



DECIPHERING HOMININ-CARNIVORE ALTERNATIONS AT LES AUZIÈRES (MÉTHAMIS, VAUCLUSE), A MIDDLE PALAEOLITHIC SITE IN SOUTH-EASTERN FRANCE

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ABSTRACT: Known since the 1970s, the archaeological and palaeontological site known as Les Auzières (Méthamis, Vaucluse, south-eastern France) presents a sequence from the Middle Palaeolithic attesting to successive occupations and interactions between Neanderthal communities and large fossil carnivores. The first excavations carried out at this site revealed a natural occupation recognized as a hyena den dating around 60 ka BP; human presence was limited to the discovery of a reduced lithic assemblage, most likely in a secondary position. Following successive field operations carried out between the 1970s and the late 1990s until 2005, we undertook new studies aimed at clarifying the chronological framework and environmental context of Les Auzières. At the end of the initial campaigns, we identified a new archaeological assemblage, Unit 7, whose archaeological (lithic industry) and faunal components attest to occupation patterns and accumulation agents distinct from those of the overlying hyena den belonging to Units 4, 5 and 6. U-Th dating indicates that this new level dates back to before 100 ka BP, during a temperate phase (Isotopic Stage 5). This publication summarises seven years of research (2014-2021) and presents data relating to these two distinct groups, carnivores on the one hand (Units 4, 5 and 6) and humans on the other (Unit 7). Accordingly, Les Auzières appears to be a rare case of a Middle Palaeolithic deposit in south-eastern France showing a succession of occupation by humans and carnivores.

Keywords: South-Eastern France; Middle Palaeolithic; Hyena den; Neanderthal; Hominid-Carnivore interactions.

1. INTRODUCTION

Palaeolithic sites are complex systems in which human communities and animal populations may interact. The karst environment appears to be an attractive location for both of them, primarily due to its sheltering qualities. Predators hold a particular position within this environment, whether they frequent it occasionally or occupy it on a long term. Caves are rarely used by a single species, so the bone accumulations are often the result of interactions and successive occupations between humans and animals (e.g. Fosse, 1994; Stiner, 1994; Discamps, 2011; Discamps et al., 2012; Lateur et al., 2024).

Palaeolithic communities of human and non-human predators shared a common ecological background. They combined the search for, acquisition of, and exploitation of food resources with the occupation of shared living spaces, such as caves and rock shelters.

Consequently, many sites contain evidence of human and other animal activity (e.g. Armand, 1998; Villa et al., 2004; Miracle, 2005; Slimak et al., 2010; Discamps, 2011; Fourvel & Fosse, 2017; Fourvel et al., 2021; Spagnolo et al., 2024). Studying these deposits involves more than just identifying the level of human occupation and describing the management and exploitation of animal resources; it also requires determining the role of each taphonomic agent (whether human or non-human) in the formation of the bone deposit.

Carnivores also influence the evolution of hunting behaviour within human groups. Carnivores and humans occupy similar ecological niches. As they co-evolve and coexist in the same environments, they regularly enter into competition with each other (Tournepiche, 1994; Brantingham, 1998; Beauval et al., 2005; Enloe, 2012; García & Virgós, 2007; Spagnolo et al., 2024). Changes in the subsistence strategies of predators (both human and non-human) are thus induced by competitive pres-

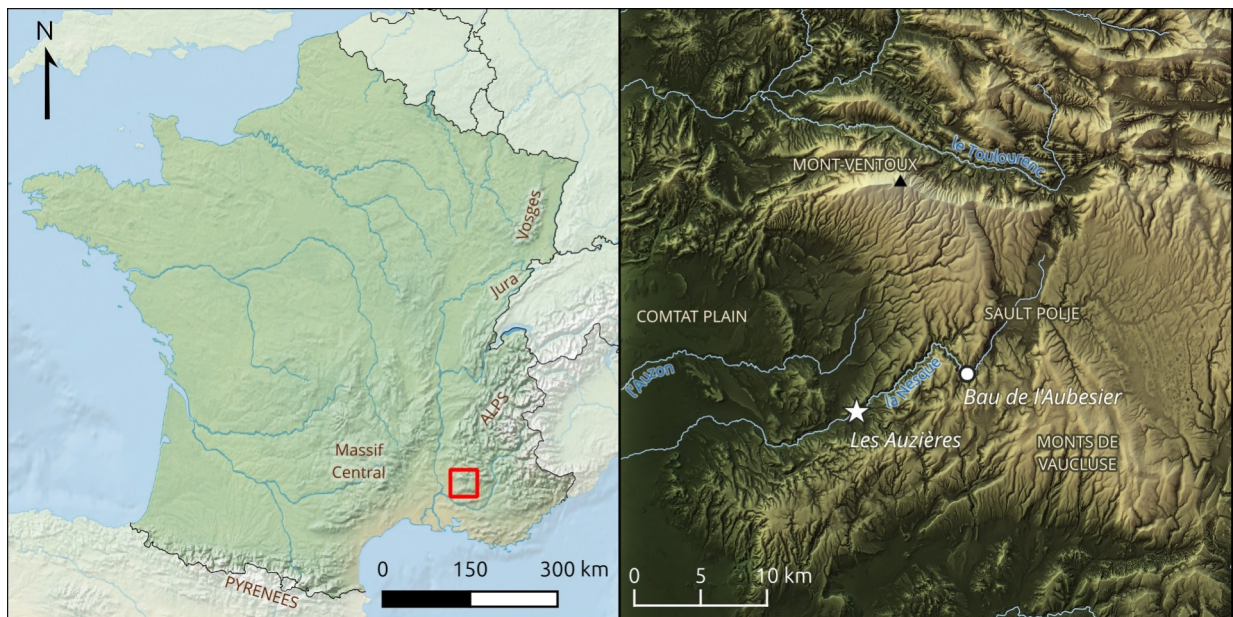


Fig. 1 - Map showing the location of Les Auzières. Sources: Natural Earth, IGN BDALTI, IGN BDTOPO. Projected coordinate system: RGF93 (EPSG:2154).

sures (e.g. Dusseldorp, 2013). However, the role of carnivores in the evolution of human behaviour and these ecological elements remain insufficiently considered.

The Vaucluse department in south-east France is notable for its substantial and diverse Neanderthal presence. Bérigoule (Murs) is notable for its Levallois indus-

try, providing insights into the mobility patterns of Neanderthal groups (Brugal et al., 1989). The abundance of artefacts recovered at La Baume des Peyrards (Buoux) makes it a significant site in the region, indicating the potential for recurring temporary settlements (Daujeard, 2008). Meanwhile, the Grand Abri aux Puces (Entrechaux) suggests a potential long-term settlement,



Fig. 2 - Les Auzières. A. view of the cave entrance (sector 2) from the south-east; B. view of sector 1 from the south-east; C. deer antlers being excavated; D. view of sector 3 (inside the cave).

with a substantial lithic and faunal assemblage (Slimak et al., 2010). Finally, the Bau de l'Aubesier rock shelter in the Gorges de la Nesque area has yielded an important stratigraphic sequence attributed to the Mousterian. This sequence preserves an abundant stone tool industry and Neanderthal remains (Lebel & Trinkaus, 2001; Lebel et al., 2001; Wilson, 2021). Nevertheless, the archaeological record in the Gorges de la Nesque remains highly incomplete.

Les Auzières (Méthamis, Vaucluse, France; Fig. 1) is therefore one of the few Middle Palaeolithic sites in the Gorges de la Nesque, and the only one with evidence of Neanderthal occupation besides the Bau de l'Aubesier. This archaeological and palaeontological site provides an interesting context for the study of interactions between hominids and carnivores in karst environments.

This study covers materials from excavations conducted by our team between 2014 and 2021 (with the exception of 2020, when no excavations took place due to the Covid-19 pandemic). These initial results offer an insight into the multiple use of the site over time, ranging from short-lived Neanderthal settlements during Marine isotope stage (MIS) 5 to hyena dens during MIS 4. We also propose a full reappraisal of the sedimentary processes that resulted in the stratigraphic sequence described by Marchal et al. (2009).

2. SITE LOCATION AND RESEARCH HISTORY

The Gorges de la Nesque demarcate the boundary between the southern slope of the Mont Ventoux and the northern tip of the Monts de Vaucluse massif. They connect the Sault polje (in the municipality of Monieux, upstream) to the Comtat plain (in the municipality of Méthamis, downstream; Fig. 1). The gorges cut through the carbonate formations from the Lower Cretaceous period that are rich in caves and rock shelters, including Les Auzières (lat. 44.020° N, long. 5.230° E; Fig. 1).

