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Gravettian societies in North-western Europe: new sites, new data, new readings

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Olivier Touzé, Nejma Goutas, Hélène Salomon, Pierre Noiret

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A Review of the Gravettian Collections from the Excavation of Maisières 'Canal' (Prov. of Hainaut, Belgium)

A Combined Study of Fossil and Non-Fossil Animal Resources for Alimentary and Technical Exploitation

Jessica Lacarrière*
Quentin Goffette**
Ivan Jadin****
Caroline Peschaux*
Hélène Salomon***
Nejma Goutas*

Résumé

Le site paléolithique de Maisières « Canal » (province de Hainaut, Belgique), constitue une référence incontournable pour le début du Paléolithique supérieur dans le Nord de l'Europe. Sa richesse documentaire permet d'approcher la complexité des dynamiques humaines, techniques et économiques qui accompagnent la disparition des industries aurignaciennes et l'apparition des premières industries gravettiennes en Belgique et plus largement dans le nord-ouest de l'Europe. Ses particularismes et son excellente conservation ont fait de ce gisement un site clé. Il apparaissait donc crucial de documenter un autre volet de l'économie : celui relatif à l'exploitation alimentaire et technique des ressources animales et à leurs éventuelles complémentarités. Un retour aux séries anciennes, publiées précédemment avec une approche principalement paléontologique (Gautier *et al.*, 1973), a donc été entrepris collectivement. L'introduction vraisemblablement anthropique de ressources marines fossiles non transformées pour la plupart autant que les modalités d'exploitation de l'ivoire de mammouth et de traitement de la petite faune confèrent une place singulière à ce gisement au sein de la « mosaïque culturelle » du Paléolithique supérieur ancien en Europe de l'Ouest. Ce travail a notamment permis un accroissement des décomptes, une analyse taphonomique comparée des différentes catégories de vestiges et enfin, ouvre la porte à de premières interprétations sur les activités menées sur ce site. Disposant d'un potentiel informatif unique et toujours à explorer, Maisières « Canal » se révèle désormais être une fenêtre d'observation majeure sur les stratégies cynégétiques et l'exploitation des matières dures animales du Paléolithique supérieur ancien.

Mots-clés : Belgique, Paléolithique supérieur ancien, Maisiérien, archéozoologie, industrie en matières dures d'origine animale, ivoire de mammouth, ongulés, lagomorphe, oiseaux, ressources marines fossiles.

Abstract

The Palaeolithic site of Maisières 'Canal' (province of Hainaut, Belgium), is a vital reference for the beginning of the Upper Palaeolithic in Northern Europe. The abundant archaeological record from the site enables us to approach the complexity of the human, technical, and economic dynamics accompanying the disappearance of Aurignacian technocomplexes and the emergence of the first Gravettian technocomplexes in Belgium, and more generally in North-western Europe. This is a key site due to its specific characteristics and its excellent preservation. It thus appears crucial to document another aspect of the economy: the alimentary and technical exploitation of animal resources and their possible complementarity. To this end, we collectively undertook a revision of the old collections, previously published as part of a mainly paleontological study (Gautier *et al.*, 1973). Because of the seemingly anthropogenic introduction of mostly non-transformed marine

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* UMR 7041 ArScAn, équipe Ethnologie préhistorique, MSH Mondes, 21 allée de l'Université, 92023 Nanterre cedex (France). Email: jessic.laca@gmail.com / nejma.goutas@cnrs.fr

** Royal Belgian Institute of Natural Sciences, OD Earth and History of Life, Archaeozoology, Vautier Street 29, 1000 Brussels (Belgium). Email: qgoffette@naturalsciences.be

*** CNRS – UMR 5204 EDyTeM, Campus Technolac, 3 boulevard de la mer Caspienne, 73376 Le Bourget-du-Lac (France). Email: helene.salomon@univ-smb.fr

**** Royal Belgian Institute of Natural Sciences, OD Earth and History of Life, Prehistory, Vautier Street 29, 1000 Brussels (Belgium). Email: Ivan.Jadin@naturalsciences.be

fossil resources, as well as the peculiar way in which ivory was worked and the processing of small game, this site holds a singular position in the 'cultural mosaic' of the Early Upper Palaeolithic in Western Europe. The present study resulted in an increase in previous counts, a comparative taphonomic analysis of the different categories of remains and lastly, paved the way for the first interpretations of the activities carried out at this site. The unique informative potential of the site of Maisières 'Canal', which is still largely unexplored, makes it a major site for our understanding of hunting strategies and the processing of hard animal materials of the Early Upper Palaeolithic.

Keywords: Belgium, Early Upper Palaeolithic, Maisierian, archaeozoology, osseous industry in hard animal materials, mammoth ivory, ungulates, lagomorph, birds, marine fossil resources.

1. Introduction

The open-air site of Maisières 'Canal', near Mons in Belgium (fig. 1, no. 1), yielded a reference sedimentary sequence for the end of the Pleistocene, comprising the remains of occupations ranging in age from 31,000 to 33,000 years. The excavations carried out in 1966 and 1967 brought to light diversified and abundant objects in a remarkable state of preservation, attesting to a rare human installation in a peripheral zone of Europe. The dates place Maisières 'Canal' in a key period of the Early Upper Palaeolithic, marked by the succession of Aurignacian technocomplexes and the first Gravettian technocomplexes. Due to its chronological characteristics, the originality of its productions and its lithic technical system, the chrono-cultural attribution of the Maisières 'Canal' assemblage was and continues to be controversial. Can this assemblage be classified among the variability of Gravettian technocomplexes or does it appear to be different? More generally, does it provide evidence of pioneering occupations by populations recolonizing North-western Europe during a climatic amelioration? The difficulty in defining this assemblage, which has no direct equivalent, is conveyed by the very essence of the term 'Maisierian', created by J.B. Campbell (1980) fourteen years after the discovery of the site. Over the past fifty years, several researchers have analysed these collections, and in particular, the lithic remains. Until now, the assemblage in hard animal materials had only been studied using typological approaches, limited to the finished objects. As for faunal analyses, they consisted solely of determinations and first observations (Gautier *et al.*, 1973).

The data presented here result from a dynamic and comprehensive restudy of the archaeological material from this reference site. The results of this combined approach are necessarily constrained by the site context (rescue excavations in difficult conditions, rather imprecise spatial data, etc.), but the primary aim of this collective work is to attempt a global reconstruction of the exploitation of animal resources. Indeed, Palaeolithic sites providing optimal conditions for the application of such approaches are extremely rare. The collective revision of the Maisières 'Canal' collections records unprecedented aspects of the site, which we will attempt to connect in order to propose a better appreciation of the taphonomic history of the site, its environment, the activities that took place there and the know-how and knowledge involved in the acquisition and exploitation of animal resources. The first results of this study are presented here. Without this type of approach, whole sectors of the economy of Palaeolithic, and particularly Gravettian groups are overlooked, as recent excavations do not yield such high-quality assemblages of fauna and artefacts in hard animal materials for the period considered (Lacarrière *et al.*, 2011; Goutas and Lacarrière, 2018). This initial review must continue and will be completed by a discussion integrating the available data on the spatial distribution of the remains.

2. Site presentation

The Maisières 'Canal' site (WGS 84 [DMS]: Long. = 3° 58' 37.5" E, Lat. = 50° 28' 52.3" N) was discovered by G. Bois d'Enghien in 1966 during the construction of the 'Canal du Centre', at the boundary of the communes of Maisières and Obourg (fig. 1, nos. 1 and 2). It is located on the north bank of the flood plain, at an altitude of 34 metres, close to the river. During surveying, G. Bois d'Enghien accumulated a small collection of remarkable remains. The 'Champs de Fouilles', the main locus of the site situated at the bottom of the earthworks (fig. 1, nos. 2, 3 and 4), was delimited by J. de Heinzelin, who was at that time a professor at Ghent University, and who directed the rescue excavations that year in the name of the Royal Belgian Institute of Natural Sciences in Brussels (RBINS). These excavations were carried out in difficult conditions, because of the instability of the sediment and the proximity of the water table (de Heinzelin, 1973; fig. 1, no. 4). The remains from these two investigations are respectively named 'collection BdE', corresponding to the assemblage derived from the first excavations by G. Bois d'Enghien, mainly from the stratigraphic unit which yielded the most archaeological remains (M.H), and 'collection

RBINS', which corresponds to the ensuing excavations, directed by J. de Heinzelin. These excavations revealed what could be attributed to a rich open-air occupation, although we cannot rule out the possibility that it may in fact correspond to a palimpsest. This occupation is located near a source of good-quality lithic raw materials, at a likely strategic hunting spot: on a hill, close to a ford, and just before the river outlet into the flood plain (*ibidem*, Gautier *et al.*, 1973). The following year, about a hundred metres from the first site, a knapping workshop zone ('Berge Nord-Est – northeast bank') was excavated by P. Haesaerts, in collaboration with J. de Heinzelin (Haesaerts and de Heinzelin, 1979; fig. 1, no. 2). Finally, in this same sector, an Aurignacian knapping workshop was excavated between 2000 and 2002 by R. Miller and M. Otte (Miller *et al.*, 2004; Prehistory Museum of the University of Liège).

Furthermore, this site documents a chrono-sedimentary and paleoclimatic reference sequence for Central Belgium (Haesaerts and de Heinzelin, 1979; Haesaerts, 2004). The analysis of this sequence showed that the colluvial deposit of sandy silts containing the remains of human occupations was affected by the development of a humic soil (units M.G. to M.I.), denoting the transition from a cold and dry climate to the Maisières interstadial, characterized as a wet and slightly less harsh period ('medium cold', Haesaerts and de Heinzelin, 1979, p. 43). The dating of this paleosoil (on humic material, unit M.G/H., GrN-5523: 27 965 ± 260 BP; *op. cit.*, p. 15) is considered to be in agreement with the dating of the human occupation remains and with regional paleoclimatic sequences (de Heinzelin, 1973; Haesaerts and de Heinzelin, 1979; Haesaerts and Damblon, 2004; Jacobi *et al.*, 2010). The position of this benchmark horizon, combined with the analysis of the geometric relationships between the sedimentary profiles, the succession of hiatuses and paleosoils and the fluctuations of the water body, established that the 'Champs de Fouilles' was contemporaneous with the 'Berge Nord-Est', where the archaeological material contained in the run-off silts of unit N.D.C was discovered lying flat, with no sign of vertical displacements (Haesaerts and de Heinzelin, 1979). Considering this sedimentary and paleoclimatic record, the occupation period of the site is presumed to be contemporaneous with a climatic amelioration of short duration. A series of ten dates was obtained in 2007 by AMS and ultrafiltration (Oxford Radiocarbon Accelerator Unit) on faunal remains taken exclusively from the 'Champs de Fouilles' collection (Jacobi *et al.*, 2010, tabl. 1 and 2). The selection included: five bones presenting anthropogenic marks but discovered in reworked or indeterminate contexts (reindeer, bear and arctic hare) and four remains with a physical link with the occupation level M.H. These latter are an 'artefact' in mammoth ivory (a bevelled piece with traces of abrasion, OxA-17962: 29 060 ± 170 BP), a mammoth tusk (OxA-17946 and OxA-17947: 28 290 ± 150 BP et 28 780 ± 170 BP), a mammoth bone gnawed by a carnivore for which the anthropogenic contribution remains uncertain (OxA-18009: 28 150 ± 160 BP) and, finally, a reindeer radio-ulna bearing cut marks, which is a reliable marker of a contemporaneous relationship between the death of the animal and the exploitation of the carcass (OxA-18007: 27 950 ± 170 BP). The dates on ivory and the gnawed mammoth bone were excluded from the Bayesian model published in 2010 (*op. cit.*), as the presence of these remains on the site was considered as a possible natural accumulation, prior to the Maisierian occupation. We will see below that the new results on ivory, involving technological data, reopen this debate. Finally, in order to determine the age and the duration of the occupation of the camp, the authors postulated a single short-duration occupation during the Maisières interstadial and assimilated all the retained dates to the same dated event. This means that they presumed that the death of the animals was contemporaneous with their consumption on site, even for remains derived from reworked contexts, suggesting a period of human presence confined to the Dansgaard-Oeschger 5 event, at around 32.5 ka cal BP (Jacobi *et al.*, 2010; fig. 7).

