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Mammoth procurement and exploitation at Milovice (Czech Republic) New data for the Moravian Gravettian

Alexis BRUGÈRE*, Laure FONTANA & Martin OLIVA*****

Abstract
The excavations of 12 sectors at Milovice yielded close to 63,000 bone remains of which 98.7% belong to the Woolly Mammoth. Human groups came several times to this place, between 26,000 and 22,000 BP, where various activities were practiced in association with the proboscidea remains, as in the neighbouring Pavlovian sites. The zooarcheological study demonstrates that Mammoth was hunted and that the Gravettian groups did not occupy the site and exploited the Mammoth only to get food. Indeed, bones and teeth were recovered and worked, some of them displaying grooves, intentional cut-marks and objects, similar to those found at other Gravettian sites (*e.g.* Dolní Vestonice, Krakow-Spadzista, Krems-Watchberg). The great under-representation of tusks and molars allows us to suppose that ivory was taken out of the site. If the Woolly Mammoth exploitation was diversified, it was not that intensive, maybe because of the site status in the Moravian area.
Keywords: Central Europe; Moravia; Gravettian-Pavlovian; Milovice; Mammoth; Hunting strategies; Exploitation patterns

Résumé - L'exploitation du Mammouth à Milovice (République tchèque) : nouvelles données pour le Gravettien de Moravie
L'étude de 12 des 13 secteurs du site gravettien de Milovice permet d'apporter un nouvel éclairage sur l'exploitation globale du Mammouth en zone morave. L'accumulation de nombreux restes de Proboscidien (98,7% des 62692 restes fauniques) sur ce site semble résulter d'une succession d'épisodes de chasse par les groupes humains, entre 26 000 et 22 000 BP. Plusieurs activités liées à son exploitation s'y sont déroulées, comme dans les sites pavloviens voisins. L'étude archéozoologique montre que l'acquisition de produits alimentaires n'est qu'un aspect parmi d'autres dans l'exploitation de cette ressource et dans la fréquentation de cet endroit par les Gravettiens. Le prélèvement de la matière osseuse et dentaire ainsi que leur transformation ont en effet été mis en évidence par l'identification d'os débités et rainurés, semblables à ceux d'autres sites gravettiens (Dolní Vestonice, Krakow-Spadzista, Krems-Wachtberg) d'une part, et par la forte sous-représentation des défenses et de certaines molaires laissant supposer un emport de l'ivoire hors du site, d'autre part. Enfin, si l'exploitation du Mammouth fut plutôt diversifiée, elle ne semble pas avoir été intensive, peut-être en raison du statut du site au sein de la zone morave.
Mots-Clés : Europe centrale ; Moravie ; Gravettien-Pavlovien ; Milovice ; Mammouth ; Stratégies de chasse ; Modes d'exploitation

Introduction

During the European Upper Palaeolithic, human groups lived by mainly exploiting Reindeer, Horse and Bison in ways that varied through time and space. In a very few areas, some other game were also exploited and became important in the economic system of human groups. Mammoth was one of them in Central and Eastern Europe. Around 14-15,000 BP, in Eastern Europe, a majority of sites of the post-Glacial Maximum Eastern Gravettian culture yielded more than 90% of Mammoth bones, and a part of them were worked and used, especially for dwelling building. In Central Europe, Mammoth is always highly represented at sites mostly located in the Eastern part of the Czech Republic during the Gravettian period (10,000 years earlier). In this area, called Moravia, a local Gravettian culture (the Pavlovian) is documented by sites that are especially rich in Mammoth bone and

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ivory remains. This richness concerns artefacts as well as bone accumulations corresponding to unorganised heaps of several square metres. Mammoth exploitation in this area raises three main questions: Which part did the Mammoth represent in the Moravian Gravettian economy? Was this exploitation aimed towards only one procurement like meat, or towards several products like bones, fat, skin, peals, viscera and ivory? Then, what was the seasonality of the whole Mammoth exploitation? One of the main issues of this study is to understand what made this economy so peculiar, in relation with the characteristics of the biggest herbivores of the Upper Pleistocene landscape. In order to do so, we need to know about the procurement strategies, as well as the exploitation and consumption patterns.

Mammoth exploitation: global perspective and questions

Mammoth sites

To understand the role of Mammoth in the Gravettian economy of Moravia, we have to get information concerning the whole annual cycle. Was the Mammoth the main species of the Gravettian meat procurement? Which product(s) was the Proboscidian sought for? Was it looked for all year round or was it a highly seasonal resource? Actually, three types of sites are known in the wide Moravian area. In a first group, Mammoth was the dominant species like at Krems-Hundssteig. In another kind of sites, Mammoth represented nearly half of the mammal individuals like at Krems-Wachtberg. Finally, there also exists sites where mammoths were a minority face to other individuals of different species like at Willendorf II c. 9 (Antl & Fladerer 2004, Fladerer & Salcher 2004, Péan 2001)[1]. In the Moravian Gravettian, Mammoth was present everywhere: ivory was used for artistic products and domestic tools (*e.g.* Předmostí, Dolní Věstonice, Pavlov); bones were worked in the same way at these sites and were often associated with burials (Předmostí: Svoboda 2008; Dolní Věstonice II: Klima 1995; Brno: Oliva 1996). Bones were also used in light dwelling structures, like at Dolní Věstonice or Milovice G (Oliva 1989a, Svoboda 2003). Mammoth was present everywhere, in the domestic, symbolic and artistic areas of these Gravettian groups. Its place in their everyday life was overwhelming and nevertheless its place in the economy is still obscure.

In fact, this Mammoth culture area of the Gravettian period is larger than the restricted Moravia (Fig. 1). In Moravia, the Pavlov Hills area concentrates three main Mammoth sites (Dolní Věstonice, Pavlov and Milovice) and Předmostí farther to the Northeast, and other sites are known outside the Moravian borders: Krakow-Spadzista in Southern Poland and Krems-Wachtberg, Krems-Hunddsteig, Grub-Kranawetberg and Stillfried in Eastern Austria . These latter Austrian sites are without true Mammoth heaps but with at least the remains of several individuals in their Gravettian context. Towards the East, some sites in Slovakia are located among the Vah valley (*e.g.* Moravany-Lopata). A distinction must be made between sites with Mammoth heaps and sites with Mammoth bones but no heaps. Whatever the reason for these two final stages, we notice that Mammoth was in every case greatly involved in the Gravettian animal exploitation patterns at these sites. But if the place of Mammoth was important at some sites, was it that important at the scale of the Gravettian economic system? What was its role in the meaty economy?

Mammoth exploitation in the Gravettian economic system

As evocated above, Mammoth was fully involved in the Gravettian-Pavlovian everyday life. To understand which role Mammoth played in the Gravettian economy, we have to identify its complete exploitation patterns, and first, its procurement patterns. Concerning Proboscidea, three types of procurement strategies are generally discussed: hunting, «active scavenging» and bone collecting. Discussing Mammoth procurement is still a sensitive topic. Olga Soffer brought up the question 20 years ago when she focused her work on the "Epigravettian" groups of the Central Russian plain and the high frequency of Mammoth remains at sites. According to this author, everything indicates Mammoth was mainly exploited for its big and heavy bones, as raw material for dwelling construction on open-air areas (Soffer 1985, 1993). She suggested bones were used *in situ* when

[1] Examples come from close Austrian sites because of the lack of information about the Moravian sites. At Pavlov, Dolní Vestonice and Předmostí, NISP are unknown, problematic or incomplete for Mammoth.