This site comprises three adjacent cavities and is located on the west bank of the Nesque meander, a few hundred metres north-east of the village of Méthamis. This karstic complex is located at an altitude of around 300 metres and opens out to the east (Figs 1 and 2A). The site was surveyed twice in the early 1980s by M. Paccard and M. Livache, and then excavated between 1998 and 2005 under the direction of H. Monchot and F. Marchal (Marchal et al., 2009).

Paccard (1971) was the first to mention Les Auzières, reporting the presence of a deposit containing Mesolithic artefacts. In 1983, Paccard described the karstic complex of Les Auzières for the first time, distinguishing three cavities within it: Les Auzières I, a large rock shelter (Fig. 2B); Les Auzières II, a rock shelter with only the roof's overhang visible (Fig. 2A); and Les Auzières III, a small alcove with no infill. Only a small deposit containing industrial elements attributed to the Epipalaeolithic period was visible in Les Auzières I, and a test pit excavated in its immediate vicinity proved sterile. M. Paccard and M. Livache also excavated a test pit in Les Auzières II, producing an initial description of the stratigraphic sequence comprising eight layers. A first set of 95 bones was unearthed. Palaeontological analysis of this assemblage attributed a Würmian age (MIS 3-4) to the fill (Crégut-Bonnoure et al., 1983).

Following this work, the site was forgotten until

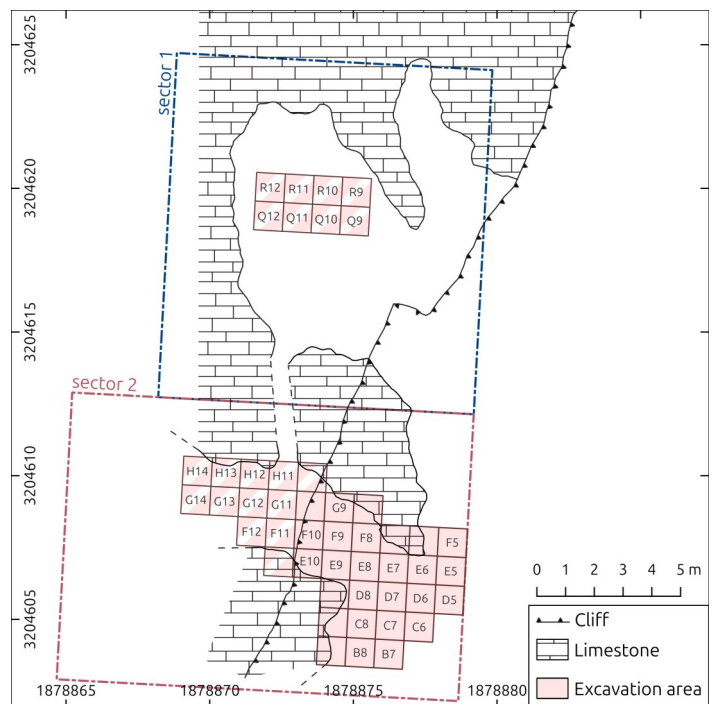


Fig. 3 - Simplified map of Les Auzières. The hatched squares are located inside the present-day cave. The innermost part of the cavity (sector 3) has been omitted. Projected coordinate system: RGF93/CC44 (EPSG:3944).

research resumed in the late 1990s. In 1998, H. Monchot and F. Marchal conducted a new survey of Les Auzières II, followed by several excavations between 2001 and 2005. The excavations focused on the front part of the current cavity (Figs 2A and 3; squares from bands 5 to 10). Sedimentological analyses divided the stratigraphic sequence into six main layers (Marchal et al., 2009). The bone material unearthed comprises a total of 206 remains, plus 42 pieces from the 1998 survey. With an average age of 60 ± 10 ka BP, the archaeological deposits fall within Isotopic Stage 4, with little archaeological evidence of human presence (around twenty lithic finds attributed to the Mousterian period; Marchal et al., 2009).

In 2014, our team resumed fieldwork at this site. We identified its rich archaeological and palaeontological potential. This enabled us to study different assemblages attesting to the successive presence of large predators and Neanderthal communities.

3. MATERIAL AND METHOD

3.1. Fieldwork and spatial recording

Since 2014, field research has been carried out once a year over a four-week period by a team of around ten people to ensure data collection, processing, and the initial stages of the study.

As the excavated area was significantly larger than in previous work, the site was divided into three sectors (Fig. 3):

Sector 1 (8 m² excavated) covers the northern part of the site and consists of a rock shelter with sterile sedimentary fill ("Les Auzières I", according to Paccard, 1983).

Sector 2 (40 m² excavated) covers the southern part of the site and is formed by the cave from which the archaeological and palaeontological material presented in this paper originates ("Les Auzières II", according to Paccard, 1983).

Sector 3 covers the deepest part of the cave including a small sinkhole located about 6 meters away from the actual entrance (Fig. 2D). This area was discovered by us during the first field season in 2014. This sector contains no archaeological material and is therefore not described here.

Following on from the work carried out by Monchot and Marchal, the excavation campaigns focused on Sector 2 (the only sector to have yielded archaeological and palaeontological material). Excavating a few square metres of the inner part of the current cavity (squares F10 to H14; Fig. 3) revealed archaeological layers continuing from those identified outside. However, the significant water flow in this area had caused extensive brecciation, making excavation particularly difficult, if not impossible, due to the risk of damaging the archaeological and palaeontological material. We therefore limited the excavation to the exterior, at the foot of the cliff face (squares D5 to H10; Fig. 3).

H. Monchot and F. Marchal used a 1 m square grid as an arbitrary reference frame to record the position of the archaeological and palaeontological finds (Fig. 3). This grid was still in place when our team resumed fieldwork. This allowed us to recalculate the geographical coordinates of material discovered between 1998 and 2005. All pieces longer than one centimetre are recorded using a total station and georeferenced using the RGF93/CC44 geographic coordinate system (EPSG:3944) and elevation above sea level (NGF /G-N69).

All excavated sediments were sieved with water using a 1 mm mesh, then air-dried and sorted. The excavated remains were photographed in situ. Photogrammetric recording was also carried out for some very specific finds.

Stratigraphic sections were documented, photographed, described and drawn during the excavation campaigns. The stratigraphic units were identified and numbered during the excavations, employing a 200-series system. These units were then reviewed during the geomorphological study. For greater relevance, the geomorphological units (from 1 to 7; see Section 4.1) are used here instead.

3.2. U-Th Dating

A sample of the upper part of a stalagmite from Unit 7 (sample No PR1708-16, from square F8), was taken for uranium-thorium dating.

After adding a triple ^{229}Th ^{233}U ^{236}U spike in a Teflon beaker, the sample was dissolved with diluted HCl. The U-Th separation and purification were performed after coprecipitation with $\text{Fe}(\text{OH})_3$, on 0.6 mL columns filled with U-TEVA and pre-filter resins, in nitric media. The U and Th isotopic compositions were analysed at the *Laboratoire des Sciences du Climat* (UMR 8212 LSCE), on a Multi-Collector inductively coupled plasma source mass spectrometer (MC-ICP-MS) Thermo Scientific™ Neptune^{plus} fitted with a desolvating introduction system (aridus II). For mass fractionation correction, we used an exponential mass fractionation law (normalized to natural $^{238}\text{U}/^{235}\text{U}$ isotopic ratio) and standard / sample bracketing. More details on the analytical procedure (chemistry and MC-ICP-MS analysis) can be found in Pons-Branchu et al. (2014). After corrections for peak tailing, hydrate interference and chemical blanks, $^{230}\text{Th}/^{234}\text{U}$ ages were calculated from measured atomic ratios through iterative age estimation using the ^{230}Th , ^{234}U and ^{238}U decay constants of Cheng et al. (2013) and Jaffey et al. (1971).

