.3 × 12.4	16 × 10.6	21.2 × 16	–	30.3 × 13.4

Notes: 1, Arambourg 1979; 2, Michel 1990 and 3, Aouraghe 2001.

entoconid and metaconid is noteworthy and characteristic of *V. vulpes*. This characteristic distinguishes the fox morphologically from *C. aureus* (Michel 1990).

The m1 from Tamaris I has the same size as those from Doukkala II (Michel 1990) and is slightly smaller than those from El Harhoura I (Aouraghe 2001).

Post-cranial bones distributed in both levels are represented by phalanges, metapodials, a calcaneum and fragments of long bones without epiphyses.

Hyaenidae

Crocuta crocuta ERXLEBEN, 1777. The spotted hyena is represented by two mandibles, one of which preserves the right side with a p3 and m1 belonging to a young individual with milk teeth. The second piece belongs to an adult, as evidenced by the wear of its teeth. The adult tooth measurements fit the average fossil spotted hyena (Table 3). A few isolated teeth and some post-cranial bones are also present.

Felidae

Panthera pardus LINNAEUS, 1758. Panthers are represented by the two first phalanxes with dimensions comparable to those of the first phalanxes of panthers in Doukkala II (Michel 1990) and El Harhoura I (Aouraghe 2001). They are reduced in size compared to those found in other sites such as Ghar-Khal and Kehf-el-Baroud (Ouchaou 2000).

Herbivores

Equidae

Equus cf. *asinus LINNAEUS, 1758*. The Equidae are represented by a fragment of an upper jugal tooth, four lower teeth (two incisors, one premolar and one third molar) and three phalanxes (one first and two second). The degree of tooth wear indicates the presence of at least two individuals, a juvenile and an adult. The dimensions ($L \times B$) of the lower jugals are teeth 26.1 × 16.4 mm for the premolar and 30.3 × 13.8 mm for the molar.

Teeth assigned to this species are small compared to the teeth of other asinians from contemporary sites. A specific allocation of these two teeth is quite difficult, but based on the morphology of the p3 or p4, the Equidae from Tamaris it can be attributed to *Equus* sp. cf. *asinus*. The small size of the phalanges fit a small equid.

Rhinocerotidae

Rhinoceros indeterminable. At Gazelle Cave, this taxon is represented by a fragment of an upper molar and two calcanea. The fragmentary state of the tooth does not allow an accurate anatomic description or a precise identification. The two calcanea correspond to the same individual, a juvenile, since the proximal end is not yet fully ossified. The calcanea are massive.

Suidae

Sus scrofa LINNAEUS, 1758. The Suidae are represented by two fragments of upper multituberculated molars attributable to the wild boar.

Bovidae

Bovids are the most common and diversified mammals in the deposit.

Bos primigenius BOJANUS, 1827. *B. primigenius* is known in the Maghreb from the Middle Pleistocene onwards (Geraads 1982). At Tamaris I, the species is represented by a few fragments of lower jugal teeth and long bones. The phalanxes are similar in size to those described at Bouknadel and Doukkala II (Michel 1990) and El Harhoura I (Aouraghe 2001).

Alcelaphus buselaphus PALLAS, 1766. The identification of some specimens as *A. buselaphus* is supported by the morphology of the m1, m2 and m3 which is very characteristic. These molars probably belong to the same individual. We also note the presence of phalanxes from individuals in different age groups and an astragalus with

Table 4. *Gazella*. Dimensions of dental series (in mm).

Mandible	Age	Length p2–m3	Length m1–m3	Length p2–p4
TAM-1111	5	62.1	41.2	21.7
TAM-1551	5		43.1	
TAM-2535	4	54.3	38.1	16.1
TAM-1549	4		42.9	
TAM-2296	5	52.5	27.3	17.4
TAM-2303	6	56.3	30.2	18.4
TAM-2304	4	52.1	34.7	17.5
TAM-1112	4		38.2	
TAM-1142	6		34.8	
TAM-1550	5		35.4	
TAM-1140	4		40.6	
TAM-1113	5	70.8	47	22
TAM-2299	4		39.4	
TAM-2297	6		41.3	
TAM-2301	4		28.6	
TAM-2302	6		23.7	
TAM-1547	5			19.4
TAM-2298	4		38.7	
TAM-1548	5		35.6	
TAM-2556	6	64.3	42.4	22.6
TAM-2555	6		42.6	
G. atlantica (1)		58.5–65.7–69.2	39–41.1–43	20.3–23.3–25
G. cuvieri (1)		62.8–64–65.5	40.4–41.8–44.5	20.7–22.1–22.8
G. dorcas (1)		51.2–55.5–60.5	33.9–36.7–39	16.7–18.2–19

Note: 1, Geraads 1980.

its overall morphology and size comparable to astragalus from Doukkala II (Michel 1990), El Harhoura I (Aouraghe 2001) and Tamar Hat and Columnata (Merzoug 2005), but it is larger than those from Ifri N'Ammar, Kehf el Hammar (Ouchaou 2000) and the extant hartebeest, and it is much smaller than in the extant wildebeest.

The astragalus of Tamaris I is close to those of the hartebeest.

Connochaetes taurinus POMEL, 1894. Based on morphometric comparisons, some phalanxes and metapodial condyles are attributable to *C. taurinus* since they are larger than those belonging to *A. buselaphus*.