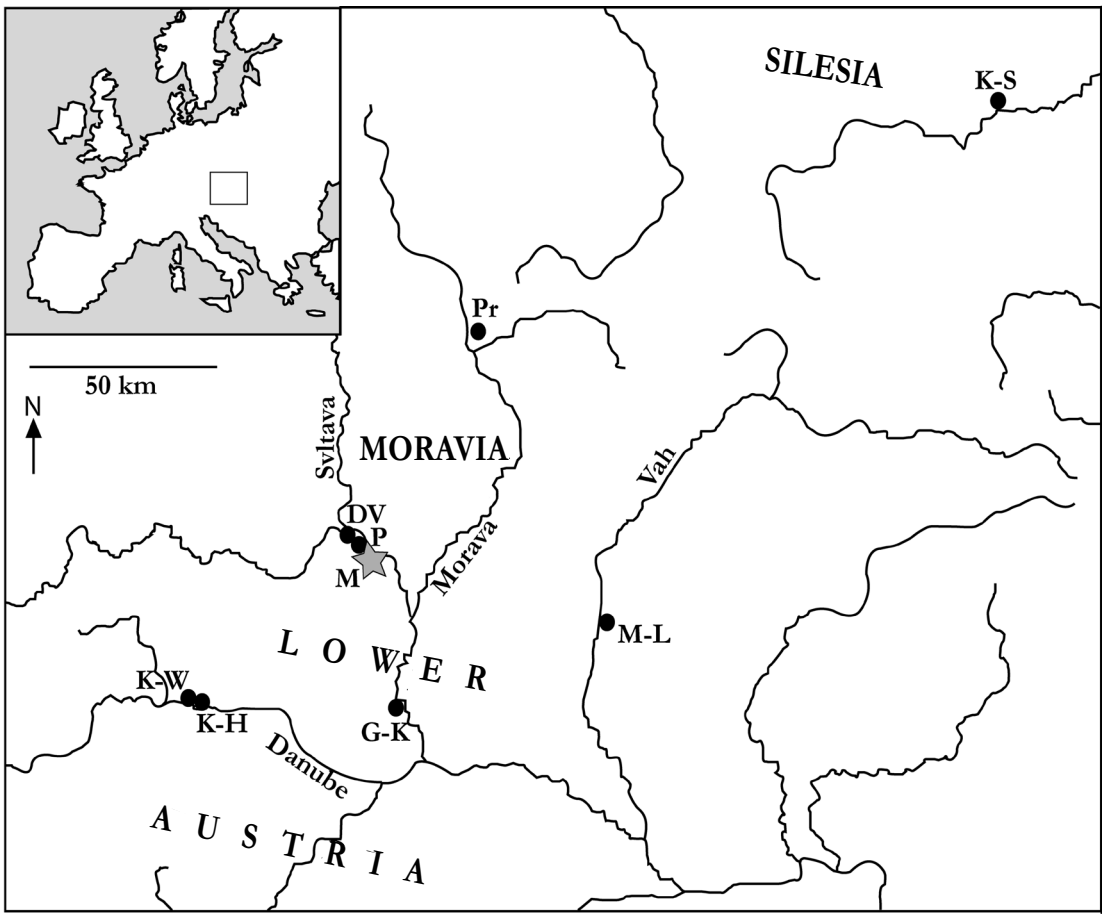


Figure 1: Main Gravettian sites with Mammoth remains (K-S: Krakow-Spadzista; Pr: Předmostí; DV: Dolní Vestonice; P: Pavlov; M: Milovice; M-L: Moravany-Lopata; G-K: Grub Kranawetberg; K-W: Krems-Wachtberg; K-H: Krems-Hundssteig).

dry or collected not far away and brought back to the site and that the same was applicable for Central Europe, in spite of a lack of analogous structures. Several Russian scientists also agree with the idea of the exploitation of natural death sites by human groups, especially for Mammoth bone accumulations found on riverbanks where artefacts are scarce, indicating a short and limited exploitation (references *in* Soffer 1985, 1993). However, many different situations are actually documented. In North American Clovis culture, Mammoth hunting and exploitation never concerned dozens of individuals but only one or two animals, and hunting was the main procurement strategy (Frison & Todd 2001). In Germany, some Aurignacian and Gravettian sites of the Swabian Jura yielded numerous Mammoth remains resulting from hunting, according to a zooarchaeological study (Münzel 2001). Florian Fladerer exposes the same idea for some Austrian Gravettian settlements that never yielded more than a few individuals (Fladerer 2001, Fladerer & Salcher 2004). Concerning the Moravian area and the Gravettian-Pavlovian culture, hunting or scavenging advocates are still discussing. According to Central Europe scientists, there is no doubt Mammoth was hunted by one of the most advanced societies of the Upper Palaeolithic around 27,000 BP (Klima 2000, Musil 1994, 1997, 2000, Oliva 2003a, Svoboda *et al.* 1996). Some other scholars plead for the exploitation of dead Proboscidea (Péan 2001), but do not exclude a human involvement (see Svoboda *et al.* 2005). Some authors also propose that hunting and scavenging could have coexisted at the same site, like at Krakow-Spadzista (Wojtal 2001, Wojtal & Sobczyk 2005). But in every case, clues are always tenuous, explaining heavy discussions.

The backdrop question concerns the human ability to kill the Mammoth and base their meaty economy on this animal. As no clear evidence (like a weapon element inserted on a bone) indicates hunting,