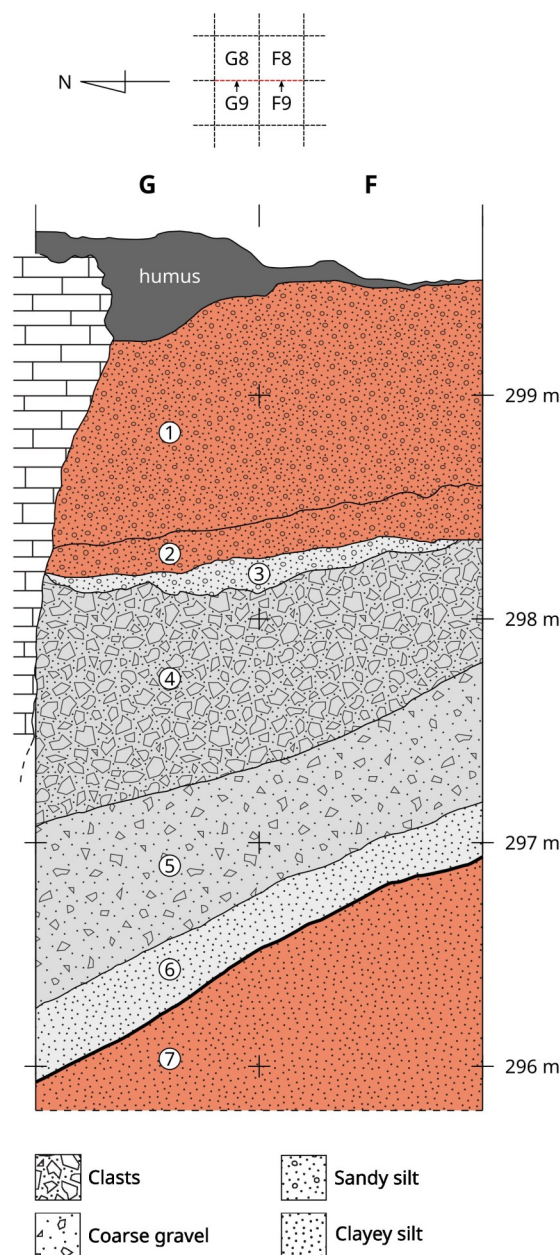


Fig. 4 - Synthetic stratigraphic section in N-S direction, seen from the west (refer to Fig. 3 to locate the section on the site and to the text for a description of the units).

3.3. Faunal analysis

The bone material was subjected to palaeontological analysis for identification purposes (comparative anatomy and morphometry). A more detailed palaeontological presentation will be the subject of a forthcoming publication. The identified faunal remains were quantified using the NISP (Number of Identified Specimens) and the MNI (Minimum number of Individuals; Lyman, 1994). All the bones were examined to record the various surface conditions. As the taphonomic analysis aimed to characterise depositional dynamics, all alterations affecting the bone surfaces were recorded. Regarding abiotic traces of karstic origin, our approach was primarily based on the work of Coumont (2006, 2008, 2009). The recording of traces produced by carnivores is

Stratigraphic Unit (Marchal et al. 2009)	Stratigraphic Unit (this study)	Geomorphological Unit (this study)	Archaeological components	Faunal components	Estimated chronology
	(humus)				
C1	205	-	Reworked lithic artefacts, ceramic sherds	Rare faunal remain (mainly related to a fox den)	Mesolithic/ Neolithic (?)
Ca	206	-	None	None	Unknown
Cb	207	1	None	None	Unknown
Cc	208	2	None	Rare faunal remains (<i>Equus germanicus</i>)	Late Pleistocene
Cd	209	3	None	Single hyena tooth	Late Pleistocene
Ce	210	4	Rare lithic artefacts	High faunal diversity, cave hyena (+++)	MIS 4
Cf1	212				
Cf2	213				
Cf3	214				
-	215	7	Mousterian lithic industries (+++) Butchering activities	Temperate fauna (e.g., red deer, roe deer, tortoise)	MIS 5

Tab. 1- Summary of observations and stratigraphic interpretations and equivalences with Marchal et al. (2009).

based on numerous existing protocols and characterisation frameworks (e.g. Sutcliffe, 1970; Maguire et al., 1980; Brain, 1981; Binford, 1981; Laroulandie, 2000). Finally, the observation of anthropogenic marks (cut marks) essentially refers to the work of Binford (1981) and the most recent publications concerning percussion marks (Vettese et al., 2020).

4. RESULTS AND DISCUSSION

4.1. Stratigraphy

The excavation in Sector 2 is located at the base of the cliff, continuing a karstic corridor. Although these deposits are now exposed to the open air, their geometry and composition suggest that they were placed under a limestone vault, as evidenced by the presence of stalagmites and interbedded calcite floors.

A stratigraphic record has been made along section F9-G9 in the north-east corner, over a depth spanning 3 metres. This crosses the main formations encountered during the excavation and enables us to propose a reference sequence. From bottom to top, the following succession has been identified (Fig. 4; Tab. 1):

Unit 7 (anthropogenic layer): The base of the sequence consists of a formation of limestone and calcite boulders. These blocks are embedded in brown, clayey silt containing gravel and cobbles. While no sedimentary features are visible in this formation, calcite concretions in their initial growth position can be observed locally. The roof of this block level is visibly truncated by a discordance. Inclined at an angle of about 30 degrees towards the interior of the cavity, this truncation represents a phase of erosion that altered part of the lower sequence before it was sealed by renewed sedimentation.

Unit 6 (hyena den): Around 30 cm of gravel (angular, slightly weathered clastic substrate averaging between 5 and 10 cm in size) lie on the boulder formation. The silty-clay matrix is locally indurated by carbonates, which may form nodules. The matrix is, however, scarce or even locally absent. This unit is oriented towards the bottom of the cavity.

Unit 5 (hyena den): This unit mainly consists of bedded coarse gravel, with an average grain size of 1-3 cm. It is 60-70 cm thick. The gravel beds alternate with finer levels of light brown, sandy silt. The gravel layers essentially comprise fairly blunt limestone plates, along with a few limestone and calcite boulders. The matrix is abundant and clearly bedded. Several well-sorted gravel beds can be distinguished, dipping at an angle of around thirty degrees towards the bottom of the cavity.

Unit 4 (hyena den): The layer of alternating coarse gravel and sandy silt continues upwards. However, the grain size increases to cobbles and boulders, which are more weathered than the underlying layers. Light-brown silty sands, interspersed with two levels of small, scattered limestone chips and locally showing carbonate crusts, are packed between the clastic formations. Thin limestone layers are also visible on the clasts. These encrustations are evidence of the remobilisation of carbonates after this level was deposited.

Unit 3: The sedimentation pattern here changes significantly, becoming a very homogeneous sandy-silt formation. Small sandy patches alternate with sandy beds, reflecting excellent granulometric sorting. This layer is no more than twenty centimetres thick.

Unit 2: A clear erosional unconformity can be seen, showing where the top of these sands has been cut off. This is underlined by a small gravel layer. This is followed by a compact, pinkish-beige sandy silt sequence containing thin gravel deposits. There are also numerous limestone puffs and whitish carbonate bands present.

Unit 1: The same pinkish-beige sandy silt formation continues upwards, but is much more homogeneous. It is still rich in carbonate bands. Visible over a thickness of around 30 cm, it forms the upper part of the sequence recorded here.

At this point, several sedimentary processes can be identified. The boulder level forming the base of the current excavation (Unit 7) formed in a cavity relatively far from the surface, although only a few metres were required for this isolation. These boulders appear to

	$[^{238}\text{U}]$ ppm		$[^{232}\text{Th}]$ ppb		$\delta^{234}\text{U}_M$ (‰)		$(^{230}\text{Th}/^{238}\text{U})$		$(^{230}\text{Th}/^{232}\text{Th})$		Corrected Age (ka BP)		$\delta^{234}\text{U}_0$ (‰)	
Sample	value	error	value	error	value	error	value	error	value	error	value	error	value	error
PR1708-16	0.128	0.001	5.039	0.044	34.65	1.11	0.6405	0.0014	49.72	0.11	102.532	1.572	46.31	1.50

Tab. 2 - Uranium and thorium data (concentrations, isotopic ratios and ages). Ages are expressed as thousand years before the year 1950 (ka BP) and are corrected for detrital fraction using $^{230}\text{Th}/^{232}\text{Th} = 1.5 \pm 50\%$. $\delta^{234}\text{U}_M = [(^{234}\text{U}/^{238}\text{U})_{\text{measured}} / (^{234}\text{U}/^{238}\text{U})_{\text{equilibrium}} - 1] \times 1000$, with $^{234}\text{U}/^{238}\text{U}_{\text{equilibrium}} = 54.89 \times 10^{-6}$ (molar ratio; Cheng et al. 2013). $\delta^{234}\text{U}_0$ is the $\delta^{234}\text{U}$ at initial time (using $^{230}\text{Th}/^{234}\text{U}$ ages).

form a north-facing slope, which was created by the collapse of the southern part of the cavity. Throughout this process, calcite speleothems have formed. Some are still growing, while others have been broken up and reworked by the continuing collapse process. While there is no direct external influence, this progressive collapse may reflect the destabilisation of the vault resulting from the dismantling of the southern part of the cavity and the decompression of the rocks. The top of this formation appears truncated by an erosive unconformity. This may indicate a significant sedimentary hiatus, particularly given the radical change in sedimentation conditions that occurred.