In consequence, the site of Maisières 'Canal' appears to be crucial for documenting the emergence of the Gravettian in the North of Europe (*op. cit.*) given its radiometric dates, the originality of its lithic industry with regard to other Early Gravettian industries (Touzé, 2018), but also its specific open-air context and the excellent preservation of the bone material (de Heinzelin, 1973; Otte, 1979; Pesesse and Flas, 2012; Touzé *et al.*, 2016; Touzé, 2018, 2019). The lithic collection of more than 34,000 artefacts records the exploitation of several types of flint, mostly from a radius of 10km around the occupation, which indicates a procurement strategy centred on the Mons Basin (Moreau *et al.*, 2013). The debitage seems to have focused mainly on the production of laminar products, which make up most of the tool blanks (77.6%). Flakes were much more rarely transformed into tools (10%) and bladelets were only occasionally retouched (0.2%; Touzé, 2018). According to the recent study and counts (*op. cit.*), out of the 945 tools, 40.4% are burins and 20.6% are points. The latter are divided into several morphological groups:

tanged points, shouldered points and points with no particular retouching of the proximal part, named 'Maisières points' (*sensu* Otte, 1979). All these points present very varied morphologies and dimensions and some are compatible with use as the apical elements of hunting weapons. The presence of diagnostic fractures confirmed this hypothesis (Rots, 2002; Pesesse and Flas, 2012), but no clear consensus has yet been reached regarding the suggestion that the points were used as armatures (Touzé, 2018). Indeed, on certain larger-sized points, the absence of specific functional fractures (linked to the impact) along with the presence of at least two tanged points bearing traces related to carcass processing butchery activities indicate that some of these tools were used as knives. The ongoing systematic micro-wear study of these artefacts should determine the proportion of points used for hunting activities (Taipale, 2020; Coppe, in prep.). In addition, a study focusing on the comparison between archaeological Maisières points and experimental points used as projectile elements is in progress in order to identify specific damage on the points according to the projecting or thrusting methods of the weapons (Coppe, in prep.). However, it is already clear that the lithic toolkit seems to have been mainly used for hunting and butchery activities.

3. Previous analyses of the faunal remains (terrestrial, avian) and marine fossil organisms

A. Gautier's study of the mammalian fauna (1973) describes a well-preserved, but very fragmented assemblage. Indeed, the excavation, often including sediment sieving, led to the recovery of mainly small-sized bone elements, a lot of which were calcined. In sectors J10-L11-M10, more than 80% of the recovered bones are burnt and most of them measure less than 3cm. The largest elements of the collection are not burnt but indicate a "very intensive intentional debitage[1]" (Gautier, 1973, p. 4). According to A. Gautier, this anthropogenic fracturing is directly linked to the use of bones as fuel, which would explain the low proportion of determinable remains. The same author presented a detailed paleontological study of the identifiable bones (tabl. 1). Among the carnivores, he identified the remains of a large-sized brown bear (*Ursus arctos*) and elements attributed to the arctic fox (*Vulpes lagopus*). The category of ungulates includes cranial and post-cranial mammoth remains (*Mammuthus primigenius*), comprising two carpal bones connecting with a metacarpal III recovered nearby on the site. Very fragmented tusk elements are also reported and seem to be concentrated in sector K11 "especially in the humic layer" (Gautier, 1973, p. 9). This detail is a reminder that the mammoth remains were not all clearly positioned in stratigraphy, as was the case during the excavation by G. Bois d'Enghien and in the reworked layers. Considering the patina on certain elements and the remnants of adhering sediments, A. Gautier (1973) suggested a different sedimentary, and therefore stratigraphic provenance. The faunal assemblage also indicates the presence of the horse: teeth, girdle bones, long bones, phalanges, a 'rolled' distal left tibia, as well as a scapula presenting a different preservation status from the rest of the material, which was interpreted as the possible consequence of an intrusion or reworking. The reindeer (*Rangifer tarandus*) was identified by antler fragments, two skulls, two left mandibles and isolated teeth. Another cervid metatarsal could be related to a large-sized deer. The large herbivores also include the cranial fragment (orbit) of a bovid, the aurochs or bison (*Bos*/*Bison*). The mountain hare (*Lepus timidus*) is an abundant species represented by cranial and post-cranial material. A. Gautier specifies that certain long bones were intentionally broken. Finally, an incomplete small-sized mustelid mandible was identified as the least weasel (*Mustela nivalis*). Two different sized classes of mostly dental vole remains were identified; a large-sized vole species (*Arvicola amphibus*/*terrestris*) and a small one (*Microtus agrestis*/*arvalis*). Finally, the tundra vole (*Microtus oeconomus*), identified at Maisières by three dental remains, indicates a wet environment. The precautionary principle must be applied regarding the association of these micro-mammals with the archaeological level (possible intrusions).

The unmodified bird remains were analysed by P. Ballmann (1973), whereas the notched bird bones were studied by J. de Heinzelin (1973). The study by P. Ballmann consisted in identifying the taxa and the anatomic elements with no particular examination of the bone surfaces. P. Ballmann identified 29 remains belonging to four taxa: a ptarmigan (*Lagopus* sp.), the black grouse (*Lyrurus tetrix*), the snowy owl (*Bubo scandiacus*) and the Northern raven (*Corvus corax*). In contrast, four tubes made of bird bones displaying transversal incisions are mentioned by M. Otte, in Haesaerts and de Heinzelin (1979, p. 72).

The formerly published assemblage in hard animal materials included 49 pieces (including two which are temporarily exposed in the Prehistomuseum (Ramioul), which we have not yet been able to study). These consist mainly in ivory elements (N = 29), bone artefacts (N = 19), and a single antler element (Otte, 1979, p. 553-556 and 620, see tabl. 2). The presence of worked bone had already been identified by A. Gautier: small mammal long bones (hare or fox) bearing transverse notches; two reindeer first phalanges interpreted as whistles and fragments of mammoth ivory bearing a geometric pattern. The above cited author also mentions ivory points and fragments of mammoth ribs bearing traces of use. These latter elements were described in more detail by J. de Heinzelin (1973, p. 31-36).

Finally, the site also yielded marine fossil organisms. Here, 'fossils' does not refer to animal elements processed by the site occupants, in contrast to the other animal remains. Instead, these elements represent fossilized marine animal remains from Mesozoic and Paleogene geological levels (-250 to -20 Ma). These fossils were considered as "objets remaniés" (reworked objects) (de Heinzelin, 1973, p. 37-38). They were studied by M. Glibert and E. Casier in the first publication of the site (de Heinzelin, 1973, p. 38). The abovementioned authors report 15 invertebrate remains (marine mollusc shells, sponges, belemnites, coral and urchin) and describe eight types of fish remains (including shark teeth), without specifying the number of these elements.

These counts subsequently underwent several changes as the invertebrates were assimilated to fossil shells and the fish remains were counted according to the number of taxa mentioned in the first publication, whereas, in reality, the fish remains are much more abundant (cf. tabl. 1).

4. Material and method

The assemblage contains a total of 10,054 mammal and bird remains, as well as 87 marine fossils (tabl. 1). This represents all the remains in hard animal materials from the RBINS and BdE collections, apart from micromammal remains.

The corpus of mammal and bird remains studied in this work includes the elements formerly determined by A. Gautier (123 pieces) and P. Ballmann (29 pieces) respectively, to which we added many bone remains classified as indeterminate by A. Gautier, but which include identifiable elements (tabl. 1). The faunal collections were reviewed in order to check for the presence of avian remains, which enabled us to enlarge the number of identified remains and separate a series of non-identifiable bird remains. Considering the difficulty in distinguishing certain small bird bone fragments from those of mammals, such as the hare or the fox, this number is probably underestimated.

Out of a total of 9,758 largely burnt and very fragmented osseous fragments which mostly come from large to very large mammals (*Equus, Bos/Bison, Coelodonta, Mammuthus*), 973 osseous mammal and bird remains were individually recorded as part of the present archaeozoological analysis. They were individually described and the following criteria were noted: identification of the species, the anatomic element and the conserved portion of fragmented remains. To facilitate species identification, we consulted the reference collection of the Royal Belgian Institute of Natural Sciences and the Royal Museum for Central Africa. Counts are expressed in number of specimens, including both determined and undetermined remains (NSP: Grayson, 1991), in number of identified specimens (NISP: Grayson, 1984) and in minimum number of individuals (MNI: Lyman, 1994).

Surface alterations were recorded by observation with a magnifying lens (magnifications 20x), in particular colour (López-González *et al.*, 2006), weathering (Behrensmeyer, 1978) and carnivore traces (Binford, 1981). In the same way, all anthropogenic modifications were systematically documented (Landt, 2007; Lyman, 1987; Pérez Ripoll, 2005-2006; Shipman and Rose, 1983; Fisher, 1995; Laroulandie, 2001; 2005; Laroulandie *et al.* 2008; Lloveras *et al.*, 2009; Saladié *et al.*, 2013). Bone fracture planes were observed by noting a certain number of criteria in order to differentiate green bone fractures from dry bone fractures (Haynes, 1983; Laroulandie, 2000; Villa and Mahieu, 1991).

As we only considered the number of identified remains by species, the size of the sample is limited and therefore differential conservation is not analysed in the present work.

The objects previously documented as osseous industry *stricto sensu*, conserved at the RBINS, were recounted, as were the marine fossils. Technological and micro-wear approaches (modifications of the surface and volume at macro- and mesoscopic scales) were applied to both categories of objects, but for the osseous industry only the remains in ivory (nearly 500 revised remains) and the productions in bone and in antler were subjected to further detailed analysis. The determination of the fossils was based on comparative anatomy using paleontological reference books (Cossmann and Pissaro, 1904-1913; Fischer, 2000) and consultations with specialists (B. Genault for the fish remains).

The ivory elements and fossils were observed for technical traces and taphonomic modifications under a stereomicroscope – Leica MZ75 with an infinity X camera and Leica S9i (magnifications 6.3x to 50x). Images were acquired in focus stacking.