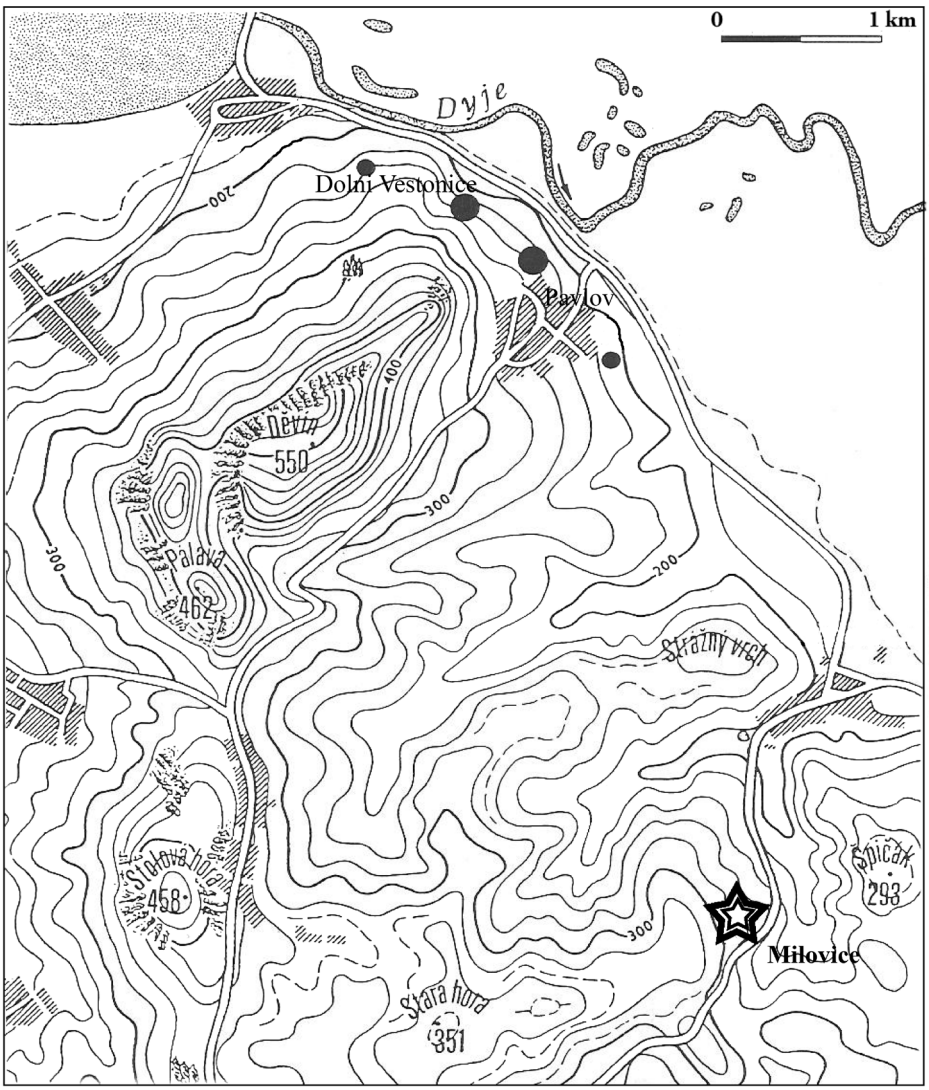


Figure 2: The Pavlov Hills area with Milovice location

like in Siberia (Lugovskoye site: Zenin *et al.* 2003), zooarcheological tools are the only means to go forward and various approaches have to be applied. One of the most used methods is the age profile, sometimes described as an indicator of mortality processes (Haynes 1986, 1991, Louguet-Lefebvre 2005, Speth 1991, Vrba 1976, 1980), but also considered as useless to distinguish human and nonhuman profiles (Soffer 1985, 1993). Nevertheless we will try to assess whether age profile can be helpful or not in discussing Mammoth procurement. Theoretically, human groups can choose individuals according to age and/or sex (which may be suggested by a selective profile) or not (suggested by a natural profile). Thus a natural age profile may also reflect a sample of the dead population in its natural setting without any selection. Morever a natural profile can also be the result of several events, similar or different: many non-selective strategies or many different selective strategies. Concerning scavenging and bone collecting, skeletal part representation is very helpful to shed light on a possible treatment of carcass. A taphonomic study is necessary to identify bone collecting by showing heterogeneity of the global bone preservation. Prior to this, it is necessary to distinguish what is relevant of the site taphonomic processes of deposition from what is relevant of the "death site" before bones were moved to their final place. Thus, several taphonomic stages of different environments should be found with selected bones.

Concerning the exploitation phase, were mammoths exploited at the death place or were they moved? Were humans looking for a preferential product or several ones? Evidence of cut-marks, worked ivory, recursive process of bone breaking pattern for marrow recovery, utilisation of bones as fuel, skeletal part representation and carnivore impact frequency are some of

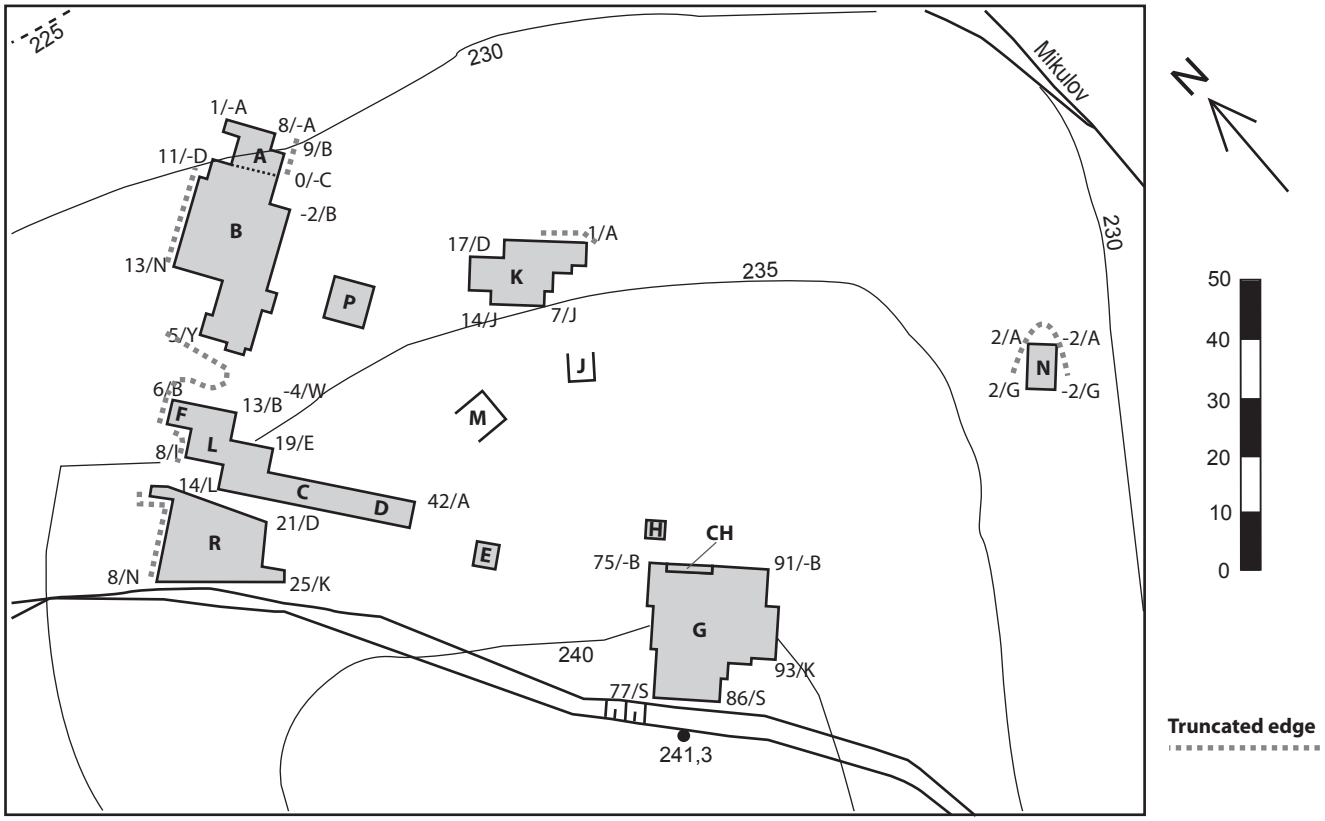


Figure 3: Site map of Milovice (after Oliva 2003b, modified)

the most available evidence to inform us about Mammoth exploitation patterns. Concerning consumption (*sensu lato*), where did it take place (*in situ* or not) and in which part? Some information comes from the analysis of cut-marks, skeletal part representation, demographic data and carnivore impact. Then, were the remains left at the death site, the exploitation place, or even the "consumption site"? Clues from spatial analysis and the importance of bone exploitation are good evidence to address this topic. These are our main questions while studying the faunal collection of Milovice, all areas -G excepted- (previously studied, see Péan 2001).