The overlying levels (Units 6, 5 and 4) reflect evolution in a less confined environment with more direct links with the surface. The sedimentary record consists of alternating layers of small limestone gravels and light-brown, sandy silts. The former clearly corresponds to gelifractions, reflecting marked periglacial surface conditions. The sandy silts are also consistent with this, strongly resembling reworked loess. Based on the palaeontological evidence (see 4.3) and previous U-Th datings (60 ± 10 ka; Marchal et al., 2009) this represents the climatic downturn of Isotopic Stage 4. The cavity is therefore a receptacle for periglacial formations that were colluvially deposited from the surface. The general dip of this sequence becomes shallower towards the top. It is clear that the cavity is now largely closed, and it is reasonable to assume that this major sedimentary aggradation has sealed off most of the entrance porch.

An unconformity marks the top of this sequence, indicating a change in sedimentary processes. The bedded silty sands (Unit 3) are the result of runoff into the cavity. Only fine sediments were deposited here, suggesting that the entrance to the cavity was still blocked, only allowing fine particles transported by runoff to pass through.

Units 1 and 2 demonstrate the internal evolution of the cavity. The origin of the sedimentary matrix remains to be determined. It may have originated from percolation at the surface, reflecting climatic conditions that are more conducive to pedogenesis. The limestone clasts have collapsed *in situ* and now lie flat, packed by the sedimentary matrix. This level is completely sterile; there was no direct connection with the surface during the deposition of these units and the cave was still not accessible to fauna.

The detrital deposits gave way to chemical sedimentation at the end. Infiltration through the vault enabled calcite concretions to form. Carbonates were transported into the underlying sequence by leaching.

4.2. Datings

A total of four radiometric and palaeodosimetric dating analyses were carried out at Les Auzières. Three ESR/U-Th analyses were conducted on horse teeth (Marchal et al., 2009), and one additional U-Th analysis was conducted on a speleothem (this study).

The three ESR/U-Th ages obtained provide a *terminus post-quem* for Unit 4. These ages (60 ± 8 , 69 ± 7 and 50 ± 7 ka BP, respectively) date Units 4, 5 and 6 to Isotopic Stage 4 (Marchal et al., 2009).

The U-Th age was obtained from the upper part of

a stalagmite found in its original position on a limestone block atop Unit 7. Given the presence of a clear unconformity at the contact with Unit 6, this concretion is part of the terminal phase of Unit 7 (Tab. 2). With an age of $102,532 \pm 1,572$ ka BP, Unit 7 is likely to have coincided during Isotopic Stage 5. Although caution is warranted regarding this attribution, given that only one U-Th age has been obtained so far, it should be noted that this is consistent with the faunal data (see Section 4.3).

4.3. Palaeontology

4.3.1. Large mammals

The large mammals unearthed in Units 4, 5, 6 and 7 are both abundant and diverse. A minimum of twenty species belonging to five orders have been identified, including carnivores, perissodactyls and cetartiodactyls (Tab. 3). The differences in the number of identified species and their relative abundance between Units 4, 5 and 6, and Unit 7, respectively, are indicative of distinct occupations (see section 4.4).

Four carnivore families are represented: Canidae, Felidae, Ursidae and Hyaenidae (Fig. 5). The only absent family is Mustelidae. Carnivores are far more abundant and diverse in Units 4, 5 and 6 (seven species and 18 individuals) than in Unit 7 (two species - apart from coprolites, as discussed below - and two individuals).

The cave hyena (*Crocota crocata spelaea*) is the most common predator in Units 4, 5 and 6 (NISP =56, MNI =5). This sample is complemented by over 70 coprolites displaying characteristic morphology. The red fox (*Vulpes vulpes*) is the second most abundant species in Units 4, 5 and 6 (NISP =97, MNI =3). The polar fox (*Vulpes lagopus*; NISP =2, MNI =1) is also present in these units. Seven cave bear (*Ursus spelaeus*) remains attest to the presence of at least three individuals in these same units. Of the felines, only the cave lynx (*Lynx spelaea*; NISP =11, MNI =3) and the wildcat (*Felis silvestris*; NISP =9, MNI =2) are present.

No remains of hyena bones have been found in Unit 7, but fifteen coprolites have been identified. Located at the interface between Units 6 and 7, the stratigraphic position of these coprolites is yet to be determined; they may be the result of reworking. Red fox (NISP =5, MNI =1) and cave bear (NISP =5, MNI =1) remains have also been identified in Unit 7.

As with carnivores, ungulates are far more abundant and diverse in Units 4, 5 and 6 (10 species) than in Unit 7 (six species; Tab. 3). Proboscideans (one species), perissodactyls (three species) and cetartiodactyls (six species) are present in Units 4, 5 and 6 (Fig. 5). The horse (NISP =96, MNI =6), the ibex (*Capra ibex*; NISP =67, MNI =5) and the chamois (*Rupicapra rupicapra*; NISP =6, MNI =2) dominate the assemblage. The megafauna includes the mammoth (*Mammuthus* sp.; one tooth fragment) and the woolly rhinoceros (*Coelodonta antiquitatis*; NISP =13, MNI =2). Cervids (giant deer, red deer and roe deer) are marginal in Units 4, 5 and 6 (NISP =1, 11 and 1; MNI =1, 3 and 1, respectively). Large bovines (*Bos* or *Bison*) and the hemione (*Equus hydruntinus*) are attested by a few specimens (NISP =1 and 4, respectively).

In Unit 7, only one perissodactyl (*Equus germani-*

Order	Family	Species	Common name	Unit 4, 5, 6			Unit 7		
				NISP	MNI	%MNI	NISP	MNI	%MNI
Carnivora	Canidae	<i>Canis lupus</i>	Wolf	1	1	2.2			
	Canidae	<i>Vulpes vulpes</i>	Red fox	97	3	6.5	5	1	6.3
	Canidae	<i>Vulpes lagopus</i>	Polar fox	2	1	2.2			
	Ursidae	<i>Ursus spelaeus</i>	Cave bear	7	3	6.5	5	1	6.3
	Felidae	<i>Lynx spelaea</i>	Cave lynx	11	3	6.5			
	Felidae	<i>Felis silvestris</i>	Wild cat	9	2	4.3			
	Hyaenidae	<i>Crocota spelaea</i>	Cave hyena	56	5	10.9			
	Hyaenidae	<i>Albus graecum</i>	Coprolite	73			15		
Proboscidea	Elephantidae	<i>Mammuthus</i> sp.	Mammoth	1	1	2.2			
Perissodactyla	Equidae	<i>Equus germanicus</i>	Wild horse	96	6	13.0	4	2	12.5
	Equidae	<i>Equus hydruntinus</i>	Wild ass	4	1	2.2			
	Rhinocerotidae	<i>Coelodonta antiquitatis</i>	Woolly rhinoceros	13	2	4.3			
Cetartiodactyla	Bovidae	<i>Bos</i> sp. / <i>Bison</i> sp.	Large-sized bovid	1	1	2.2	13	1	6.3
	Bovidae	<i>Capra ibex</i>	Ibex	67	5	10.9			
	Bovidae	<i>Rupicapra rupicapra</i> ssp.	Chamois	6	2	4.3			
	Suidae	<i>Sus s. scrofa</i>	Wildboar				11	1	6.3
	Cervidae	<i>Megaloceros giganteus</i>	Giant deer	1	1	2.2			
	Cervidae	cf. <i>Dama</i> sp.	Fallow deer				2	1	6.3
	Cervidae	<i>Cervus elaphus</i>	Red deer	11	3	6.5	165	7	43.8
	Cervidae	<i>Capreolus capreolus</i>	Roe deer	1	1	2.2	25	2	12.5
Lagomorpha	Leporidae	<i>Lepus europeus</i>	Hare	65	5	10.9			
Total				522	46	100.0	245	16	100.0

Tab. 3 - Large mammals species identified at Les Auzières.

cus) and five cetartiodactyls have been identified. Cervids, including red deer and roe deer, dominate the assemblage (NISP =165 and 25, MNI =7 and 2, respectively). Large bovines are present with 13 bone remains, and there are four bone remains belonging to horse. In addition to lower diversity (consistent with the composition of the bone assemblage, see section 4.4), Unit 7 is distinguished from the overlying units by the presence of wild boar (*Sus s. scrofa*; NISP =11, MNI =1) and fallow deer (cf. *Dama* sp.; NISP =2, MNI =1).

The fauna of Units 4, 5 and 6 indicates a cool environment, as evidenced by the presence of polar foxes, mammoths and woolly rhinoceroses. Meanwhile, the presence of deer and wildcats suggests that there was woodland in the vicinity of the site. The presence of rupicolous species such as ibex and chamois, as well as gregarious open environment species such as horses, perfectly reflects the site's geographical location at the interface between the steep Gorges de la Nesque and the Comtat plain. In contrast, Unit 7 is characterised by the absence of typical species of cold environments. Temperate species dominate here, with red deer, roe deer, wild boar and fallow deer providing further evidence of a cool-temperate environment with greater plant cover. Species inhabited a patchy landscape interfering wooded, rupicolous and few grassland biomes.