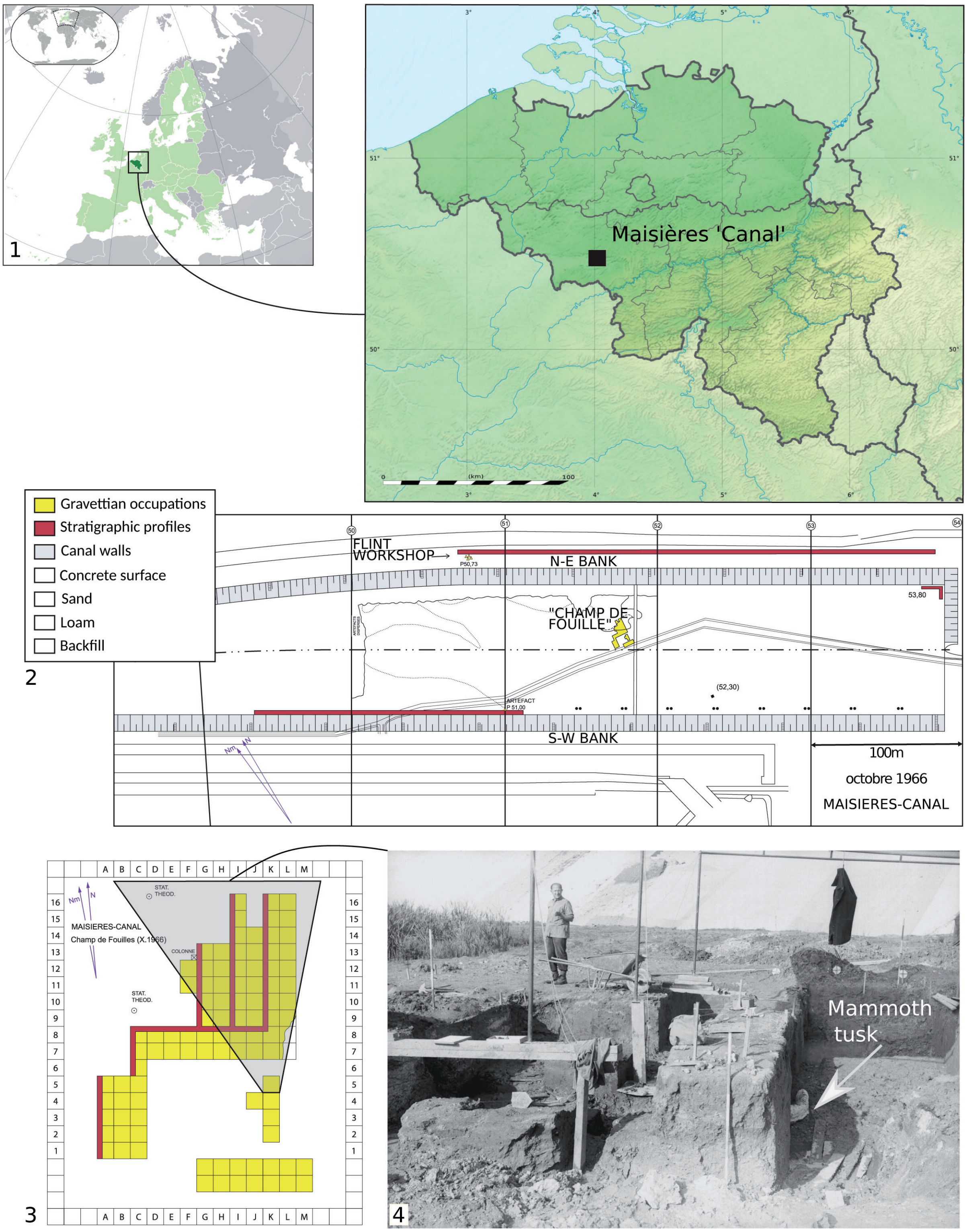

Figure 1 – Situation et contexte général du site. 1 : Localisation ; 2 : Plan général du secteur des fouilles à Maisières « Canal », position des levées sédimentaires du « Champ de fouilles » et de l'« atelier de taille » ; 3 : plan du « Champ de fouilles » et position des levées stratigraphiques ; 4 : Photographie du « Champ de fouilles » couche M.G.-H., carrés I-J-K10-11 (sources : Nuclear Vacuum ; plans d'après Haesaerts et de Heinzelin, 1979, modifié ; DAO : O. Touzé ; photographie : coll. IRSNB).

Figure 1 – Position and general context of the site. 1: Localisation; 2: General plan of the excavation sector at Maisières 'Canal', position of the sedimentary sections of 'Champs de fouilles' and 'atelier de taille'; 3: 'Champs de fouilles' plan and position of the stratigraphic sections; 4: 'Champs de fouilles' photos M.G.-H. layer, I-J-K10-11 squares (sources: Nuclear Vacuum; plots from Haesaerts and de Heinzelin, 1979, modified; CAD: O. Touzé; picture: coll. RBINS).

	Gautier *et al*., 1973 (fauna); Otte 1979, Haesaerts and Heinzelin, 1979 (industry)			Lacarrière *et al.*, this article; Goffette *et al.*, in prep.; Peschaux, this volume		
TAXA MAMMALS	**NSP fauna minimum (MNI)**	**NSP osseous industry**	**TOTAL NSP (MNI)**	**NSP fauna (MNI)**	**NSP osseous industry**	**TOTAL NSP (NMI)**
Ursus arctos	5 (1)		5 (1)	5 (1)		5 (1)
Alopex lagopus/ Vulpes sp	>19 (4)		>19 (4)	84 (6)		84 (6)
Mammuthus primigenius (excluding ivory)	>17 (1)	2 (according to de Heinzelin in Otte, 1979, p, 554) and exact count not given (in Haesaerts and Heinzelin, 1979)	>19 (1)	14 (1)	2 (according to de Heinzelin in Otte, 1979, p, 554) and exact count not given (in Haesaerts et Heinzelin, 1979) but not studied here	>529 (1)
ivory only	>3	29 (after Otte, 1979) and 28 (after Haesaerts and Heinzelin, 1979)	> or = 32	235	278 (including the 2 pieces curated at Ramioul Museum, but not studied here)	
Equus sp.	7 (1)			12 (1)		12 (1)
Rangifer tarandus	>23 (2)	1 (after Otte, 1979) and 0 (after Haesaerts and Heinzelin, 1979)	>24 (2)	90 (2)	at least 1 (after Otte, 1979) but not studied here	91 (2)
Cervus sp.	1 (1)		1 (1)	1		1 (1)
Bos/Bison	1 (1)		1 (1)	4 (1)		4 (1)
Lepus timidus	47 (8)		47 (8)	185 (8)		185 (8)
Total identified mammals	***>123 (>19)***	***32***	***>155***	***630***	***281***	***911***
Indeterminate mammals	>678 (count of the calcined bones from sector M10, after Gautier *et al.*, 1973, p. 4)	13 (after Otte, 1979) and >9 (after Haesaerts and Heinzelin, 1979)	>13 or >9	267	13 artefacts in bone (after Otte, 1979) and >9 (after Haesaerts et Heinzelin, 1979), not studied here	280 or 276
Number of mammal remains (excluding industry) not studied here				8785	/	8785
TOTAL MAMMALS	**>801**	**45 (after Otte, 1979) and >41 (after Haesaerts and Heinzelin, 1979)**	**>846 or >842**	**9682**	**294 or 290**	**9976 or 9972**
BIRDS						
Lagopus sp.	1 (1)			11 (2)		11 (2)
cf. *Lagopus* sp.	0			1 (-)		1 (-)
Lyrurus tetrix	17 (4)			0		0
Anas sp.	0			1 (1)		1 (1)
Anatinae	0			18 (7)		18 (7)
Charadriidae cf. *Pluvialis squatarola*	0			1 (1)		1 (1)
Bubo scandiacus	4 (1)			5 (2)	2	7 (2)
cf. *Bubo scandiacus*				2 (-)		2 (-)
Asio flammeus				1 (1)		1 (1)
Corvus corax	7 (2)			7 (3)		7 (3)
Total of identified birds	***29 (8)***			***47 (17)***	***2***	***49 (17)***
Indeterminate birds		4 (Otte, 1979 and Haesaerts and Heinzelin, 1979)		27	2	29
TOTAL BIRDS	**29**	**33**		**74**	**4**	**78**
TOTAL BIRDS + MAMMALS	**>830**	**49 (according to Otte, 1979) and > 41 (according to Haesaerts and Heinzelin, 1979)**	**>879 or >871**	**9756**	**298**	**10054**
MARINE FOSSILS						
Fish (fossils)						
Odontaspidae and Lamniformes (shark)	"*isolated teeth*" (*cf*. E. Casien *in* De Heinzelin 1973)	8* (cf. Otte 1979)		50		50
Odontaspis hopei (shark)	"*isolated teeth*" (*cf*. E. Casien *in* De Heinzelin 1973)			16		16
Lamna verticalis (shark)	1 (*cf*. E. Casien *in* De Heinzelin 1973)			1		1
Striatolamia macrota (shark)	1 (*cf*. E. Casien *in* De Heinzelin 1973)			1		1
Pristidae (sawfish)	1 (*cf*. E. Casien *in* De Heinzelin 1973)			1		1
Myliobatidae (ray)	1 (*cf*. E. Casien *in* De Heinzelin 1973)			1		1
Sparidae (bony fish)	1 (*cf*. E. Casien *in* De Heinzelin 1973)			1		1
Molluscs (fossils)						
Natica epiglottina (natice)	1 (*cf*. M. Glibert *in* De Heinzelin 1973)	15* (cf. Otte 1979)		1		1
fragment indeterminate gastropod	1 (*cf*. M. Glibert *in* De Heinzelin 1973)			1	1	2
Other marine organisms (fossils)						
Porifera (sponge)	8 (*cf*. M. Glibert *in* De Heinzelin 1973)			8		8
Belemnoidea (belemnite)	2 (*cf*. M. Glibert *in* De Heinzelin 1973)			2		2
Inoceramus sp. (Inoceramus)	1 (*cf*. M. Glibert *in* De Heinzelin 1973)			1		1
Hexacorallia (coral)	1 (*cf*. M. Glibert *in* De Heinzelin 1973)			1		1
Echinoidea (urchin)	1 (*cf*. M. Glibert *in* De Heinzelin 1973)			1		1
TOTAL FISH + FOSSILS						**87**

Tableau 1 – Anciens et nouveaux inventaires du matériel faunique et fossiles (coll. G. Bois d'Enghien et coll. IRSNB). Colonnes de gauche : décomptes A. Gautier de la faune mammalienne exprimés en nombre minimum de restes (lorsque cela est précisé) et nombre minimum d'individus (entre parenthèses). Décomptes P. Ballmann pour les restes aviaires. Décomptes E. Casier et M. Glibert pour les fossiles. *Voir le texte pour une explication sur la confusion entre les différents décomptes anciennement publiés. Colonnes de droite : décomptes actualisés suite à la reprise de la collection.

Table 1 – Former and new inventories of faunal material and fossils (G. Bois d'Enghien and RBINS coll.). A. Gautier's counts of mammalian fauna are expressed as Number of Specimen (NSP, when it specified) and as minimum number of individuals (MNI, in parentheses). P. Ballmann's counts for the avian remains. E. Casier's and M. Glibert's counts for fossils. *See text for an explanation on the confusion between the different formerly published counts. Columns on the right: updated counts after the revision of the collection.

Formerly published Industry				
A- Counts after Otte 1979	**Bone**	**Ivory**	**Antler**	**TOTAL**
Smoother-burnisher	3	/	/	**3**
Spatulas (?)	2		/	**2**
Ivory rods	/	18	/	**18**
Worked fragments	8	/	/	**8**
Whistles (?)	2	/	/	**2**
Edges of recipients (?) in ivory	/	2	/	**2**
Decorated needle in ivory	/	1	/	**1**
Notched tubes	4	/	/	**4**
Incised plaquettes	/	5	/	**5**
"Spear" (?)		3	/	/
Antler with "grooved cutting (…) until the medullary part"	/	/	1	**1**
TOTAL (Otte, 1979)	**19**	**29**	**1**	**49**
B- Counts after Haesaerts and de Heinzelin (1979) *pieces published under the category "témoins esthétiques"	**Bone**	**Ivory**	**Antler**	**TOTAL**
Bipoint	/	1	/	1
Short points with severed base	/	2	/	2
Spatulas	2		/	2
Ivory blade	/	1	/	1
Rods	/	8	/	8
Bâtonnets (sometimes pointed)	/	8	/	8
Punch (thick rib fragments)	5	/	/	5
Perforated reindeer phalanges	2	/	/	2
Cylindrical recipients	/	2	/	2
Diverse massive fragments with traces of work	?	/	/	?
Diverse fragments of massive ribs suggesting smoothers or burnishers	?	/	/	?
Needle*	/	1	/	1
Tubes and incised (avifauna)*	4	/	/	4
Decorated plaquettes*	/	5	/	5
TOTAL	**> 13**	**28**	**0**	**> 41**

Tableau 2 – Inventaires anciennement publiés de l'industrie osseuse de Maisières « Canal » (A : d'après Otte, 1979, p. 554-556 et p. 62 ; B : d'après Haesaerts et de Heinzelin, 1979, p. 72).