Milovice data

The site

About 880m South-Southwest of the Milovice village (South Moravia, Czech Republic), the site is located on the eastern slope of the Pavlov Hills, between 225 and 240 meters above sea level (Fig. 2). The settlement is partly situated in a small depression and partly on a soft headland dominating a dry and blind small valley running into the Dyje River two kilometres to the North. Pavlov and Dolní Věstonice settlements are located nearby, just three kilometres to the North. The site was discovered when dam construction needed sediment exploitation, although B. Klima did signal Mammoth bones in this area in 1949 and 1986. The rescue excavation -conducted by M. Oliva from 1986 to 1990- allowed to uncover close to 500 square metres. Thirteen units (Fig. 3), named "areas"[2] , have been singled out, corresponding to actual units and in any case to a true past archaeological spatial organisation. Two of these areas contained Mammoth bone heaps (A+B and K). Some areas were distant by several metres without any archaeological items between them.

A single thick Gravettian layer has been identified through the entire site. Its stratigraphic position sets the cultural level in a highly gleyfied soil at the basis of the loess sequence. Only area L showed an older occupation related to an Aurignacian settlement. Area G is the most studied area, as it is the richest in artefact remains

[2] A+B, C, CH, D, E, F, G, H, K, L, N, P, R. Consider area A+B as one area because originally these two were joined but they have been separated for field excavation.

(Oliva 1999, Péan 2001). A light circular hut structure and two hearths have also been found in this area (Oliva 1988, 1989a). Several conventional radiocarbon dates, made on Mammoth bones and charcoals coming from different areas, seem to indicate two main periods of human occupation: one around 26-24,000 BP and one around 22-21,000 BP (Oliva 2003b). The site was partly destroyed, especially along its northern side affecting part of areas A+B, L and R. Area K has also been affected by tiny destructions. As area N was the most affected, it is not representative of the initial deposit.

The lithic industry in area G is composed of many microlithic backed points, often with supplementary ventral retouch on both extremities; also occur small shouldered points, but without ventral retouch, so that they don't belong to the Kostienki points. The *débitage* was directed towards blade production rather than flakes, with almost no cores (Oliva 1999, in press). Kostenki knives are completely missing. Burins, endscrapers and the few other tools were made at the site. The radiolarite backed points with ventral retouch can be associated with the area G occupation. Radiolarite and local chert prevail over the Silesian flint. This lithic raw material provenance differs highly from the neighbouring Pavlovian sites. Occupation of the northern areas is more recent and the lithic industry (mainly using the Northern flint) seems to be less characteristic. Tools are rare but there are quite numerous choppers between the bones in the accumulation B. The only known Mammoth bone industry is a rounded molar root that might be interpreted as an anthropomorphic sculpture, similar to the one from Pavlov I (Klima 1989) and a hammer made in a Mammoth tusk from area G (Oliva in press). Other Herbivore worked organic material is scarce in area G: an adze made in a large Reindeer antler and a chipped Lion bone. In the same area some beads made on mollusc were found. The Southern part of the Mammoth bone heap (area B) provides two human milk molars. Some elements in area G could recall Pavlovian behaviour but could more clearly be the signature of the Mediterranean Gravettian area (Oliva 1999). In that way, Milovice is different from the classical "Pavlovian Mammoth culture", as defined by K. Valoch and J. Svoboda (Valoch 1996, Svoboda 2004) and revised by M. Oliva (2007).

Mammoth part at Milovice and its game status

At Milovice, Mammoth is dominant in every area, accounting for 86 to 100% of the total number of identified skeletal parts (NISP: *ca*. 63,000) and an average of 98.6% (Fig. 4). Far behind, Horse and Reindeer represent only 0.65 and 0.38%. If we compare the species representation without Mammoth, we notice that Horse (51.8%) and Reindeer (30.3%) dominate (Fig. 5) and that Wolf, one of the three carnivore species, is well represented (15%). Far behind, Lion represents 1.7%, and the remaining species count for less than one percent: Elk, Rhinoceros, Fox and Hare. According to this faunal sample, Milovice belongs to the first kind of sites we distinguished (see *supra*).

Do the remains document Mammoth hunting? What is the site position in the animal exploitation annual cycle? To identify the origin of Mammoth remains at the site, we analysed the skeletal part representation and assessed the carnivore impact on bones. First, all the Mammoth skeletal parts are present at the site, even fragile and small bones like sternum, caudal vertebrae or hyoid bones (Fig. 6a, 6b, 6c). The homogeneity of skeletal body parts indicates that carcasses were left complete at the site, and probably that most animals died *in situ* or close by. Several bone and tooth refits have been successful within each area, but not between them, indicating that all areas were homogenous and independent. Differences in body part representation could be induced by differential preservation, carnivore action or related to human activities. The overall satisfying state of preservation of the bone sample is indicated by the presence of small and fragile bones as foetus ones. Carnivorous gnawing pattern is anecdotic with 48 gnawing remains affecting 17 types of bone elements (long bones, carpals and metacarpals, vertebrae). The most affected are long bones and especially the distal epiphysis (49%) more than the proximal one and the diaphysis (23% each). These body parts (proximal femur, distal humerus) are not the first to be exposed to carnivore jaws, indicating Mammoth skeletons were always dismembered when this limited gnawing action started. Furthermore, if carnivores took away some bones, it seems limited enough. Dismembering could result from a natural process or a human activity. For now, nothing seems to indicate a differential treatment except a natural one. In fact, one exception concerns the teeth, surprisingly missing considering the resistance of