4.3.2. Small mammals

The infill of Les Auzières yielded over a hundred anatomical elements of small mammals that have been identified. A total of 20 taxa (including insectivores, bats, rodents and lagomorphs) and 127 individuals were identified (Tab. 4). Although the identified small mammalian community is not of major biostratigraphic interest, it provides information on palaeoclimates and palaeoenvironments within the sequence.

ronments within the sequence.

Crocodylus leucon is generally absent from Mediterranean regions, while *Crocodylus suaveolens* inhabits various environments, including forests, scrubland, hedgerows, maquis and coastal dunes. It can also be found on the banks of rivers and lakes. Its distribution is sporadic in France, but it is widespread in southern and central Europe, as far south as the Caucasus (Saint-Girons, 1973).

As for the order Chiroptera, the species *Rhinolophus ferrumequinum* is sedentary, cavernicolous and thermophilic. It is widespread in Mediterranean Europe (Schilling et al., 1986). *Rhinolophus hipposideros* inhabits warm, open yet wooded areas. *Miniopterus schreibersii* is a cave-dwelling species found in karst landscapes on plains and in mountains. *Tadarida teniotis* is a rare species of bat in France, preferring the Mediterranean region for its cliff-dwelling habitat. Finally, the ubiquitous *Pipistrellus pipistrellus* lives in tree trunks as well as cavities.

Among rodents unearthed in Les Auzières, *Microtus arvalis* is still widespread in France, although it is absent from Mediterranean regions where vegetation is hardly favourable (Saint-Girons, 1973). On the other hand, *Microtus agrestis* is widespread in rather damp, open environments such as fields and plains. *Chionomys nivalis* inhabits rocky mountainous areas with sparse vegetation. *Apodemus sylvaticus* is found throughout most of Europe (Schilling et al., 1986). Thanks to its great adaptability, it can be found in a wide variety of habitats, wherever there is herbaceous vegetation (e.g. deciduous and coniferous forests). *Microtus (T.) duodecimcostatus* is mainly confined to the Mediterranean biome, while *Microtus (T.) multiplex* is still found in the south-eastern quarter of France, on the left bank

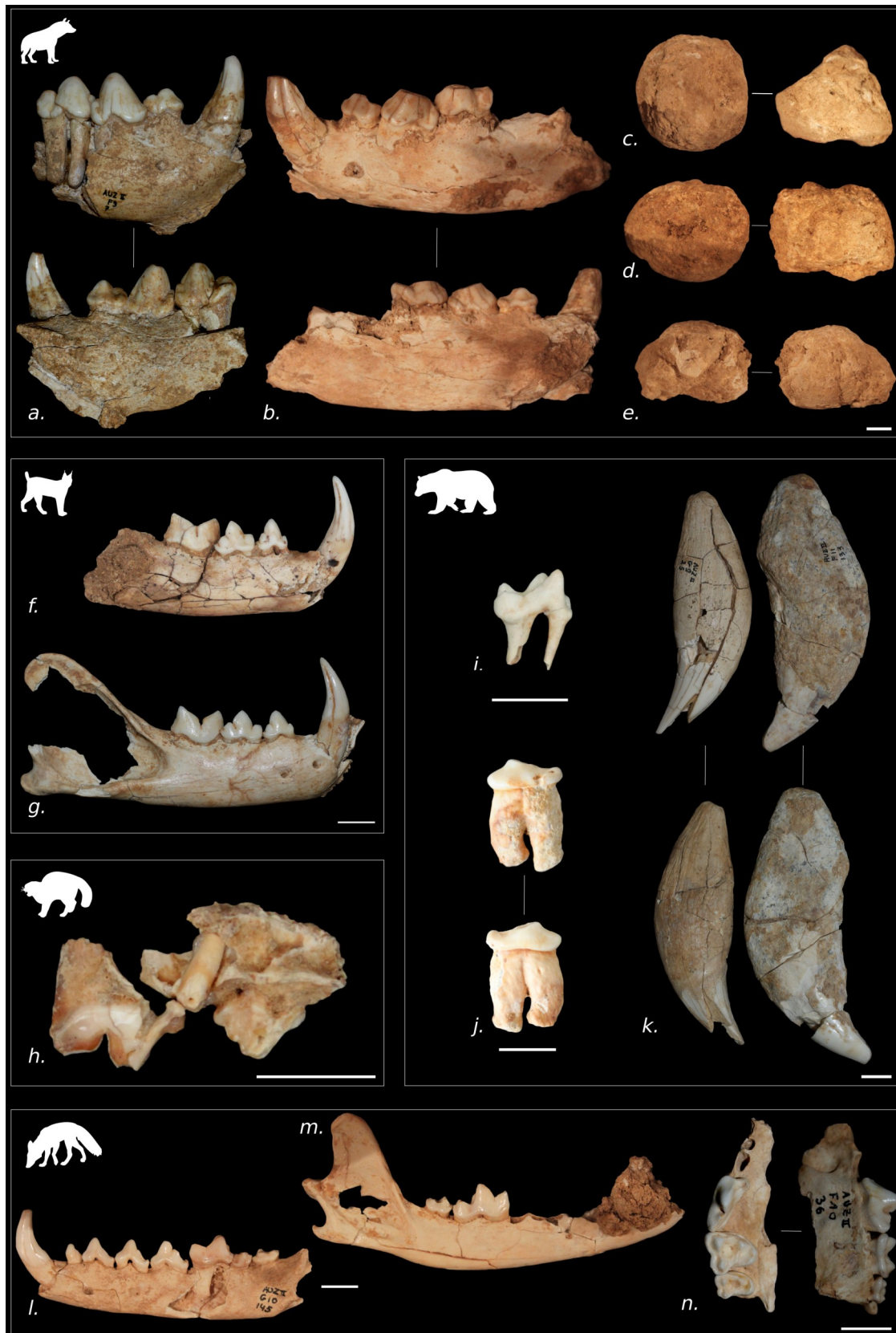


Fig. 5 - Carnivore remains from Les Auzières. a. cave hyena right mandible (vestibular and lingual views); b. cave hyena left mandible (vestibular and lingual views); c, d and e. cave hyena coprolites; f and g. cave lynx right mandibles (vestibular views); h. wildcat left maxilla (lingual view); i. cave bear deciduous tooth; j. cave bear lower premolar; k. cave bear right (female) and left (male) upper canines; l. red fox left mandible; m. red fox right mandible; n. red fox right maxilla. Scale bar: 10 mm.

Order	Family	Species	Common name	Units 4, 5, 6	Unit 7
Eulipotyphla	Talpidae	<i>Talpa europaea</i>	European mole	3	4
	Soricidae	<i>Crociodura cf. suaveolens</i>	Lesser white-toothed shrew	1	2
	Soricidae	<i>Crociodura leucodon</i>	Bicoloured white-toothed shrew	1	2
	Soricidae	<i>Sorex ex. gr. araneus / coronatus</i>	Unidentified shrew		1
Chiroptera	Rhinolophidae	<i>Rhinolophus cf. hipposideros</i>	Lesser horseshoe bat	1	2
	Rhinolophidae	<i>Rhinolophus ferrumequinum</i>	Greater horseshoe bat	1	8
	Miniopteridae	<i>Miniopterus schreibersii</i>	Schreiber's long-fingered bat		1
	Molossidae	<i>Tadarida teniotis</i>	European free-tailed bat		1
	Vespertilionidae	<i>Pipistrellus pipistrellus</i>	Common pipistrelle		1
	Vespertilionidae	<i>Myotis myotis / blythii</i>	Mouse-eared bat		1
Rodentia	Cricetidae	<i>Microtus ex. gr. arvalis / agrestis</i>	Unidentified vole	1	3
	Cricetidae	<i>Microtus agrestis</i>	Short-tailed vole	1	6
	Cricetidae	<i>Microtus arvalis</i>	Common vole	1	8
	Cricetidae	<i>Chionomys nivalis</i>	European snow vole		2
	Cricetidae	<i>Microtus cf. duodecimcostatus</i>	Mediterranean pine vole	8	33
	Cricetidae	<i>Microtus multiplex</i>	Alpine pine vole	1	2
	Cricetidae	<i>Arvicola cf. sapidus</i>	Southwestern water vole	1	1
	Cricetidae	<i>Arvicola amphibius</i>	European water vole	1	3
	Muridae	<i>Apodemus sylvaticus</i>	Wood mouse	4	21

Tab. 4 - Small mammals identified at Les Auzières.

of the Rhône.