Table 2 – Previously published inventories of the bone industry at Maisières 'Canal' (A: after Otte, 1979, p. 554-556 and p. 62; B: after Haesaerts and de Heinzelin, 1979, p. 72).

5. Faunal spectrum and anatomic representation (JL, QG and CP)

The updated counts with the number of faunal remains and the number of elements attributed to the osseous industry category (including transformed or non-transformed ivory) show that the best represented species in terms of the number of remains is the mammoth with 529 fragments or whole short determined bones (tabl. 1). More than 97% of these remains (N = 512, see tabl. 3) are elements in ivory, resulting from the fragmentation of one or several tusks. This fragmentary state of the ivory artificially amplifies the importance of this species in the corpus. The rest of the corpus comprises a molar, at least four rib fragments and several fragments of non-identified long bones, including one similar to a humerus, a fragment of a flat bone (scapula or coxal), a tarsal and two phalanges 3 (tabl. 3).

The hare is the second most represented species (NISP = 185) with a minimum of seven adult individuals and one immature individual. The latter was recognised by the presence of a fusing bone epiphysis. All the skeletal elements are represented, apart from carpals and phalanges (tabl. 3; fig. 3). For this species, cranial elements (including maxillaries, mandibles and isolated teeth) are the most frequent. They are followed by the long bones, particularly the radius, ulna and tibia. It is important to note that because long bone cylinders (without conserved articular extremities) were not included in the study (since the distinction between fox and hare diaphysis fragments is in progress), long bones are slightly underrepresented in these counts. Remains from the scapular and pelvic girdle are abundant whereas vertebra and rib fragments are rare and very fragmented. The axial skeleton may be underrepresented due to the difficulty in distinguishing it from that of the fox, which is also frequent in the assemblage. The undetermined bones attributed to size class 1 (see tabl. 1) are mostly composed of very fragmented spine elements. Tarsals are frequent, contrasting with the absence of carpals and phalanges. This does not seem to be due to excavation techniques as small elements, such as malleoli and isolated teeth, are present. This overall skeletal representation could indicate a skinning activity (rarity of lower limbs, high proportion of cranial elements) and culinary preparation (frequency of girdle bones, limbs and mandibles; see Cochard, 2004).

The reindeer is the third species of the corpus with 91 osseous remains belonging to at least two individuals, an adult and an immature specimen. Cranial elements are the most frequent, mainly made up of antler (NISP = 22). Several isolated upper and lower dental remains show that at least two skulls and mandibles (an adult and a young animal) were transported to the site. Most of the ribs present a whole section, but they are fragmented and generally represented by the mesial part. Only two articular extremities were observed. Two sternum fragments were identified. On the other hand, no vertebrae were recorded. Girdle bones are rare, as are forelimb elements (tabl. 3). Metacarpals and carpals are absent. As for the hindlimbs, femurs are less represented than tibias, mainly identified by shafts. Tarsal and metatarsal shafts also indicate the transport of lower rear limbs. Finally, six anterior or posterior phalanges (phalange 1 = 4; phalange 2 = 1; phalange 3 = 1) were identified.

The fox (NISP = 84 for a minimum number of six individuals) is represented by most of the skeletal elements, apart from carpals, malleoli, sesamoids and ribs. The latter are difficult to differentiate from hare ribs, and they may thus be present in the assemblage but temporarily classified with the indeterminates. A more in-depth analysis may lead to the reattribution of some of the class 1 sized remains (cf. *supra*). Long bones are not very frequent in comparison to the shoulder girdle and metapodials.

The horse (NISP = 12 for an MNI of one), is mainly represented by fragments of ribs and girdle bones: shoulder and coxal elements. A metacarpal IV, a phalange 2 and a proximal ulna form the rest of the corpus.

For the bear (NISP = 5), a first phalange, a distal tibia, two tarsals and a metatarsal indicate the presence of at least one individual.

Finally, a bovid (NISP = 4), with a cranial remain, two rib fragments and a humerus, and a red deer (NISP = 1), with a single metatarsal, are represented by one individual each.

At least six bird taxa were identified for a minimum number of 17 individuals (tabl. 1). Ducks (Anatinae) are the best represented with 19 remains (including 17 elements formerly attributed to the black grouse by P. Ballmann) and a minimum of eight individuals. Only radius fragments were recovered for this taxon. They are followed by ptarmigans with 11 remains that represent all the anatomic parts, apart from the head, and which belong to at least two individuals.

The Northern raven (NISP = 7), with a minimum of three individuals, yielded a vertebra and coracoid and ulna fragments. The snowy owl (NISP = 7, MNI = 2) is represented by most of the skeletal parts, apart from vertebrae, the sternum and ribs.

	Ungulates						Carnivores	
	Mammoth	Bovid	Horse	Red deer?	Reindeer	Hare	Bear	Fox
Skull (including antler for cervids)		1			27	10		5
Isolated dental remains	513				7	44		
Mandible					5	17		1
Vertebra						6		9
Rib (including sternum)	4	2	5		12	4		
Scapula			1		2	10		13
Humerus		1			2	8		2
Radius			1		2	11		3
Ulna			1			9		5
Metacarpal			1			3		15
Carpals								
Coxal			2		1	12		2
Femur					4	15		2
Tibia (including malleolus)					10	26	1	2
Metatarsal				1	4	3	1	13
Tarsals	2				6	7	2	2
Sesamoids					1			
Phalange 1					6		1	7
Phalange 2			1		1			3
Phalange 3	2				1			
Indeterminate long bone	7							
Indeterminate flat bones	1							
TOTAL	529	4	12	1	91	185	5	84

Tableau 3 – Représentation squelettique des ongulés et des carnivores présentée en NRDt par élément squelettique.

Table 3 – Skeletal representation of ungulates and carnivores presented as NISP per skeletal element.

Taphonomic modifications	Mammals	Birds
Coloration	79.8	3.8
Traces of roots	31.2	33.8
Weathering	8.9	10.0
Carnivores	1.3	0

Tableau 4 – Caractérisation des principales atteintes taphonomiques et traces anthropiques observables sur les surfaces osseuses présentées en % NISP (mammifères et oiseaux).

Table 4 – Characterization of the main taphonomic and anthropogenic marks observed on bone surfaces presented in % NISP (mammals and birds).

Figure 2 – États de surfaces des ossements et des fossiles découverts à Maisières « Canal ». 1 : coxal de cheval avec traces de mâchonnement ; 2 : phalange de renne digérée ; 3 : coxal de lièvre présentant des traces de radicelles ; 4 : coracoïde de harfang des neiges (*Bubo scandiacus*) présentant des traces de radicelles et des dépôts de colle résultant d'un remontage ancien ; 5 : fragment d'ivoire présentant des stigmates de dissolution, des dépôts de fer et de manganèse et une texture fibreuse ; 6 : fossile de dent de requin présentant des traces de radicelles. Barres d'échelle : 1 cm. Coll. IRSNB (clichés : É. Dewamme, J. Lacarrière, C. Peschaux, H. Salomon).

Figure 2 – Surface conditions of the bones and fossils discovered at Maisières 'Canal'. 1: Horse coxal with chewing marks; 2: Digested reindeer phalange; 3: Hare coxal with root marks; 4: Snowy owl (*Bubo scandiacus*) coracoid with root marks and traces of glue applied during former restoration; 5: Ivory fragment with dissolution marks, iron and manganese deposits and a fibrous texture; 6: Fossil shark tooth with root marks. Scale: 1cm. RBINS coll. (pictures: É. Dewamme, J. Lacarrière, C. Peschaux, H. Salomon).


Maisières Canal
5cm
1
2
3
4
5
6
1cm

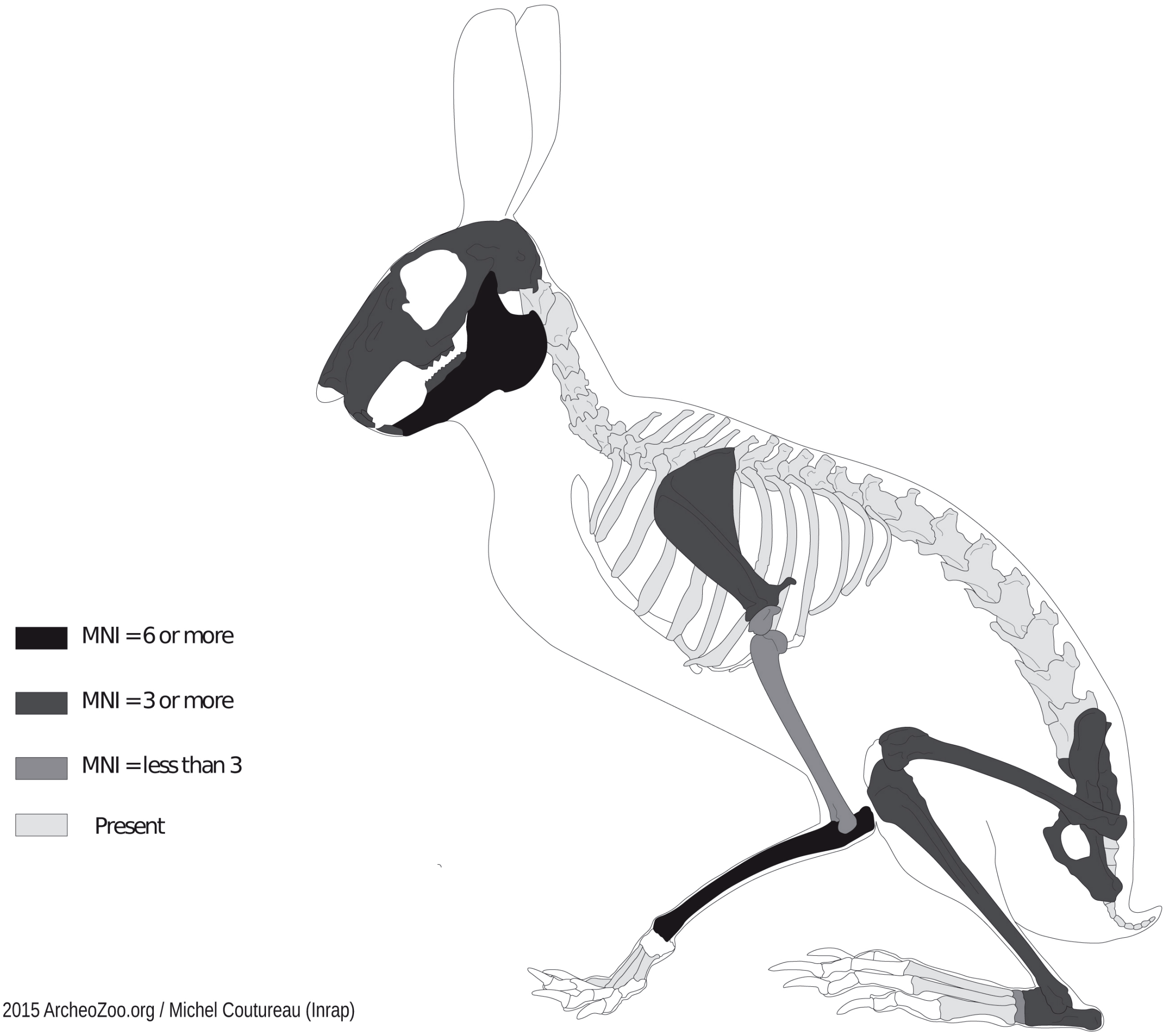

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Figure 3 – Représentation anatomique du lièvre (*Lepus timidus*) présenté en nombre minimum d'individu.
D'après : Squelette remonté.