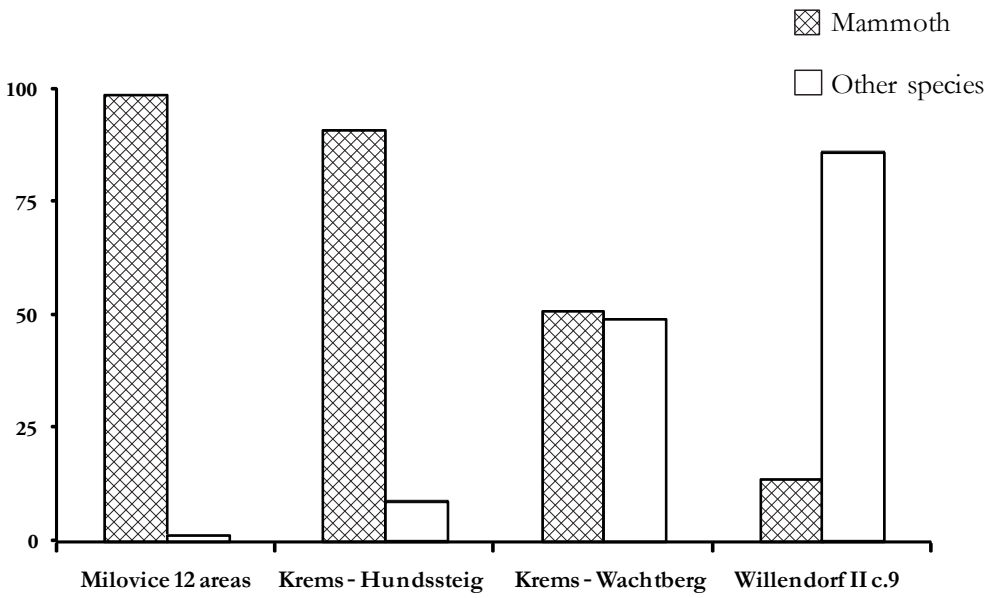
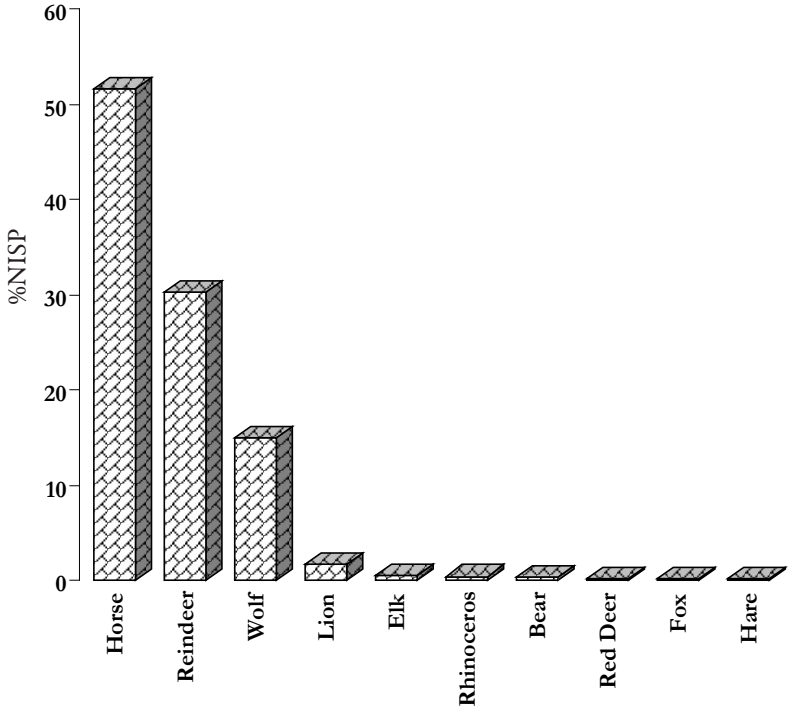


Figure 4: Part of Mammoth remains vs other species at various sites



Taxa	NISP	%NISP
Horse	405	51.8
Reindeer	237	30.3
Wolf	117	15
Lion	13	1.7
Elk	4	0.5
Rhinoceros	3	0.4
Red Deer	1	0.1
Fox	1	0.1
Hare	1	0.1
Total	782	

Figure 5: Taxa representation at Milovice (12 areas) without Mammoth

this material. Remaining molars and two unused second lacteal premolars are globally well preserved. Tusks were strongly smashed to pieces by natural processes. There are only 19 elements for an expected number of 172 according to the MNIc. The few data concerning spatial distribution do not indicate any recognizable pattern in the different areas. No anthropic structure or bone selection appears. Some bones may have been put together intentionally with a radiolarite endscraper in a pit of 50cm depth in area A+B. Also, no natural skeletal dismembering of naturally dead carcass is visible. All of the carcasses are mixed. Anatomical connections are rare and concern only a few vertebrae, phalanges and metapodials. All the other body parts are dismembered and scattered. Moreover, we

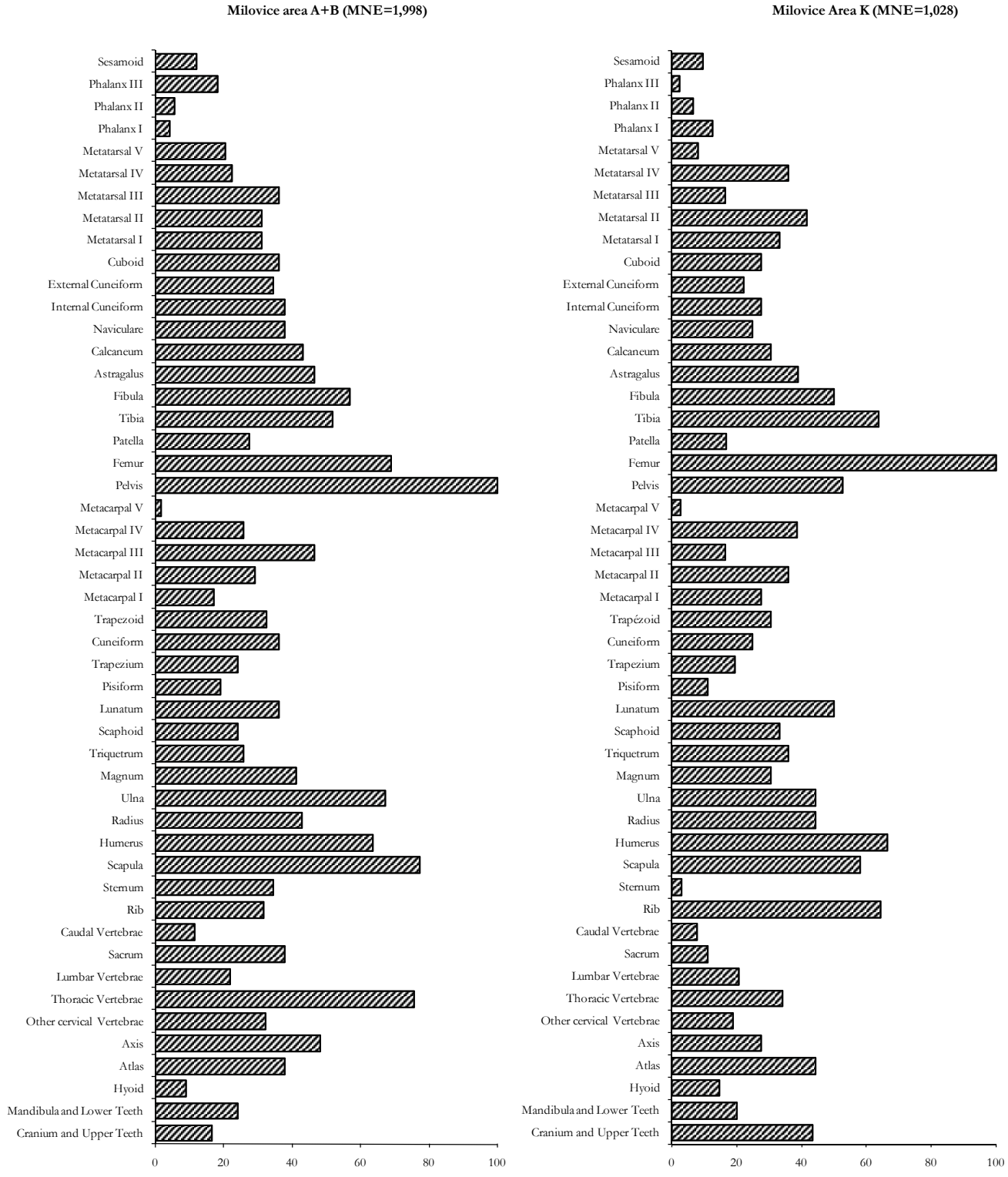


Figure 6a: Mammoth skeletal part representation (% Survival) for the two main areas (A+B and K)