Gazelles

Gazelles are very abundant and many skeletal elements have been identified. The minimum number of individuals (MNI), based on the mandibles, is 30. These mandibles belong to different age groups (Table 4).

The morphology of the horn-core is a good diagnostic criterion for the distinction of different species of the genus *Gazella* in North Africa (Arambourg 1957; Michel 1990; Amani 1991). The horn-cores from Tamaris I (Figures 3(F),(G)) show the presence of three species.

- *Gazella atlantica* BOURGUINAT, 1870: short horn-cores, bulky, arched posteriorly with circular or slightly oval section and usually smoother on the outside. The material studied includes three pieces, one attributed to a male individual and two fragments belonging to a female.
- *Gazelle cuvieri* OGIBY, 1841: This species is represented in the site by nine horn-cores, representing three males and six females. These horn-cores have sections that are elliptical at the base. They are long, massive and divergent towards the apex.
- *Gazella dorcas* LINNAEUS, 1758: in this species, the horn-core is elliptical with a very pronounced curvature posteriorly and a twist bringing the tip towards the inside edge. The site has yielded three specimens all representing female individuals.

Ammotragus lervia *PALLAS, 1777*

A. lervia is represented by a very robust horn-core (Figure 3(D),(E)). The cross-section of the base is rounded with a slightly flattened anterior border, which differentiates it from gazelles and other antelopes. It is equipped with a slightly pronounced stop earlier. The dimensions are close to those of barbary sheep from Ifri el Baroud (Mouhsine 1997) and Ifri N'Ammar (Mouhsine 2003).

This material confirms the presence of Barbary sheep in the Upper Pleistocene on the Moroccan coast. Barbary sheep were previously considered as confined to the mountain regions. However, it is worth noting that

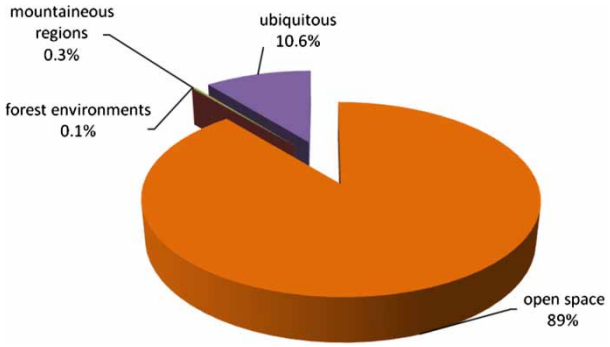


Figure 4. Graphic representation of the ecological affinities of the different species of 'Grotte des gazelles' in % NRD.

A. lervia was reported in the fauna of Dar es Soltan (Arambourg in Ruhlmann 1951) in strata of Late Pleistocene and Holocene age and also from the sandstones of Rabat (Ennouchi 1952).

Conclusion

The significance of the Tamaris I cave lies in the wealth of mammal remains, but also in the presence of human remains and the lithic industry.

The faunal list includes: *C. aureus*, *Canis* sp., *V. vulpes*, *C. crocuta*, *P. pardus*, *E.* cf. *asinus*, *S. scrofa*, *G. atlantica*, *G. cuvieri*, *G. dorcas*, *A. buselaphus*, *C. taurinus*, *B. primigenius*, *A. lervia* and *Rhinoceros* indet.

No trace of human activity was observed on the bones in the assemblage. However, there were gnawing traces at the epiphyses of some long bones. Traces of hyena activity have been identified. These are the presence of chewed long bones and some coprolites. In both levels of the pocket bone preservation is poor. The fossils are scattered, especially in the upper level. They do not show a preferred orientation and are often broken. The absence of remains in anatomical connection and the distribution of the remains show that the carcasses were severely disrupted. These disturbances are probably due to colluvium. The flows transported both detrital elements and animal remains, and from this follows that the animals found in this site did not die *in situ.*

Biochronology

The carnivores found at Gazelle Cave are frequently mentioned in other Pleistocene sites.

The presence of *S. scrofa* is characteristic of the Pleistocene (Hadjouis 1993). *E. asinus* also goes back to that period. Another element of this procession, *G. atlantica*, have gradually disappeared in the Late Pleistocene (Geraads 1980). The *A. buselaphus* is known in this period from many deposits of Pleistocene age which include Sidi Abderrahmane II and Bel Kifen Ghomari (Mas 1955), Tit Mellil (Arambourg 1938), Bouknadel and Doukkala II (Michel 1990) and El Harhoura I (Aouraghe 2001).

The association of species identified in the site Tamaris I are reminiscent of many Pleistocene faunal sites in Morocco. For example, this is the case at Bouknadel and Doukkala II (Michel 1990), at El Harhoura I (Aouraghe 2004), El Harhoura II (Campmas et al. 2008), El Mnasra (Nespoulet et al. 2008) and particularly the site geographically closest, the 'Grotte des Félins' (Raynal et al. 2008).

Paleoenvironment

From an environmental viewpoint, the faunal assemblage is characteristic for a savannah (Figure 4). Such an environment would be necessary for the development of grazing animals adapted to a semi-arid climate (Stoezel et al. 2007; Campmas et al. 2008). The upper level is more humid as it is characterised by the appearance of three new species. One of these is characteristic of forest environments (*S. scrofa*) and two are found in mountainous regions (*G. cuvieri* and *A. lervia*).

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