Figure 3 – Anatomical representation of the hare (*Lepus timidus*) presented as minimum number of individuals.
Based on: reassembled Skeleton

A fragment of a Charadriid tarsometatarsus, a small wader, probably belongs to a grey plover (*Pluvialis squatarola*), and a fragment of a short-eared owl (*Asio flammeus*) carpometacarpus was also identified.

Overall, a clear imbalance emerges in the skeletal remains with a predominance of wing bones for the snowy owl, the Northern raven, and especially for the ducks.

Among the 86 fossils (tabl. 1), only two correspond to marine gastropod shells. The first is a Natica belonging to the *Natica epiglottina* species and the second is a fragment of a large elongated gastropod, perhaps the base of a Fusidae, Conidae or Volutidae shell. Large fish remains are remarkably abundant with 71 elements. They consist of 68 shark teeth, mainly belonging to the Odontaspidae and Lamniforme families. Eighteen teeth can be accurately determined (Casier *in* de Heinzelin, 1973, p. 38): 16 are *Odontapsis hopei* front row teeth, one is a juvenile *Striatolamia macrota* tooth, and one is a *Lamna verticalis* front tooth. Three other fish remains were also identified: a rostral sawfish tooth from the Pristid family, the middle part of a caudal spur with spines attributed to the Myliobatid ray family and a bony fish grinding molar, probably belonging to the Sparid family. Finally, the fossils also include 13 mineralised internal casts corresponding to eight sponges (Porifera), two belemnite fragments (Belemnoidea), a fragment of an Inocerid (*Inoceramus* sp.; which is a large bivalve that went extinct during the Cretaceous period), a Hexacorallia type coral and a fragment of an urchin radiole (Echinoidea).

6. Taphonomic observations (JL, QG, NG and CP)

Generally speaking, the preservation status of the osseous remains (excluding the marine fossils) is very good (mammals and birds), which is exceptional for an Early Upper Palaeolithic open-air site. However, a number of taphonomic modifications are observable (fig. 2; tabl. 4). The most obvious of these is the diversified colouring of the osseous surfaces (light-brown, grey-black, orange-red). This colouring has been observed on 80% of the remains analysed up until now (tabl. 4) and is due to the formation of metallic oxides (red iron oxides, yellowy-brown iron ox(yhydrox)ides and black manganese oxides) on the surface of remains in hydromorphic soils (Goldberg and Macphail, 2006, p. 26 and 67 and fig. 2, no. 4) and to the decomposition of organic matter (*op. cit.*, p. 97). Traces of roots are also frequent and were observed on nearly a third of the analysed osseous remains (31.2%; fig. 2, nos. 3, 5 and 6). Finally, several markers of weathering (longitudinal cracks, desquamation and 'splitting' *sensu* Berhensenmeyer, 1978) were identified on less than 10% of the remains. Concretion zones were also recorded in similar proportions. The latter were probably formed by the precipitation of calcite present in water.

Indicators of carnivore passage are also particularly tenuous on the mammal bones and absent from the bird bones. Only eight remains present diagnostic traces. These remains include two reindeer first phalanges that bear marks of digestion (fig. 2, no. 2), a reindeer metatarsal shaft fragment which presents scoring marks (*sensu* Binford, 1981) on the cortical surface, and the horse scapula and the two hemi-coxal horse bones (fig. 2, no. 1), as well as a mammoth rib fragment and a mammoth carpal that have notched or gnawed edges indicating the intervention of a large carnivore. Several bones attributed to the three main large herbivores were thus modified by a carnivore, but the latter is difficult to identify. However, the presence of digested reindeer phalanges points to a canid or the hyena. Nevertheless, the low frequency of these traces rules out the hypothesis of carnivore involvement in the formation of the accumulation. They appear rather to represent occasional scavenging. Puncture type marks were also observed on hare long bones and coxal bones. However, each bone only bears single marks and they are not associated with other types of carnivore marks (namely scoring or chewing). Their frequent association with butchery striations is an additional argument for attributing these marks to human activities, rather than to carnivores (see part 7).

Most of the ungulate and lagomorph bones are significantly fragmented. Few whole bones were observed. Among the main species, 11% of the remains attributed to the reindeer (tarsals, sesamoids) and 9.5% of those attributed to the hare (metacarpal, metatarsal and tarsals) are complete. Fracture surfaces with a helicoidal morphology are observable in varying proportions on long bones (between 0 and 45% for the hare and from 0 to 50% for the reindeer).

The mammoth ivory is also extremely fragmented. These fragments present variable dimensions (lengths ranging between 2 and 104mm) and variable surface conditions. In some cases, they present soil sheen and disorganized striations mainly affecting the ridges of the pieces, which probably result from low amplitude thrusting. Several pieces bear traces of heating, similar to carbonization (cracks, grey and black colouring). On the other hand, traces of metallic oxidation are abundant (iron and manganese). Some rare recent alterations were observed—taking into account the patina and more generally the taphonomic condition of the remains—resulting from natural disintegration (often superficial) and several traces of roots (fig. 2, no. 5). Remains without manual marking (*e.g.* inventory number) are rare (less than ten), demonstrating that the abundant fragmentary pieces of the collection do not result from manipulation after their discovery. It also indicates that the material underwent little post-excavation alteration (breaks or 'drawer splittings' in the museum).

The systematic observation of all these fragments under the microscope showed that 235 (out of a total of 484) do not bear any clear technical or functional stigmata. These are mainly laminae resulting from (ancient and in rare cases recent) disintegration or fragments derived from post-depositional fractures, and are not, strictly speaking, osseous industry remains. The associated fracture planes are clear and rectilinear, often giving the pieces a narrow quadrangular morphology. Lastly, certain indicators point to ivory processing at different stages of imbibition (cf. parts 8 and 10).

The surfaces of the fossils are generally well preserved. "Les vermiculations visibles sur la couronne de certaines dents sont les mêmes traces de radicelles qui se trouvent sur les ossements contemporains du gisement…[2]" (de Heinzelin, 1973, p. 38), but these traces do not affect the observation of anthropogenic modifications (fig. 2, no. 4). The gastropod shells bear ancient breaks, but the test is nonetheless very well preserved, which is characteristic of fossil shells from the primary Eocene deposits of the Paris Basin. The shark teeth are complete apart from the eight samples broken at the crown or at one of the root protrusions. The fish remains are very rolled, which suggests that they come from secondary deposits such as the 'base gravels' present at the base of Belgian Cenozoic formations, which are strongly eroded levels with abundant shark and fish remains (with several thousand elements per square metre). This surface condition could also indicate a river bed provenance, as the latter can sometimes contain a sparser concentration of fossils at the base of continental Quaternary deposits, in reworked contexts (Nolf, 1988).

7. First observations of the butchery sequence (JL and QG)

Most of the identified species present evidence of anthropogenic modification. A long bone from an unidentified very large mammal, perhaps the mammoth, bears a cut mark beside one of its extremities (presence of spongiosa). Two non-identified long bones, which could also belong to a proboscidean, present removal scars on the shaft, recording percussion activity. The purpose of the latter is not yet known and could be technical or alimentary. On the horse, two ribs present cut marks pointing to defleshing (fig. 4, no. 1). Defleshing was also identified on the bovine humerus. The fox presents several cut marks on an atlas (disarticulation of the skull) and a femur (defleshing).

More diversified activities are documented for the two prevalent mammal species in the assemblage. Nearly a quarter (23%) of the reindeer bones bear butchery marks (NISP = 21). They are present on all the portions apart from the pelvis and the mandible. They record all the butchery stages:

- Removal of the skin (cut marks located on the parietal bone).
- Disarticulation of the axial skeleton (on proximal rib and sternum), the shoulder (transverse cut marks on proximal humerus), the femur (cut marks under the femoral neck), tarsals at the distal tibia and on a refitted talus (fig. 4, no. 2), as well as the phalanges.
- Cut marks attributed to defleshing are observed on a rib, a scapula, two femur and tibia fragments.
- Cut marks linked to tendon removal were observed on a metatarsal.
- Scraping marks were observed on several elements (proximal rib, tibia shaft and metatarsal) and could be linked to the preparation of the percussion zone.
- Several bones were broken for marrow extraction, including the tibias, the radii and a mandible. Several phalanges could also have been intentionally broken but this cannot be categorically confirmed by the observation of the fractures.

Cut marks are remarkably abundant on hare bones (fig. 4, nos. 3 to 5) and were observed on 11.9% of the bones (long bones, coxals and tarsals). They are linked to skinning (radius), disarticulation (scapula, radius, coxal and calcaneum) and flesh removal (humerus, radius, coxal, femur and tibia) (fig. 4, no. 3). Circular shaped *punctures* were observed on or beside the articular parts on 13% of the observed bones. They are frequent on coxal bones (37.5%), and in two out of three cases, these punctiform depressions are situated above the notch and are the departure point for pulling away the iliac bone. They are also very frequent on the femur (43%) where they are mostly distributed over the proximal part (four out of six). One is on the distal part and the last is in the middle of a shaft. Finally, these traces are present on the proximal part of two tibias (16.6%). They are associated with butchery marks in 36.4% of the cases. The overall data are comparable to the observations of Lloveras and collaborators (2016) on lagomorph remains in the evolved Aurignacian of Arbreda, where these marks are interpreted as traces left by human teeth, as the bone was gnawed or broken by dental pressure in order to reach the medullary cavity. Finally, many long bone shaft fragments present helicoidal fractures indicating that the bones were broken while fresh (green fractures). This is the case, in particular for femurs and tibias.

As for the birds, the duck radii bear numerous longitudinal scraping striations. Longitudinal and transverse cut marks are present on a proximal coracoid and two snowy owl distal humeri as well as on a scapula blade and the proximal extremity of a ulna of ptarmigan (fig. 4, no. 6). These traces are linked to the disarticulation and defleshing of the carcasses. The longitudinal striations on the snowy owl humerus are rather sparse and localized, and could possibly result from the preparation of these elements for subsequent processing. However, this hypothesis needs to be proven. An ongoing in-depth analysis should better characterize these traces and clarify what these elements were used for (Goffette *et al.*, in prep.).

Figure 4 – Traces anthropiques relevant des activités de boucherie. 1 : stries sur côte de cheval ; 2 : tibia et talus de renne avec stries de désarticulation ; 3 : coxal de lièvre avec stries de boucherie et arrachement de matière osseuse ; 4 : calcanéum de lièvre portant des traces de désarticulation ; 5 : Deux radius de lièvre présentant des stries de décharnement ; 6 : ulna de lagopède présentant des stries de boucherie. Coll. IRSNB (clichés : É. Dewamme, J. Lacarrière, H. Salomon).