	NISP				MNE				MNIf	MNIc	IS	% S
Skeletal Part	**R**	**L**	**A**	**Total**	**R**	**L**	**A**	**Total**				
Cranium and Upper Teeth	13	22	5549	**5643**	10	14	12	**34**	6	9	7	16.7
Mandibula and Lower Teeth	34	37	1555	**1612**	20	22	1	**35**	16	17	5	24.1
Hyoid	5	6	12	**23**	4	4	2	**8**	4	5	3	9.2
Atlas				**12**				**11**	11	11	1	37.9
Axis				**20**				**14**	14	14	1	48.3
Other cervical Vertebrae				**218**				**47**	10	11	5	32.4
Thoracic Vertebrae				**2333**				**418**	11	11	19	75.9
Lumbar Vertebrae				**98**				**32**	7	8	5	22.1
Sacrum				**106**				**11**	11	11	1	37.9
Caudal Vertebrae				**104**				**61**	4	4	18	11.7
Rib	300	284	3178	**3762**	160	147	57	**351**	19	21	38	31.9
Sternum				**38**				**10**	1	3	1	34.5
Scapula	201	40	714	**955**	24	18	6	**45**	24	24	2	77.6
Humerus	44	62	369	**475**	15	19	3	**37**	19	23	2	63.8
Radius	46	21	6	**73**	13	12	1	**25**	13	16	2	43.1
Ulna	58	49	8	**115**	18	20	4	**39**	20	28	2	67.2
Magnum	11	12		**23**	10	12		**24**	12	16	2	41.4
Triquetrum	10	6		**16**	9	6		**15**	9	11	2	25.9
Scaphoid	4	11		**15**	4	10		**14**	10	12	2	24.1
Lunatum	11	10		**21**	11	10		**21**	11	13	2	36.2
Pisiform	5	6		**11**	5	6		**11**	6	8	2	19.0
Trapezium	4	9	1	**14**	4	9	1	**14**	9	9	2	24.1
Cuneiform	10	12		**22**	9	12		**21**	12	12	2	36.2
Trapezoid	10	10		**20**	10	9		**19**	10	12	2	32,8
Metacarpal I	6	4		**10**	6	4		**10**	6	6	2	17.2
Metacarpal II	7	11		**18**	7	10		**17**	10	10	2	29.3
Metacarpal III	14	15		**29**	13	14		**27**	14	14	2	46.6
Metacarpal IV	8	8		**16**	8	7		**15**	8	8	2	25.9
Metacarpal V		1		**1**		1		**1**	1	1	2	1.7
Pelvis	267	310	336	**913**	29	29	2	**58**	29	30	2	100.0
Femur	45	53	270	**368**	18	19	10	**40**	19	28	2	69.0
Patella	5	8	3	**16**	5	8	3	**16**	8	9	2	27.6
Tibia	31	45	24	**100**	12	17	4	**30**	17	24	2	51.7
Fibula	30	26	1	**57**	18	15	1	**33**	18	23	2	56.9
Astragalus	16	13		**29**	16	11		**27**	16	17	2	46.6
Calcaneum	19	8	2	**29**	16	8	1	**25**	16	16	2	43.1
Naviculare	10	12		**22**	10	12		**22**	12	14	2	37.9
Internal Cuneiform	10	11	1	**22**	10	11	1	**22**	11	14	2	37.9
External Cuneiform	7	11	2	**20**	7	11	2	**20**	11	13	2	34.5
Cuboid	14	8		**22**	13	8		**21**	13	14	2	36.2
Metatarsal I	10	9		**19**	9	9		**18**	9	9	2	31.0
Metatarsal II	10	8		**18**	10	8		**18**	10	10	2	31.0
Metatarsal III	9	12		**21**	9	12		**21**	12	12	2	36.2
Metatarsal IV	7	7		**14**	6	7		**13**	7	7	2	22.4
Metatarsal V	6	6		**12**	6	6		**12**	6	6	2	20.7
Phalanx I	30	17	49	**96**			25	**25**	2	2	20	4.3
Phalanx II	1	2	31	**34**	1	2	31	**34**	2	2	20	5.9
Phalanx III			25	**25**	28	16	48	**85**	5	5	16	18.3
Sesamoid				**71**				**71**	4		20	12.2
Total	1328	1202	12136	**17711**	583	575	215	**1998**	29	30		

Figure 6b: Detailed data for figure 6a (area A+B) (IS: Initial Skeleton; % S: % Survival)

	NISP				MNE				MNIf	MNIc	IS	% S
Skeletal Part	**R**	**L**	**A**	**Total**	**R**	**L**	**A**	**Total**				
Cranium and Upper Teeth	33	39	2650	**2725**	21	23	11	**55**	16	32	7	43.7
Mandibula and Lower Teeth	9	12	283	**319**	7	8	3	**18**	4	11	5	20.0
Hyoid				**10**				**8**	3	3	3	14.8
Atlas				**11**				**8**	8	8	1	44.4
Axis				**9**				**5**	5	6	1	27.8
Other cervical Vertebrae				**30**				**17**	4	6	5	18.9
Thoracic Vertebrae				**331**				**117**	9	9	19	34.2
Lumbar Vertebrae				**25**				**15**	4	5	4	20.8
Sacrum				**3**				**2**	2	2	1	11.1
Caudal Vertebrae				**36**				**26**	2	4	18	8.0
Rib	92	95	1537	**1724**	88	77	56	**221**	9	10	19	64.6
Sternum			5	**5**			5	**5**	1	2	9	3.1
Scapula	16	17	46	**79**	10	11		**21**	11	12	2	58.3
Humerus	31	25	33	**89**	13	11		**24**	13	13	2	66.7
Radius	11	12	2	**25**	7	8	1	**16**	8	9	2	44.4
Ulna	13	15	8	**36**	7	9		**16**	9	9	2	44.4
Magnum	2	9		**11**	2	9		**11**	9	9	2	30.6
Triquetrum	7	6		**13**	7	6		**13**	7	7	2	36.1
Scaphoid	3	9	1	**13**	3	9		**12**	9	9	2	33.3
Lunatum	9	9		**18**	9	9		**18**	9	10	2	50.0
Pisiform	2	2		**4**	2	2		**4**	2	4	2	11.1
Trapezium	3	4		**7**	3	4		**7**	4	6	2	19.4
Cuneiform	4	5		**9**	4	4		**9**	4	4	2	25.0
Trapezoid	7	4		**11**	7	4		**11**	7	7	2	30.6
Metacarpal I	6	3	1	**10**	6	4		**10**	6	6	2	27.8
Metacarpal II	6	7		**13**	6	7		**13**	7	7	2	36.1
Metacarpal III	3	3		**6**	3	3		**6**	3	3	2	16.7
Metacarpal IV	6	8		**14**	6	8		**14**	8	8	2	38.9
Metacarpal V	1			**1**	1			**1**	1	1	2	2.8
Pelvis	10	13	7	**30**	7	9	3	**19**	11	11	2	52.8
Femur	28	50	35	**113**	18	18		**36**	18	24	2	100.0
Patella	2	3	1	**6**	2	3	1	**6**	3	3	2	16.7
Tibia	21	29	11	**61**	12	11		**23**	12	16	2	63.9
Fibula	16	14	3	**33**	10	8		**18**	10	10	2	50.0
Astragalus	10	5		**15**	9	5		**14**	9	9	2	38.9
Calcaneum	8	6	1	**15**	6	5		**11**	6	6	2	30.6
Naviculare	7	4	1	**12**	4	5		**9**	5	5	2	25.0
Internal Cuneiform	6	4		**10**	6	4		**10**	6	6	2	27.8
External Cuneiform	3	5		**8**	3	5		**8**	5	4	2	22.2
Cuboid	5	5		**10**	5	5		**10**	5	5	2	27.8
Metatarsal I	9	3		**12**	9	3		**12**	9	9	2	33.3
Metatarsal II	7	8		**15**	7	8		**15**	7	7	2	41.7
Metatarsal III	2	4		**6**	2	4		**6**	4	4	2	16.7
Metatarsal IV	5	8		**13**	5	8		**13**	8	8	2	36.1
Metatarsal V	2	1		**3**	2	1		**3**	2	2	2	8.3
Phalanx I	1	4	42	**47**	1	4	41	**46**	3	3	20	12.8
Phalanx II				**24**				**24**	2	2	20	6.7
Phalanx III				**7**				**7**	1	1	16	2.4
Sesamoid				**35**				**35**	4		20	9.7
Total	**406**	**450**	**4667**	**6062**	**320**	**322**	**121**	**1028**	18	32		