Thus, the small mammal community comprises thermophilic species that are likely to still be present in the region today (*T. europaea*, *C. suaveolens*, *R. ferrumequinum*, *M. schreibersii*, *T. teniotis*, *P. pipistrellus*, *Microtus agrestis*, *A. sylvaticus*, *M. (T.) multiplex* and *M. (T.) duodecimcostatus*). There are also a few taxa generally rare or absent from the Mediterranean biome (*C. nivalis*, *M. arvalis* and *C. leucodon*). The microvertebrate community at Les Auzières (particularly in Unit 7) has a distinct temperate and forested character, though this is limited by the presence of species better suited to a continental climate.

4.3.3. Birds

The avian remains belong to five orders and around a dozen species (Tab. 5). Passeriformes dominate the samples collected in all fossiliferous units. Among these, corvids have been identified, including the red-billed (*Pyrrhocorax pyrrhocorax*) and the yellow-billed chough (*Pyrrhocorax graculus*). There is also a member of the family Turdidae (blackbird or thrushes) and at least three small species similar in size to sparrows. Unit 7 contains the remains of four raptor species, two diurnal and two nocturnal: the European sparrow-

hawk (*Accipiter nisus*), the black vulture (*Aegypius monachus*), the little owl (*Athene noctua*) and the tawny owl (*Strix aluco*). Next come the Galliformes and Columbiformes, to which rare remains have been attributed in Units 4, 5, 6 and 7.

The identified birds belong to various climatic and ecological categories (Vilette, 1983). The yellow-billed chough is a species that inhabits cold open spaces. Black vultures and red-billed choughs are species that thrive in dry, sunny conditions with low temperature requirements. The European sparrowhawk and the tawny owl are temperate forest species. The pigeon also belongs to this category, whereas its cousin, the rock dove, is classified as a rock and mountain species. The little owl, on the other hand, prefers temperate open spaces.

For Unit 7 in particular, the picture that emerges is of a cool to temperate climate with a forest environment interspersed with open spaces. This is consistent with the information obtained for ungulates (see 4.2.1) and small mammals (see 4.2.3). However, the small number of avian remains identified until then makes it impossible to assess changes between Units 5 and 6 and Unit 7.

A few marks are evidence of predation. Traces of digestion are visible on eight bones belonging to small

Order	Family	Species	Common name	Units 4, 5, 6	Unit 7
Galliformes	Phasianidae	<i>Perdix / Alectoris</i>	Partridge	X	X
	Accipitridae	<i>Accipiter nisus</i>	Eurasian sparrowhawk		X
Accipitriformes	Accipitridae	<i>Aegypius monachus</i>	Eurasian black vulture		X
	Accipitridae	<i>Aegypius monachus / Gyps fulvus</i>	Unid. Vulture	X	X
Columbiformes	Columbidae	<i>Columba livia / oenas</i>	Pigeon	X	X
Strigiformes	Strigidae	<i>Athene noctua</i>	Little owl		X
	Strigidae	<i>Strix aluco</i>	Tawny owl		X
Passeriformes	Corvidae	<i>Pyrrhocorax graculus</i>	Alpine chough	X	X
	Corvidae	<i>Pyrrhocorax pyrrhocorax</i>	Red-billed chough		X
	Corvidae	<i>Pyrrhocorax sp.</i>	Chough	X	X
	Turdidae	<i>Turdus sp.</i>	True thrush	X	
	Unidentified	unidentified	-	X	X

Tab. 5 - Bird species identified at Les Auzières (excavations 2015-2017).

Order	Family	Species	Common name	Units 4, 5, 6	Unit 7
Testudines	Testudinidae	<i>Testudo hermanni</i>	Hermann's tortoise		X
Anura	Bufonidae	<i>Bufo calamita</i>	Natterjack toad		X
	Bufonidae	<i>Bufo bufo</i>	Common toad		X
	Pelodytidae / Hylidae	<i>Pelodytes sp. / Hyla sp.</i>	Unid. frog		X
Squamata	Lacertidae	<i>Lacerta agilis</i>	Sand lizard		X
	Lacertidae	<i>Lacerta bilineata</i>	Western green lizard		X
	Lacertidae	<i>Psammodromus sp.</i>	Unid. lizard		X
	Colubridae	<i>Coronella girondica</i>	Southern smooth snake		X
	Colubridae	<i>Rhinechis scalaris</i>	Ladder snake		X
	Colubridae	<i>Zamenis longissimus</i>	Aesculapian snake		X
	Viperidae	<i>Vipera aspis</i>	European asp		X
	Anguidae	<i>Anguis fragilis</i>	Slowworm		X

Tab. 6 - Reptile species identified at Les Auzières.

and medium-sized passerines and one unidentified medium-sized bird, most probably attributable to a bird of prey. The remains of a black vulture (*Aegypius monachus*) from Unit 7 show signs of chewing, likely caused by carnivores. The death of certain individuals without the intervention of predators cannot be ruled out, particularly for species that frequent rock outcrops, such as choughs and pigeons (especially Rock dove, *C. livia*, and more exceptionally, *C. oenas*).

4.3.4. Herpetofauna

All of the reptile and chelonian remains were found in Unit 7; none were found in the overlying units. Most of these remains were obtained by sieving the sediments. A total of 787 herpetofaunal remains were identified. Of these, 19 (2.5% NISP) belong to Anura, nine bones belong to saurians (1% NISP) and 759 belong to snakes (94.5% NISP). A dozen taxa appear to be present (Tab. 6): the Common Toad (*Bufo bufo*) and a small Anura (either *Pelodytes sp.* or *Hyla sp.*); two or three lacertids, including the Western Green Lizard (*Lacerta bilineata*), probably two smaller lizards (the Sand Lizard, *Lacerta agilis*, and possibly a representative of the *Psammodromus* genus) and the Slow Worm (*Anguis fragilis s. l.*); and three snakes, the Aesculapian Snake (*Zamenis longissimus*), a species of the *Coronella* genus, and the Asp Viper (*Vipera aspis*).

Of the various herpetofaunal taxa identified, the European asp is the most abundant and best represented species in the entire sequence studied, with 748 remains accounting for 95% of the total. This sample also includes a number of turtle shell fragments (NISP =4), whose morphology suggests they belong to Hermann's Turtle (*Testudo hermanni*). In addition to its paleoecological implications, the presence of this thermophilic species in Unit 7 provides further insight into the exploitation of local fauna by human communities (see Section 4.4).

The herpetofauna assemblage is dominated by species with a southern European distribution, such as Hermann's Tortoise, the Western Green Lizard, the Aesculapian Snake and the Asp Viper, or species with southern affinities, such as the Slow Worm. In contrast, the Sand lizard has a more northerly distribution that avoids the Mediterranean region, whereas representatives of the *Psammodromus* genus are characteristic of the latter. The Common Toad is a widespread Eurasian species. This assemblage suggests the existence of a relatively temperate climate.

4.4. Lithic industries

Research conducted at Les Auzières between 2014 and 2019 yielded a small assemblage of 77 lithic artifacts (Tab. 7). All the raw materials used are Cretaceous flints, whose sources are primarily to be sought within a relatively local radius. It is worth noting the presence of several heavily burned pieces. These artifacts, literally destroyed in terms of their functional potential by the action of fire (Fig. 6), were most likely burned locally. This indicates the existence of hearths in the immediate vicinity of the excavated areas or within the site itself.

The 77 flints are distributed across four stratigraphic units, layers 4 to 7 (Tab. 7). Eight pieces remain of uncertain origin (layer 5 or 6) and are here simply grouped under the designation 5-6. These two stratigraphic units are interpreted as hyena-dominated phases with minimal human presence, with only two pieces from layer 5 and four from layer 6. Human indicators are therefore extremely discreet within these two units considered together: six flakes, three pseudo-Levallois points (technical by-products resulting from Discoid or Levallois core reduction), a rather expedient core showing only a few removals, two retouched pieces, and a single recurrent unipolar convergent Levallois flake (Fig. 7).

Four of the artifacts attributed to units 5-6 display a strong white patina as well as surface alterations, edge chipping, and micro-denticulations. These elements, undoubtedly Mousterian in character, may be in secondary position and not clearly related to a genuine human occupation of the cavity.

A single flake from layer 4 also points to extremely rare human visits to the cavity subsequent to layer 7. It is possible that some of the pieces recovered from units 4 to 6 are out-of-context artifacts dispersed within these layers. Nevertheless, even a discreet human presence must be considered. Continued excavation may help

Category	Unit	4	5	5-6	6	7	Total
Micro-flake						25	25
Flake		1	2	3	1	19	26
Flake fragment				1		5	6
Pseudo-Levallois point				2	1	1	4
Retouched tool				2		1	3
Levallois flake cf. preferential						3	3
Recurrent unipolar Levallois flake						3	3
Recurrent unipolar convergent Levallois flake					1	4	5
Expedient core					1	1	2
Total		1	2	8	4	62	77

Tab. 7 - Lithic industries from Les Auzières (number of elements).

clarify the status of these units.