Figure 4 – Anthropogenic traces related to butchery activities. 1: Cutmarks on horse rib; 2: Tibia and talus of reindeer with disarticulation cutmarks; 3: Hare coxal with cutmarks and tearing of bone matter; 4: Hare calcaneus with disarticulation marks; 5: Two hare radiuses with defleshing cutmarks; 6: Ptarmigan ulna with butchery traces. RBINS Coll. (pictures: É. Dewamme, J. Lacarrière, H. Salomon).

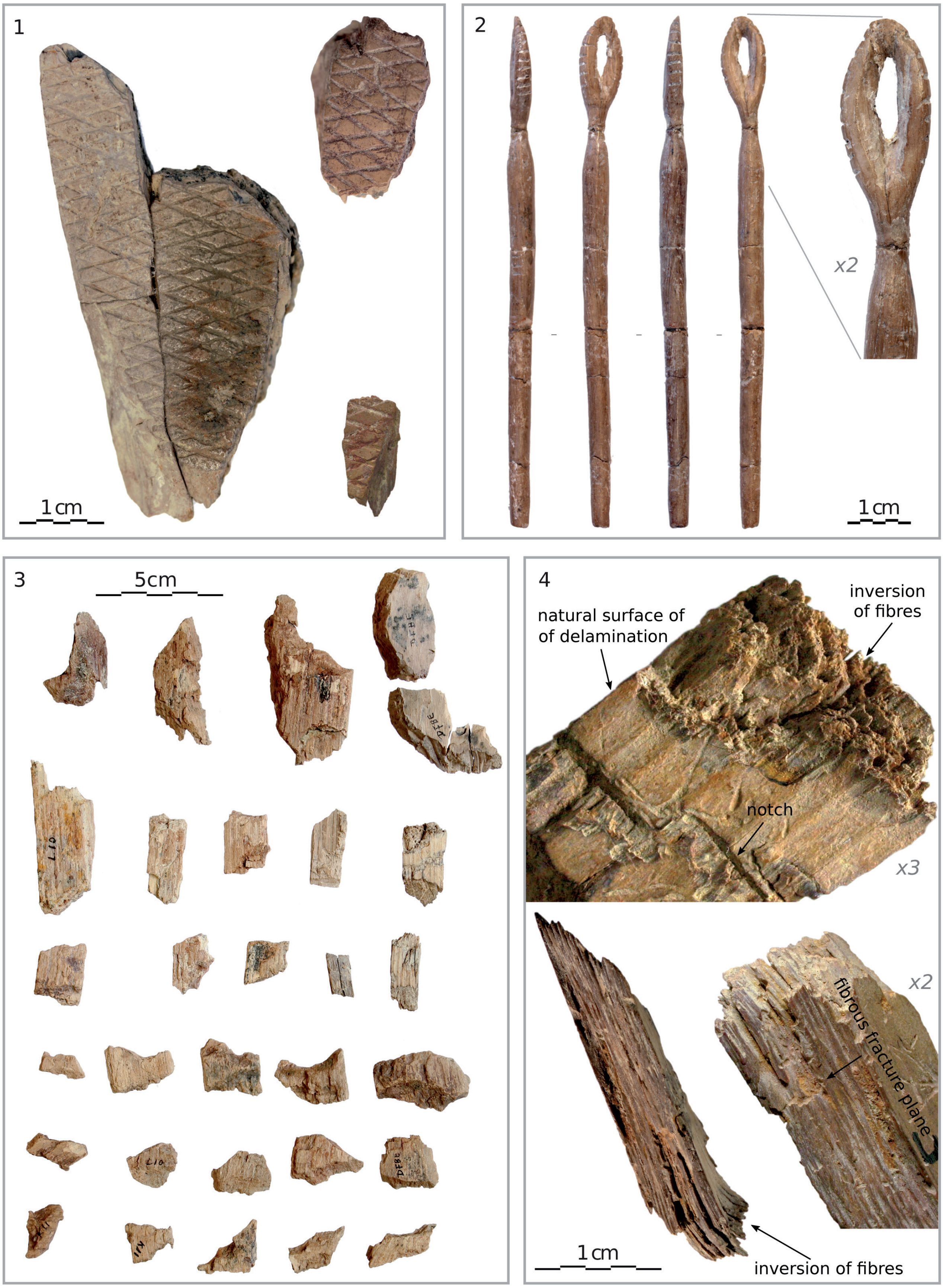

Figure 5 – Exemples de vestiges en ivoire découverts à Maisières « Canal ». 1 : fragments de plaquettes gravées de motifs losangiques ; 2 : « épingle » ; 3 et 4 : déchets variés. Coll. IRSNB (clichés : N. Goutas, H. Salomon).

Figure 5 – Examples of ivory remains discovered at Maisières 'Canal'. 1: fragments of engraved plaquettes with rhombic motifs; 2: 'pin'; 3 and 4: various waste products. RBINS Coll. (pictures: N. Goutas, H. Salomon).

8. Singular ivory exploitation (NG)

We recorded and studied 513 ivory remains under the stereomicroscope: 29 previously published pieces and 484 unpublished fragmentary remains. Out of these 484 fragments (a lot of which are less than 500mm), 249 present definite or very probable anthropogenic modifications (fig. 5). This micro-fraction of the ivory industry does not result from crumbling and post-depositional fragmentation (cf. *supra*). In a number of cases, these small fragments are manufacturing waste (N = 233). They consist of varied waste products, including flakes or splinters formed during diverse debitage actions. These products were probably produced accidentally, and can be referred to as 'spontaneous flakes and splinters', according to the expression of M.H. Newcomer (1976). Other elements are waste resulting from length reduction or blank sharpening and perhaps waste resulting from repair, as well as possible fragments of blanks (plaquettes and rods, N = 3) and functional waste (related to tool damage, N = 2). Recurrent types of waste have been identified and are in the process of being classified. This assemblage could be linked to discharge from a manufacturing area. The spatial analysis of these remains will allow us to test this hypothesis (Goutas *et al.*, in prep.).

Ultimately, after this revision, the updated corpus[3] consists of 278 worked ivory remains, which represents a ten-fold increase in the corpus (see tabl. 2 and 5). Most of the finished objects are massive or fine pointed objects, with an oval to elliptic cross-section (tabl. 5), which could be attributed to the category of projectile points (N = 7), as well as transformation tools with a rounded and/or bevelled active part (N = 4). There is also a bi-pointed object (tool or hunting or fishing weapons, noted as 'bi-pointed' or 'bi-conical' respectively in de Heinzelin 1973, p. 34; Haesaerts and Heinzelin, 1979, p. 72), but also more unusual productions, such as two fragments of possible containers (noted "recipients" in Otte, 1979, p. 554), a needle with a perforated and incised head, and finally eight flat blank fragments decorated with rhombic patterns that may be part of the same object (physical connections or strong complementarity). We also note the presence of a massive, very worked flake (tool fragment?), with very discrete incisions, which we presume are part of the decoration, truncated by a fracture. Finally, at least 16 fragments seem to be part of worked objects of indeterminate technical status.

Based on the fact that the surfaces of disintegration ('*surface de délitage*': Poplin, 1995; Christensen, 1999) are overlapped by technical marks (notching and scraping), we can suggest that the ivory was worked in a subfossil state, although not necessarily exclusively. As a consequence, ivory was worked when it had already begun to undergo a process of natural delamination (altered ivory), which is incompatible with 'fresh ivory' (Christensen, 2009; Goutas, 2004; Goutas and Simonet, 2009). In contrast, fresh ivory is characterized by the absence of delamination and fracturing along natural weak planes (Heckel *et al.*, 2014).

Count of the ivory industry after revision of the Royal Belgian Institute of Natural Sciences collections	NB
Potential or confirmed projectile armatures	**7**
Transformation tools with an active blunt and/or bevelled part	**4**
Bipoint	**1**
Decorated fragments of plaquettes with rhombic patterns	**1**
Containers in tusk sections ("recipients")	**2**
Needle with perforated head	**1**
Fragments of plaquettes decorated with rhombic patterns	**7**
Massive, very worked and finely decorated flake	**1**
Fragments of worked objects of indeterminate technical status	**16**
Varied manufacture waste	**233**
Functional chutes	**2**
Fragments of blanks (rods and plaquettes)	**3**
TOTAL	**278**

Tableau 5 – Inventaire de l'industrie sur ivoire de Maisières « Canal » après révision des collections de l'IRSNB.

Table 5 – Inventory of the ivory industry of Maisières 'Canal' after revision of the RBINS collections.

We recall here that according to experiments on fresh proboscidean (elephant) ivory, "soaking was only very slightly effective, as only the very superficial layer was affected by the treatment". On the other hand, on subfossil ivory (mammoth) "(…) with already altered organic matter, the experiments show that there is a clear improvement after several hours of soaking" (Christensen and Tejero, 2015, p. 86; Christensen, 1999). Indeed, over time, when ivory is no longer fresh *stricto sensu*, it acquires the capacity to absorb a large quantity of water, which makes it easier to work (after Semenov and Filipov in Geneste *et al.*, 2018). By 'fresh ivory *stricto sensu*', we mean ivory which is processed at the same time or not long after the death of the mammoth, and we prefer not to use this term for ivory that is several thousand years old, even when it is frozen (Christensen, 1999; Goutas and Lacarrière, 2018). Indeed, from our point of view, the apparent wholeness of this type of tusk (at a macroscopic scale), does not imply that it is intact from a microstructural point of view (loss of collagen, weight of the sediments could have initiated microcracks invisible to the naked eye, impregnation of metallic oxides, etc.). We thus deliberately reserve the term 'fresh' for a recently produced or collected material, which has not undergone any macroscopic or microscopic, mechanical or chemical alteration (since it fell or since it was retrieved from a dead animal). For mammoth tusks frozen for several thousand years, we prefer to speak of 'fresh ivory *lato sensu*' (Goutas and Lacarrière, 2018) or 'macroscopically unaltered ivory'.

Moreover, several evidence—significant inversion of fibres, fibrous to very fibrous aspect of the fracture planes, sharpness (grooving, sawing plane), or on the other hand, the chewed aspect of the stigmata (notching)—point to ivory processing at different stages of imbibition (wet to very wet). This softening is not necessarily intentional and/or of anthropogenic origin; the occupants of Maisières 'Canal' could have taken advantage of a natural modification of the ivory. It is important to recall that the Maisières site is located on the edge of a riverbank, in a floodable zone. Ultimately, the markers of ivory working with signs of natural delamination suggest that the subfossilised tusks were already weathered by water when they were opportunely (and opportunistically) collected.

9. The introduction of fossils of marine origin: for what purpose? (CP)

The marine fossils discovered during the sieving of backfill can clearly be considered as an anthropogenic input in so far as these elements are not naturally found in Quaternary loessic sequences. Some of these fossils may have been collected along the riverbanks (such as the internal casts), but others were procured further away. The composition and the very good preservation of the marine mollusc shells indicate an origin in the Eocene fossiliferous outcrops of the Paris Basin, situated 100-250km to the south. The high number of fish remains points to an origin in the 'base gravels', where they are abundant. The ichthyofaunal spectrum shows that these are Eocene fossils found, in particular, in the base gravels of the Lede sands (pers. comm. B. Genault), which outcrop 50-70km towards the north in the regions of Brussels and Ghent.

Only one shell (a fragment of a large elongated gastropod, fig. 6) bears traces of anthropogenic modification involving a sawing technique, materialized by the presence of three groove marks at the lip. These grooves may have served as an attachment (perhaps a perforation), but this cannot be demonstrated in its present state. The second shell is broken at the lip and the back, perhaps marking the position of possible modifications. No anthropogenic modifications are observed on the shark teeth and the other fossils. A preliminary examination for macrotraces of use did not yield any further information. This will be completed by more in-depth microscopic observation in order to identify any possible microtraces of use (such as polish).