Figure 6c: Detailed data for figure 6a (Area K) (IS: Initial Skeleton; % S: % Survival)

noticed the lack of bones discovered in vertical position and in area K bones were primarily horizontally deposited. This information allows us to exclude a natural death after getting trapped in a bog. Absence of a cliff, mineral resources or water point as attracting spots also contributes to make the hypothesis of a natural origin unlikely.

So the homogeneous carcass representation indicates mammoths died at the site or very close to it. The total lack of organisation of the bone accumulation and the absence of water-point, mineral source spot or a bog do not indicate a natural death pattern. Moreover carnivores were not able to reach the bones freely and the ivory is missing. Even though our results reveal that human groups were probably responsible for the death of mammoths at Milovice, another set of data is still necessary to confirm that it was the result of hunting practices.

The skeletal part analysis indicates that bone collecting was not the strategy responsible for the accumulation of this deposit, as no preferential collecting does exist. Moreover, the taphonomic analysis (presented in detail *in* Brugère & Fontana 2009) does not show any differential preservation due to different exposures before carcasses were brought up to their final place. The slight differences we notice are due to the spatial scattering of carcasses deposited at the site (more than 100m between areas A and G). So the remaining strategy is hunting or active scavenging.

Mammoth is a gregarious mammal, with different social structures depending on the sex, the age and the season. So along with trying to characterize the dead population at Milovice and the death strategy, we also have to look at the whole demographic data to reach the one or several social structures involved in the death events. The social behaviour of Mammoth is considered close to that of the actual Elephant and is also known thanks to the natural death sites of Mammoth (Haynes 1991 and references). The Elephant main social structure is the family unit, composed of a female and its offspring. Adult (25-60 years, counting for 17%) and subadult (13-24 years: 23%) females stay all together with their young (0-12 years: 60%) of both sexes forming herds of 15 individuals in average, but up to 30 or more, sometimes aggregating with other family herds. The sexual maturity is reached during the adolescence. Males leave the family group during this period, living alone or in small bands. Females can also leave the group to seek males. They can have five to fifteen calves in their life and the pregnancy period runs over 22 months. Mammoth birth probably took place during the Springtime between the end of April and the beginning of June, considering many periglacial species behaviour for increasing their juvenile's chances to survive their first Winter (Guthrie 1990). Females stay with their mother, aggregating with aunts, cousins and sisters. Elephant bulls live alone or in small bands joining adult females and young animals of both sexes for the reproductive period (for Mammoth probably July or August, following the



Figure 7: Milovice Mammoth age profile : area K (left) and area A+B (right)

estimated pregnancy period). It does not exclude that some adult males can join the family groups at any given period. In the case of a long bone accumulation as at Milovice, it could become harder to distinguish a procurement strategy if many different ones are mixed. Indeed, a natural profile may reflect the lack of any special choice or, on the contrary, several ones. To shed light on this point, we established the Mammoth age profile (after Laws and Haynes age classes, in African Elephant Years) using the lower molars (Fig. 7)[3]. The profile clearly points out the domination of adults (73% MNIc) over adolescents (17% MNIc). Young individuals are scarce (10% MNIc) and old individuals are completely missing. This kind of profile does not correspond to a mortality profile (showing a decreasing rate from calves to old individuals), so the Milovice Mammoth population does not represent a natural one. Is it the reflection of a natural social structure that exists at a precise season or does it demonstrate a selective strategy? We cannot answer without assessing the *sex ratio*. Bones that could demonstrate sexual dimorphism are few and have to be complete (Averianov 1996, Lister 1996), which is not the case at Milovice. Lenka Halámková studied the paleontological aspect of the Milovice Proboscidian. Because of the lack of complete characteristic bones like the pelvis (Lister 1999), she had to take specific measurements on well-preserved long bones with fused epiphyses (Halámková personal communication). She was able to identify at least six females. One adult male is also present according to our study: if measurements are not possible, the size of some remains is not questionable (especially an unfused distal of femur and a talus). The *sex ratio* data coupled with the age profile and the presence of some young and newborn individuals indicate that matriarchal social groups were more affected by death. So it appears the age profiles are representative of a mortality affecting adult animals (between 25 to 48 years old), coming from different social structures: undoubtedly the matriarchal group and a male coming from a male band or isolated. So these profiles are the result of at least two death episodes. They can be connected with one of the profiles Gary Haynes proposed (Fig. 8, Haynes 1991). There is a similarity with his type C, not because "affecting males only or a declining population" (Haynes 1991, p. 217), but representing a "selective mortality over an extended period of time" (p. 218). At Milovice old individuals are missing and females are well represented, along with their young and newborn. The very low proportion of young animals may also suggest a wish not to kill too many newborn for species management unless the adult target responds to specific needs for human groups. Mammoth in Moravia was present after 25,000 BP and it appears difficult to define the state of a healthy or a declining population when the deposit has been probably built between 26 and 22,000 BP, a time range long enough to include several "population" health states. Considering the age profile including area G (Péan 2001), the global site in Mammoth population is still dominated by adult animals, even if young ones are better represented, reaching 49% MNIc (Fig. 9). The global aspect of this profile may recall the "D type" age profile of Gary Haynes (see Fig. 8). But once again, differences are evident like the presence at Milovice of all age classes, but the last one. Another interesting point is the age class spatial scattering. Area G profile yielded young animals (52% MNIc) followed by subadult ones (29% MNIc) and young adults (25-36 years: 19% MNIc), without mature (37-48 years) and old individuals (49-60 years) (Fig. 10). It was interpreted first as a catastrophic profile by S. Péan (2001). But a revised interpretation, with mature and old individuals saved or missing, does not support the catastrophic profile (Svoboda *et al*. 2005). It seems adult animals were saved in a non-selective death pattern. How could this difference between area G and the others be explained? Is that spatial difference related to the period of occupation, a different death agent, a different death season, a different procurement strategy or a different occupation by a different human group?