Layer 7 provides the principal anthropogenic signal, with 62 lithic artifacts out of the 77 pieces recovered from the entire Mousterian sequence. These artifacts are perfectly preserved, with minimal patination and no alteration of their cutting edges, which remain sharp and functional. They are clearly in primary position and show no significant post-depositional movement. We are therefore dealing with a genuine archaeological signature, offering the possibility of investigating human behavior within this cavity.

The distinctive character of this assemblage lies in the proportion of finished products within the unit: 11 Levallois blanks compared to only 19 débitage flakes (and five flake fragments). Levallois blanks represent more than a quarter of the corpus and are therefore clearly overrepresented. The production of Levallois blanks normally generates numerous undifferentiated by-products, yet elements related to their manufacture are absent from the excavated areas. This suggests either that production zones were located outside the site, or that they remain in unexplored sectors.

Notably, both flakes and micro-flakes are underrepresented, which strongly suggests that the Levallois production phases took place off-site in a broad sense. The knappers likely arrived at Auzières already carrying these Levallois blanks. This interpretation is fully consistent with the rarity of cores: only two poorly invested, expedient cores are present, from which a few undifferentiated flakes were rapidly extracted. This clearly reflects the need to obtain a small number of cutting edges without engaging in more elaborate production phases. We are clearly dealing with expedient behavior: individuals arriving with Levallois products already prepared, extracting a few additional flakes for rapid, immediate use. This is consistent with previous observations in contexts characterised by the alternating or coexisting use of subterranean environments by humans and carnivores (e.g. Lateur et al., 2023; Delpiano et al., 2026).

Most Levallois flakes were produced through unipolar or unipolar convergent reduction strategies (Fig. 8). These finished Levallois products are relatively large (70-80 mm in length) and display minimally prepared striking platforms, only three of which are finely faceted. The industry has an elongated, pointed character, with two or three pieces fitting the strict definition of Levallois points.

4.5. Zooarchaeology and taphonomy

Les Auzières is notable for its succession of human and animal occupations between Isotopic Stages 5 and 4, as revealed by the 2014-2021 excavations. These include cave hyena occupation in Units 4, 5 and 6 (ca. 60 ka BP), as well as an underlying unit (Unit 7) related to Isotopic Stage 5, attesting to the presence of Neanderthal groups. Analysis of the bone surfaces allows us to document the specific behaviours of these groups.

4.5.1. Abiotic processes

The bones exhibit a variety of surface alterations. Traces associated with preservation in a karstic context can be observed (see Coumont, 2009, for more details). These stigmata may be traces of dissolution or cracks resulting from compaction, which have caused deformations of some of the remains. A comparative analysis of the remains unearthed in Units 4, 5 and 6, and in Unit 7, reveals distinct preservation processes.

Traces of non-biological origin are essentially limited to concretions and dissolution processes. These natural alterations are not particularly common and primarily affect material in Units 4, 5 and 6. Some surfaces



Fig. 6 - Burnt Levallois flake (E10.160) from Unit 7.



Fig. 7 - Unipolar convergent Levallois flake (F8.186) from Units 5-6.



Fig. 8 - Recurrent unipolar convergent Levallois flake (E10.163) from Unit 7.

may show cracks and small pits resulting from dissolution. Some specimens are encrusted with brecciated sediment resulting from calcareous runoff. The palaeontological material in Units 4, 5 and 6 is difficult to extract and fragile. Dry fracturing (as defined by Villa & Mahieu, 1991) is rare, indicating a low rate of secondary reworking of the material after burial.

Unit 7 contains material that has been much less altered by abiotic changes. Preserved in a calcification-free sedimentary matrix, none of the pieces have become encrusted. Apart from a few cracks, the bone surfaces are rarely altered. Depending on their general morphology, the largest remains (over 10 cm) show deformations resulting from compaction (e.g. flat bones and belts), or alterations resulting from the structure of the anatomical element itself (e.g. the fragility of antlers).

4.5.2. Carnivore impact

Units 4, 5 and 6 have distinctive faunistic and taphonomic features. The faunal spectrum is highly diverse (see section 4.2). The cave hyena is the most abundant large carnivore; paleontological remains suggest that older individuals most probably died naturally in the cavity. Additionally, the presence of around a hundred coprolites reflects the hyena's long-term occupation of the site.

The remains of numerous animal prey (including horses, ibexes, rhinoceroses and mammoths) have been found. This material often exhibits characteristic tooth marks, as documented by Sutcliffe (1970), Maguire et al. (1980), Brain (1981), Binford (1981) and Fourvel (2012). Traces of carnivore teeth are mainly evidenced by punctures and tooth pits (Binford, 1981; Brain, 1981). These tooth marks affect ungulates, particularly ibex (*Capra ibex*) and horses (*Equus germanicus*), which are the most frequent taxa in Units 4, 5 and 6 (Fig. 9).

Traces of digestion are also abundant. There are numerous horse remains, particularly foal remains, and a large number of small bone fragments that have a polished, sometimes pitted and perforated appearance (Fig. 9). These signs indicate the ingestion and subsequent regurgitation (or defecation) of large quantities of bone. Traces of ingestion are also visible in the remains of other species, such as rhinoceroses and mammoths (dissolved juvenile dental fragments).

The hyena's ability to break and consume bone provides significant evidence for the presence of ingested bones (Sutcliffe, 1970; Maguire et al., 1980). Digested bones are commonly found in fossil accumulations (e.g. Fouvent in Fourvel, 2012; Fourvel et al., 2014; Lunel-Viel 1 in Fosse, 1994; Bois-Roche in Villa et al., 2010; San Teodoro in Mangano, 2011), as well as in modern assemblages (e.g. Mills & Mills, 1977; Horwitz, 1990; Kuhn, 2006). Several studies have examined hyena-digested bones and the osteogenic content of coprolites, as well as distinguishing the impact of hyenas from that of other predators (Horwitz & Goldberg, 1989; Horwitz, 1990; Fosse et al., 2011; Fourvel, 2012; Sanz et al., 2016), and identifying anthropogenic alterations (D'Errico & Villa, 1997). Based on this documentation, the remains of Units 4, 5 and 6 that have been digested are perfectly compatible with the elements found in modern and cave hyena dens.

Despite the proven presence of the red fox, which is known for its ability to mix bone material (e.g. Castel, 1999; Krajcarz & Krajcarz, 2014; Yravedra et al., 2014; Arilla et al., 2019), the effect of carnivores on the material in Unit 7 is virtually non-existent. Furthermore, while fifteen coprolites have been identified in Unit 7, there

are no hyena remains, nor any evidence of digestion or large tooth marks that would suggest the impact of carnivores.

From a taphonomic perspective, it is notable that a high proportion of Arvicolinae incisors and molars exhibit specific alterations induced by predator digestive fluids. The intensity of digestion is characterised by substantial enamel alteration and, in some cases, significant dentin damage. A significant number of Murinae also display low-intensity dental enamel alterations. According to Andrews (1990) and Fernandez-Jalvo & Andrews (2016), this configuration is characteristic of the current coprocoenoses of predators such as *Strix aluco*, *Bubo bubo* and *Genetta genetta* (category 3). The assemblage's taxonomic composition, which is characterised by a limited number of lagomorphs and medium-sized species (mesofauna), suggests *Strix aluco* as the predator. This nocturnal raptor has an eclectic diet and is therefore unlikely to have introduced a predation bias.

The avian bone remains were modified by several agents, including raptors and carnivores. Currently, there is no evidence linking the presence of these remains to the activity of the human communities that occupied the site. Nevertheless, this negative result contributes to a better understanding of the long-term relationship between Neanderthals and birds of prey (e.g. Peresani et al., 2011; Finlayson et al., 2012; Morin & Laroulandie, 2012; Romandini et al., 2014; Radović et al., 2015; Laroulandie et al., 2016).

4.5.3. Anthropogenic activities

A review of the bones excavated by H. Monchot and F. Marchal from Units 4, 5 and 6 allows a single fragment of a deer humerus showing butchery marks to be identified. In the absence of other anthropogenic elements, these remains are anecdotal in the upper layers of the sequence. Evidence of human presence within palaeontological deposits is not uncommon (see Brugal & Jaubert, 1991; Discamps et al., 2012; Fourvel & Fosse, 2017). These remains reflect the complexity of human-carnivore interactions in ancient contexts. They may be the result of a fortuitous introduction, the episodic passage of human groups, or the scavenging and collection of food by hyenas or other carnivores.