The presence of anthropogenic modifications on a shell which may be related to the way it was attached suggests that this type of fossil was used as a decorative element, as is commonly observed in the Gravettian in North-western Europe (cf. Peschaux, this volume). On the other hand, the functional status of the other fossils is more difficult to determine, due to the absence of anthropogenic modifications. It is possible that these objects of curiosity were simply collected and brought back to the site. An ornamental use can also be proposed for the fossil shark teeth, as these objects are frequently discovered at Upper Palaeolithic sites with no anthropogenic modification, but also perforated or modified, implying that they were suspended. In addition, the 'Y' shape of these teeth suggests that they could have been suspended without being modified, by using appropriate attachment methods (knotting, mounting, etc.). Finally, we can also envisage the use of these teeth as tools as they bear natural points and cutting edges representing effective potential active zones (Hladilová and Mikuláš, 2005).

Figure 6 – Quelques fossiles découverts à Maisières « Canal ». 1 : fragment de coquille fossile indéterminée (les flèches indiquent les traces de sciage) ; 2 : coquille fossile de Natice (*Natica epiglottina*) ; 3 à 8 : dents de requin fossiles (Odontaspidés et Lamniformes) ; 9 à 14 : dents de requin fossiles (*Odontapsis hopei*) ; 15 : dent de requin fossile (*Striatolamia macrota*) ; 16 : dent de requin fossile (*Lamna verticalis*) ; 17 : dent rostrale de poisson-scie (Pristidé) ; 18 : aiguillon caudal de raie (Myliobatidé) ; 19 : molaire broyeuse de poisson osseux (Sparidé ?) ; 20 : radiole d'oursin (*Echinoidea*) ; 21 et 22 : spongiaires (*Porifera*) ; 23 et 24 : rostres de bélemnite (*Belemnoidea*). Coll. IRSNB (clichés : C. Peschaux, H. Salomon).

Figure 6 – Some of the fossils discovered at Maisières 'Canal'. 1: undetermined fossil shell fragment (arrows indicate traces of sawing); 2: Natice fossil shell (*Natica epiglottina*); 3 to 8: fossil shark teeth (*Odontaspidae* and Lamniformes); 9 to 14: fossil shark teeth (*Odontapsis hopei*); 15: fossil shark tooth (*Striatolamia macrota*); 16: fossil shark tooth (*Lamna verticalis*); 17: sawfish rostral tooth (*Pristidae*); 18: ray caudal spur (*Myliobatidae*); 19: bone fish crusher molar (*Sparidae*?); 20: sea urchin radiole (*Echinoidea*); 21 and 22: sponges (*Porifera*); 23 and 24: belemnite rostra (*Belemnoidea*). RBINS coll. (pictures: C. Peschaux, H. Salomon).

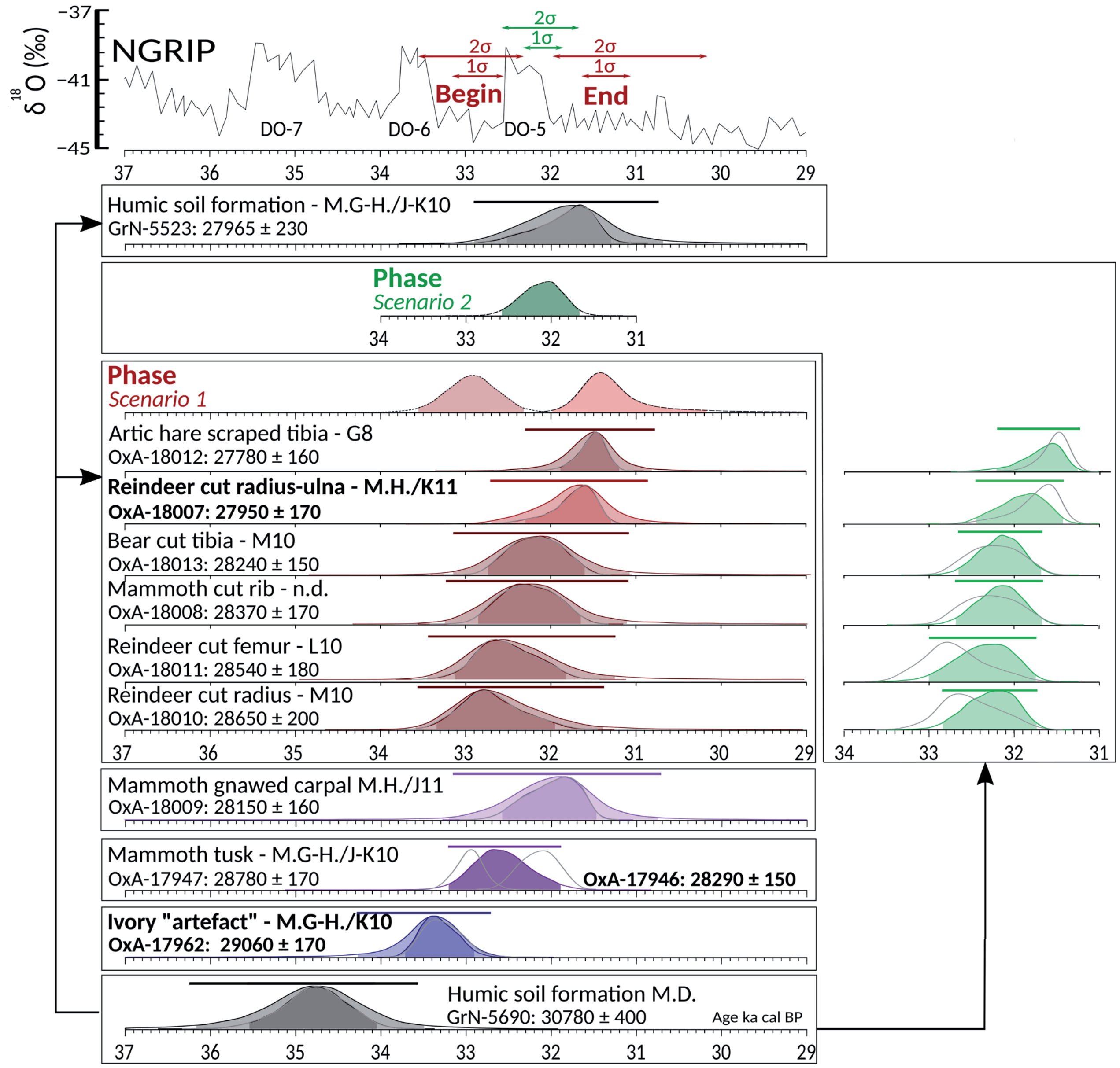

Figure 7 – Représentation de la modélisation des datations calibrées avec la courbe IntCal13 (Reimer *et al.*, 2013). Les deux scenarii traitent l'ivoire de mammouth à part et font apparaître les relations chronologiques de succession (flèches) déduites de l'enregistrement sédimentaire et de l'étude en cours des vestiges archéologiques. Le scenario 1 (en rouge) présente l'hypothèse de l'absence de relation entre les décès des animaux dont les restes ont été datés, situant une ou des occupations entre 33.15 et 31.07 ka cal BP (1σ). Le scenario 2 (en vert) reproduit l'hypothèse émise par Jacobi *et al.*, 2010, proposant la contemporanéité des décès des animaux dont les restes sont datés, ce qui situerait l'occupation humaine (supposée unique) entre 32.31 et 31.86 ka cal BP (1σ). Les résultats sont confrontés à la courbe du *North Greenland Ice Core Project* (NGRIP) des δ^{18}O. Les cycles de Dansgaard-Oeschger (DO) se caractérisent par un réchauffement rapide.
Sources : ChronoModel (Lanos *et al.*, 2015), NGRIP (Stocker et Johnsen, 2003). Graphiques : H. Salomon.

Figure 7 – Representation of the modelling of the calibrated dates with the IntCal13 curve (Reimer *et al.*, 2013). The two scenarios treat the mammoth ivory separately and reveal the chronological successional relationships (arrows) derived from the sedimentary record and the ongoing study of the archaeological remains. Scenario 1 (in red) presents the hypothesis of the absence of a relationship between the deaths of the dated animal remains, placing one or more occupations between 33.15 et 31.07 ka cal BP (1σ). Scenario 2 (in green) reproduces the hypothesis put forward by Jacobi *et al.* 2010, proposing the contemporaneity of the deaths of the dated animal remains, which would place the (supposedly single) human occupation between 32.31 et 31.86 ka cal BP (1σ). The results are confronted with the *North Greenland Ice Core Project* (NGRIP) curve of δ^{18}O. The Dansgaard-Oeschger (DO) cycles are characterized by rapid warming. Sources: ChronoModel (Lanos *et al.*, 2015), NGRIP (Stocker and Johnsen, 2003). Graphics: H. Salomon.

10. Synthesis, interpretation and discussion

A contribution to the paleoenvironmental characterization of the Maisières interstadial

The first main contributions of this study of the hard animal materials concern the identification of new taxa and the information this revised faunal association provides for the paleoenvironmental reconstruction of the occupation.

The association of the reindeer, horse and a large bovine, possibly the bison, at this open-air site, outlines an environment similar to the steppe and the tundra. The association of these animals with the mammoth is debatable as, considering the data showing that the ivory at the site was processed in a subfossil state, at least some of the identified mammoth remains belong to an animal that died long before the human occupation (cf. *supra*, part 8). The presence of the mountain hare is considered as a marker of 'cold climatic conditions' (Donard, 1982), as, up until now, this species has not been recorded in temperate Pleistocene archaeological contexts. Furthermore, it currently lives in high altitudes and latitudes (Pelletier *et al.*, 2015). However, in the North of Europe, it has to compete with the European hare (*Lepus europaeus*), and it could have favoured these ecological niches as a response to this competition. Its preferred habitat is not exclusively limited to cold conditions and its current distribution could be due to an adaptation linked to interspecific competition (*ibid.*).

Among the birds, the snowy owl and ptarmigan taxa are clearly associated with cold climates. Today, they are confined to the high latitudes of the northern hemisphere, where they mainly nest in the arctic tundra, and in the case of the Alpine ptarmigan, in mountainous regions (*Lagopus muta*, see de Juana *et al.*, 2018a; 2018b; Holt *et al.*, 2018). The snowy owl is a migrating species, but remains confined to northern regions (Canada, Scandinavia and Siberia), even outside the breeding period. On the other hand, ptarmigans are generally sedentary, although certain willow ptarmigans (*Lagopus lagopus*) cover distances of up to several hundred kilometres to reach wintering areas in forest environments. The probable grey plover identified in the material from Maisières 'Canal' also nests in the arctic tundra, from the extreme north of Siberia to North America. Like most small waders, it winters along the coast (Wiersma *et al.*, 2018), and its presence in the assemblage therefore suggests that it nested locally, although we cannot totally rule out a migrating bird. The short-eared owl can also nest very far north, beyond the Arctic Circle, but likewise at much lower latitudes. Nonetheless, like for the precited species, its nidification habitat is typically an open tundra type, swamp or heath environment (Olsen *et al.*, 2018). Thus, in addition to the steppe-tundra environment, a 'swampy' component in the landscape of the Maisières 'Canal' occupation is also supported by the presence of ducks.