There is abundant evidence of human presence in Unit 7. The limited range of fauna (mainly deer) suggests specialised hunting, and the bones show signs of butchery. These include cutmarks, fracture notches, and burnt bones (Fig. 10). Deer are the most frequently exploited species. Twenty-six pieces, i.e. almost 16% of the deer remains, show cutmarks or fracture patterns attributable to carcass processing by Neanderthals. These include fresh oblique and spiral fractures (as defined by Villa & Mahieu, 1991), as well as numerous cutmarks affecting cranial elements (e.g. mandibles and antler bases) and postcranial elements (e.g. tibia and phalanges; Fig. 10).

Although there are only four horse remains in Unit 7, they all attest to having been and butchered by human communities. The right innominate bone, consisting of two separate unfused pieces (E9.482 and G9.378), shows signs of butchery, such as cutmarks and notches (Fig. 9). The specimens were found almost 1.5 metres apart, suggesting that part of the carcass processing took place *in situ*, consistent with the low degree of reworking of the archaeological level. The fresh fracture edges indicate that the innominate was fractured shortly after the animal's death. In addition, refitting reveals a clear, large, sub-circular notch, indicating intentional fracturing. The ilium portion (G9.378) shows numerous cutmarks on the inner side of the pallet (Fig. 10). Similar

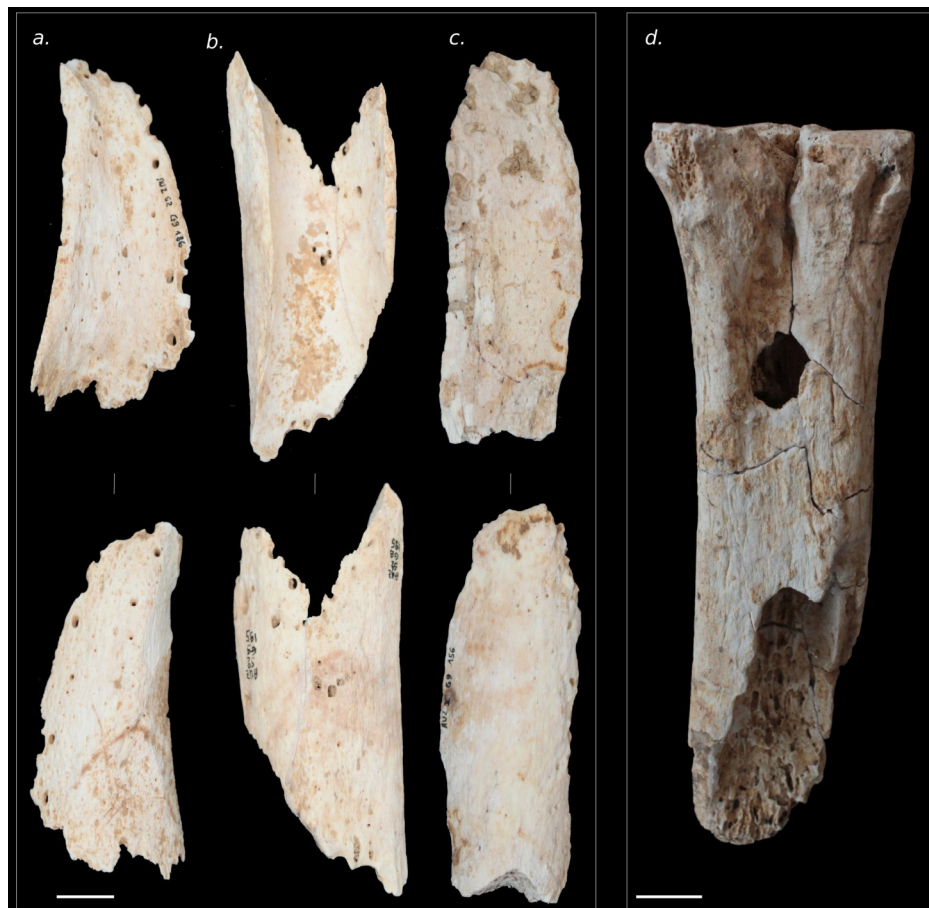


Fig. 9 - Carnivore consumption marks observed at Les Auzières. a to c. bone flakes bearing digestion marks; d. ibex metacarpal bearing carnivore puncture and notch on its palmar surface. Scale bar: 10 mm.

marks can be seen on the iliac ramus (close to the fracture) and behind the acetabulum (at the level of the sciatic spine) of the second fragment (E9.482; Fig. 10). The location of these marks is the result of meat removal.

The cave bear was identified in Unit 7. A portion of a mandible (left ascending limb with the condyle; E9.442) suggests that Neanderthals exploited this species. Located beneath the condyle are a series of cutmarks that suggest the slitting of flesh and muscle in order to disarticulate the animal's jaw. Also found were a rib fragment with no traces of anthropic action, a phalanx (E10.270), and a fractured mandible (F10.271 + E10.275) bearing anthropogenic marks. The fracture separating these fragments of mandible appears fresh, indicating that it was fractured well before burial and most likely shortly after the animal's death.

In addition, the refitting of fragments F10.271 and E10.275 reveals a notch that is characteristic of intentional fracturing. The phalanx (E10.270) bears a series of cutmarks on the palmar surface (Fig. 10). These striations are located on the proximal part of the shaft and are perpendicular to the bone's axis. Such butchery marks are often the result of skinning. These specimens are relevant to the subject of relations between Palaeolithic communities and bears, which has been the focus of research for almost a century (e.g. Lateur et al., 2024).

Lastly, the presence of the Hermann's tortoise raises questions as they are not a troglophile species. Although tortoise remains can be calcinated by a number of phenomena (Royer et al., 2011), the identification of

several burnt carapace fragments (Fig. 10), combined with contextual data from Unit 7 (lithic industries and exploitation of mammalian fauna), suggests that these remains are the result of human activity.

5. CONCLUDING REMARKS

All paleontological (large mammals, small mammals, birds and herpetofauna) and archaeological findings are consistent with sedimentological and geochronological data. Les Auzières, initially described as a hyena den (Marchal et al., 2009), now appears as a mixed-use site and a key element in understanding the role of carnivores in a karst environment. Les Auzières is of particular interest in the Vaucluse Mountains and south-eastern France more broadly, where knowledge of how Palaeolithic human communities exploited their territory is limited, as it helps to fill biochronological and palaeoecological gaps (Crégut et al., 2010).

This site also offers the opportunity to study the relationships and interactions between human groups and communities of large predators, thanks to the alternation between animal occupation (cave hyena den) and human presence (Mousterian hunting halt). The presence of lithic industries in units (Units 4, 5 and 7) corresponding to hyena occupations indicates the occasional presence of human groups through the Gorges de la Nesque during Isotopic Stage 4, whereas the sole anthropogenic unit (Unit 7) is characterised by the scarcity of evidence relating to carnivores. However, the presence of butchered bear remains highlights the sig-



Fig. 10 - Anthropogenic modifications observed at Les Auzières. a and b. red deer rib portion bearing cutmarks; c. cave bear first phalange with skinning-marks on the palmar surface; d. burnt tortoise shell; e to h. horse right ilium bearing cutmarks and percussion notch. Scale bar: 10 mm.

nificance of carnivore fauna in Neanderthal culture.

Despite the limited size of the lithic assemblage, we can identify a cultural signature for these populations. MIS 5 populations remain poorly documented. Chronological attributions within this long period are generally broad and generic. The presence of temperate

fauna and scarce or imprecise dating are often used to identify MIS 5, or even MIS 5e (Slimak & Nicholson 2020). Our documentary gaps here are evident. The sequence at Baume Moula-Guercy records occupations of major significance attributable to MIS 5. The lithic industries from units XIV and XV are nonetheless

sparse, with layer XV yielding more human remains than retouched tools, pointing to highly singular forms of occupation within this cavity. The time for a comprehensive regional synthesis of MIS 5 human societies has therefore not yet come. However, each of these small-scale records will ultimately contribute to defining the cultural structure of these “warm Mousterian” societies within the Mediterranean region.

Two sequences, Le Grand Abri aux Puces and Mandrin units G to J, provide rich information regarding the technical and cultural traditions of populations in the middle Rhône valley (Slimak et al., 2021). The Grand Abri aux Puces sequence spans 12 meters of stratigraphy and fifteen units, likely covering all phases of MIS 5 (see Slimak et al. 2021). These unipolar or unipolar convergent Levallois reduction strategies, relatively expedient, minimally faceted, elongated and pointed, are regionally recognizable in GAP Alpha units, at Mandrin G to J (Slimak et al., 2021), and at Bau de l'Aubesier (Carmignani & Soressi 2023).

These elements remain somewhat generic at present. However, in the long term, they may allow us to define one of the regional cultural entities of MIS 5, and to further interrogate the expedient yet significant presence of these populations within Les Auzières.

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