All these data are compatible with the interpretation of the sedimentary sequence indicating a milder and wetter period than the previous one, with a short amelioration of climatic conditions (Haesaerts and de Heinzelin, 1979; Haesaerts, 2004). In Upper Pleniglacial contexts in Western Europe, through the development of combined approaches, namely malacological and isotopic studies, it is possible to establish correlations between interstadial episodes and the presence of northern human occupations (Paris *et al.*, 2017; Moine *et al.*, 2017). This is the case in particular for the open-air site of Renancourt, located less than 200km from Maisières 'Canal' in Picardy, in the north of France, where one of the sectors (Renancourt 2) records an occupation attributed to the early Gravettian, contemporaneous with the GI-5.2 interstadial (between 32 and 32.6 ka b2k, Rasmussen *et al.*, 2014). The critical re-examination of the dates for Maisières 'Canal' carried out as part of the present study (fig. 7) enables us to propose an age of between 33.2 and 31.1 ka cal BP for the occupation(s), with no possible further precision (with an uncertainty interval at 1σ). This is relatively similar to the chronological range of the site of Renancourt 2, where, furthermore, the only hunted mammal is the reindeer (Paris *et al.*, 2019).

The natural lacustrine record of Bergsee, in the south of the Black Forest in Germany, shows an increase in *Betula* and *Pinus* pollen around 32.4 ka cal BP (Duprat-Ouallid *et al.*, 2017). This points to climatic conditions propitious to the development of trees and provides additional paleoenvironmental data on this chronological period. This pollen signal could correspond to the less harsh episode described at Maisières 'Canal' in layer M.H.

A combined taphonomic approach

The second major contribution of this study is the combined taphonomic approach which suggests that several phases of fossil accumulation took place at Maisières, linked to natural, then anthropogenic processes.

The study of the surface conditions of the ivory remains, completed by the technological data, attest to the processing of subfossil ivory, which was softened by water in most cases. The fact that these mammoth tusks were easily accessible (natural accumulations) probably participated in the choice of the site by the occupants. The action of water then continued after the abandonment of the site and throughout the burial phase. The most important damage seems to have occurred during this ultimate phase, which lasted for about 30,000 years, when most of the oxidization seems to have taken place. The processing of subfossil ivory was clearly identified on manufacturing waste (cf. *supra*, part 8), but we cannot affirm that the dated mammoth ivory tool (OxA-17962: manufactured object) was also made from subfossil ivory. However, if this tool also corresponds to the processing of subfossil ivory, this date would provide a *terminus post quem* for the human occupation of Maisières 'Canal'. Considering the discrepancies between the dated ivory samples, these radiometric measurements must be interpreted with caution. In any case, it is possible that the tusks come from different individuals who died at distinct times. In the same way, the comparison of the dates obtained on the ivory tool with the carpal gnawed by a carnivore (archaeological level M.H.), are incompatible, which would tend to corroborate the hypothesis of dual natural and anthropogenic accumulation.

The singular configuration of the site, on the edge of a channel, could have favoured the accidental death of these very large herbivores, and the mammoth remains were probably accumulated over a long period of time.

In contrast, the paucity of traces of weathering or carnivore marks on the rest of the well-preserved mammal and bird remains attests to rapid burial. Overall, they present similar surface conditions, suggesting simultaneous burial, apart from two horse remains that appear to be intrusive.

An unprecedented record of alimentary and technical activities

The skeletal representation of the ungulates indicates selective modes of transport for the large herbivores (reindeer, bovids and horse). On the other hand, the presence of most of the skeletal elements of the hare indicates that these animals were brought to the site whole. The numerous traces on these bones are compatible with human consumption (Pérez Ripoll, 2005-2006; Lloveras *et al.*, 2016) and show that the lagomorph was consumed on site. The presence of broken long bones backs up this hypothesis. Moreover, the specific skeletal representation of this taxon, characterized by the absence of phalanges, could indicate the transport of pelts to other places (Cochard, 2004). The concomitant presence of defleshing marks and indicators of marrow consumption on this species is noteworthy. The cut marks show that the meat was not boiled when removed from the carcass, while the systematic breakage of all the long bones tends to indicate that the marrow was retrieved from uncooked bones, as marrow tends to dry out during cooking (Pérez Ripoll, 2004). On the other hand, the punctiform depressions observed on the articular extremities may be connected to the consumption of meat cooked on the bone, or may have been made in order to break the bones to extract the marrow.

As for the birds, ptarmigans were probably brought to the site as whole carcasses, whereas an overrepresentation of wing bones is observed for the snowy owl, the Northern raven and ducks. This marked interest in wings strongly suggests the use of the large wing feathers, although no traces suggestive of anthropogenic exploitation of feathers have been observed at Maisières 'Canal'. Perhaps the intention was to use the wing bones, which are longer than the leg bones in these taxa, as raw materials. The only avian species used for raw materials is the snowy owl, for which the humeri and radii were transformed. The sole presence of the radii among ducks suggests marked selection or the specific treatment of this species, which requires further analysis.

Activities associated with the marine fossils also seem to have been carried out at the site. The shells may be related to ornamental elements but they are only present in small quantities, and are fragmented, which seems to suggest the occasional loss of worn elements rather than an on-site production of ornamental objects on fossil shells. On the other hand, the relatively high number of shark teeth seems to indicate that these elements are linked to specific activities during the occupation. But, as of now, the nature of these activities has not been determined and the shark teeth from Maisières 'Canal' may have played a functional or ornamental role.

Why Maisières 'Canal'?

Several different factors seem to have been auspicious to the human occupation at the site of Maisières 'Canal', such as the availability of animal and lithic raw materials. Indeed, the identification of subfossil ivory and mammoth bones in anatomic connection suggests the presence of one or several tusks or skeletal portions at the site. The ivory and bones seem to have been used for making tools and perhaps also as fuel, as suggested by A. Gautier. In contrast, the marine fossils were not procured locally.

The site was also propitious to hunting practices. The diversity of the animal species present at Maisières 'Canal' shows that the strategy of the occupants was to hunt a wide variety of taxa, rather than targeting vast herd of mammals. This taxonomic diversity indicates a rich and varied environment, even though it was dominated by the tundra. The topography of the site, located on a prominence near a watercourse crossing, is a strategic location for hunting practices. The abundance of the lithic productions intended for use as projectiles and butchery tools and the on-site production of elongated and pointed ivory blanks, which were also part of this equipment, underline the importance of the acquisition of animal resources. The latter were intensively exploited: removal of pelts, meat, tendons, fracturing in order to extract the marrow, use of bones for fuel and processing of bone, reindeer antler and ivory mammoth for the manufacture of hunting equipment and everyday objects, some of which were decorated.

The river was probably an advantage for hunting practices, but it does not seem to have been used as a source of animal protein. Indeed, ichthyofaunal remains are absent or were not preserved.

Moreover, the hunting of waterfowl, such as ducks, is not necessarily linked to the proximity of the river, but could also have taken place around shallow seasonal expanses of water in the tundra.

Hunting techniques must have been as varied as the hunted species, which range in size from small to large game. Small-sized animals, such as the fox, the hare and birds, were captured in abundance, perhaps by trapping, considering the absence of small projectile armatures.

Pending questions… Occupation season and duration?

Based on the degree of epiphysation of the young reindeer long bones and comparisons with data issued from current populations (Pasda, 2009), we can cautiously propose estimations of the slaughter season. A distal tibia presents a line of osseous suture, indicating that this individual was slaughtered before it was 30 months old, that is at the end of the summer or at the beginning of autumn.

The presence of several bird species nesting in the arctic environment but wintering in different biotopes suggests that they were hunted around the nesting period, that is roughly between March and September.

There are relatively few indicators of seasonality, but at this stage of our research, they converge towards an acquisition of resources towards the end of the summer until the autumn. A more accurate estimation of the season(s) of occupation would enable us to discuss the activities that took place at Maisières 'Canal' in more detail. On the other hand, the duration of the occupation is difficult to assess. The massive presence of burnt bones could be an argument pointing to a short-duration occupation, as the use of bone as fuel would in this case have compensated for the lack of sufficient dry wood (Théry-Parisot and Costamagno, 2005). However, the contrary argument could also be advanced, whereby the massive presence of burnt bones would indicate that a considerable quantity of fuel was burnt and that the wood was not preserved (differential conservation with poorer preservation of ligneous wood, in particular at open-air sites). Nonetheless, the abundance of lithic production at the site and the working of ivory, bone and antler (at least one piece of antler debitage waste) do not argue for a very short-duration occupation.

The archaeozoological analysis requires further study regarding seasonality aspects, the processing of bird bones and the study of burnt bones. These data will provide us with an enhanced perception of the activities of hunter-gatherers at this site.

Conclusion

The originality and the specificity of Maisières 'Canal' in terms of the processing of fossil and non-fossil animal resources tend to point to its status as an 'interface' between Western and Central Europe.

On one hand, the acquisition of fossil shells reveals a link with the Paris Basin and in particular with the sites of Les Bossats at Ormesson, Amiens-Renancourt 1 and Arcy-sur-Cure (Peschaux, this volume). On the other hand, the diversified faunal spectrum denotes extended territorial exploitation which could be compared to the eponymous site of the Pavlovian (Wojtal *et al.*, 2012). The assemblage from Pavlov I is much larger, but the most frequent species is the hare, followed by the reindeer, the horse and the mammoth. Bird remains are also abundant and represent about twenty different taxa. The high proportion of Northern raven ulna fragments at Maisières 'Canal' is also reminiscent of the situation observed at the Pavlov I site, where the ulna is also the best represented Northern raven bone (Bochenski *et al.*, 2009).

Moreover, the processing of certain worked raw materials, such as mammoth ivory, which is materialized by numerous fragments and varied productions (domestic, hunting and non-utilitarian), is comparable in several regards to the industries of Central Europe (Pavlov I, Předmostí: Goutas, 2013). Remarkably, Renancourt 1 also yielded a massive tool made of a portion of a very large mammal rib (the size of a rhinoceros or mammoth; Goutas, ongoing study), which is very similar to those from Maisières 'Canal' and Předmostí, from a typological point of view. Finally, the recovery of fossil shark teeth is also observed in Central Europe (Pavlov: Hladilová and Mikuláš, 2005) and in France (Abri Pataud: Pottier, 2005).

If we focus on chronological affinities independently of presumed chrono-cultural filiations, it is interesting to note several similitudes with two German sites. The site of Breitenbach is considered as Aurignacian (Moreau, 2012), but has yielded more recent dates, closer to the Gravettian interval (Flas, 2005). It comprises a similar, but much smaller, faunal spectrum to that of Maisières 'Canal', where the mammoth, the reindeer, the red deer, the fox and a possible corvid have been identified (Groiss, 1987). Further east, at Geiβenklösterle, the bear is, remarkably, the most frequent species in the Gravettian level (Münzel, 1997), followed by the horse-reindeer-mammoth trio.

The taxonomic diversity of the spectrum reflects a particular relationship with the local environment, which appears to be rich and varied and suggests multiple acquisition strategies, such as trapping, active hunting or gathering. These require further scrutiny, in particular through studies of the industries in lithic raw materials and hard animal material (and in particular projectile armatures), in order to place them in the broader economic context of the 'Maisierian' technofacies, from 33 to 31 ka cal BP (29-27 ka BP).

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Endnotes

1. This term, used by A. Gautier, refers here to the breaking of bones for food purposes and not to the intentional action of producing a blank, which is the current use of the term debitage.
2. Authors' translation: "the same traces of rootlets [as those] found on bones contemporaneous with the site".
3. Our count includes the two pieces in ivory curated at the Préhistomuseum at Ramioul, but not yet studied. These are a fragment of a 'container' and a fragment of a plaquette decorated with rhombic patterns.

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