Seasonality data are partially available directly from the Mammoth at Milovice. The presence of at least one foetus, three freshly newborn (or animals close to be born), and a one-year-old Mammoth (based on bone measurements, Maschenko 2006), indicates they were killed between April and the end of June, considering the birth time range. It also indicates that at least one mother was killed at that period. The birth period may have been a good time for Mammoth procurement, considering the several calves present at Milovice. We cannot say anything for the 80 remaining individuals. Considering Mammoth as a nomadic species more than a migrant one, following Gary Haynes's definition (Haynes 1991, p. 61),

[3] MNIc based on the lower molars of the 12 areas: A+B=16; K=11; H=1; N=1; C=1.

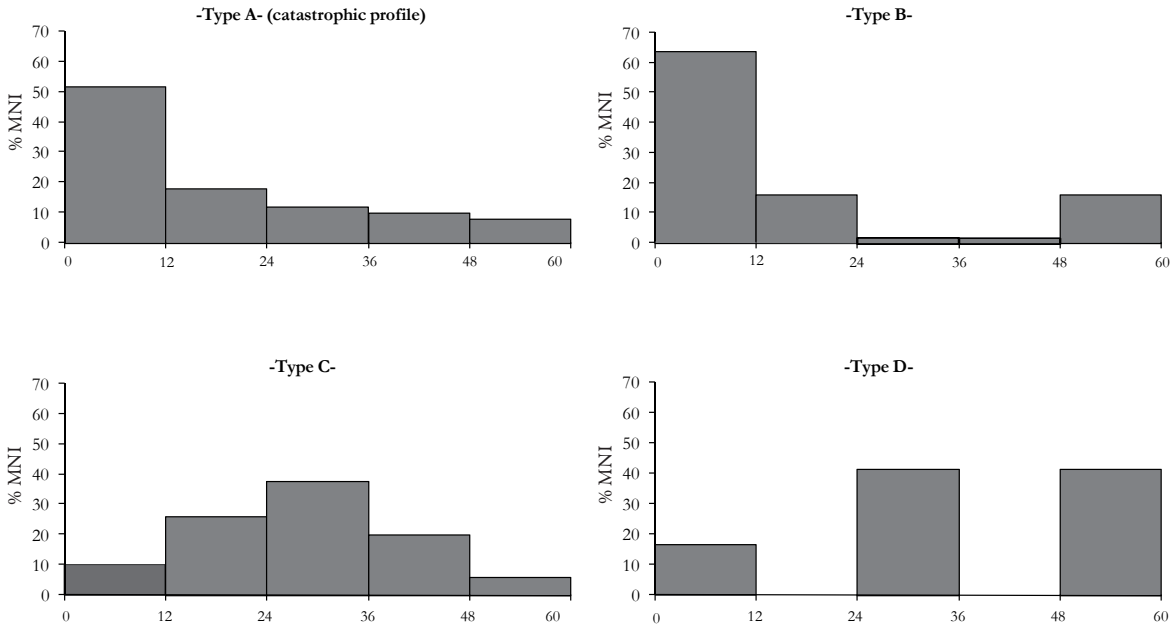


Figure 8: Haynes different interpretations of Proboscidian age profiles (Age class in AEY, after Laws 1966) (Haynes 1991).

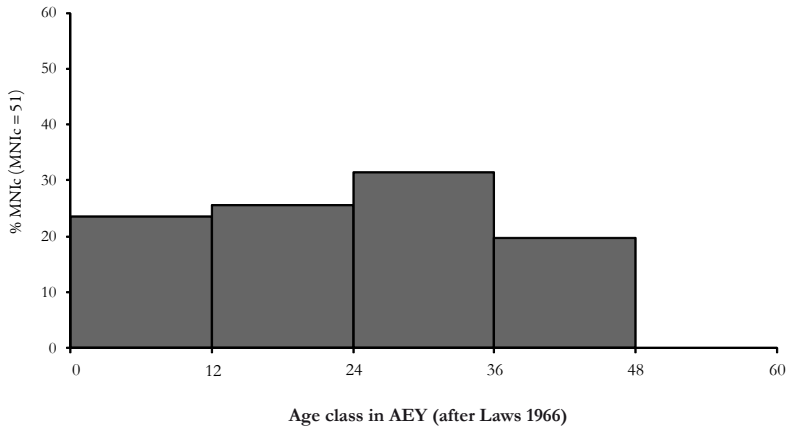


Figure 9: Milovice Mammoth age profile -all areas-



Figure 10: Milovice Mammoth age profile -area G- (After Péan 2001)

its presence during this "arctic Spring" would indicate it spent Winter months in southern areas and Summer months in northern areas, or locally if the birthplace was close to the Summer area, meaning mammoths gave birth after their main seasonal move to reach the Summer area (the presence of newborn slowed down but did not stop it).

Considering these results, it is obvious that neither bone collecting nor natural death were responsible for Mammoth bone accumulation at Milovice. Carnivores are also excluded from this process, as their gnawing activity and impact on carcasses are very limited face to such an amount of meaty remains. The origin of the Mammoth accumulation at Milovice is the result of an anthropic behaviour. Human groups focused their hunting on adult individuals, overall females from matriarchal groups, once or several times between late April and mid-June. This important involvement of the Gravettian groups in Mammoth procurement makes the Proboscidian a major game at Milovice. We have now to shed light on human goals related to this particular game procurement.

Proboscidian Exploitation and consumption

Mammoth accumulation at Milovice is resulting from human activity. So what were the main goals of this procurement? Was the Proboscidian sought for one or several products interesting diet or any technical field?

Was the Mammoth a meat commodity and what was its butchering exploitation for? Usually, butchering activity is demonstrated by the presence of cut-marks and/or by a special representation of body parts, depending on their nutritive interest and the site status (a "killing site" with nutritive bone removal or a "butchering/consumption" site with interesting body part supply). Dealing with Proboscidea modifies the usual scheme known for middle-sized species. At Milovice G, butchering cut-marks are present on several skeletal parts (Péan 2001). At other areas of the site, despite an overall satisfying bone preservation, external surfaces are damaged enough to have erased some of the thinner grooves. However, the scarcity of cut-marks (three parallel ones on a rib: Fig. 11) does not imply *de facto* a low butchering exploitation, especially on the Proboscidea as it has been shown at different Palaeolithic and actual elephant butchering sites (Fisher 2001, Gaudzinski *et al.* 2005). The human dexterity, the difficulty to leave cut-marks on Proboscidian bones (Frison 1989, Frison & Todd 2001), the lightness of these marks and the significant presence of superficial damage -particularly root etches- are as many factors that could reduce their visibility. Also, in some Palaeolithic sites, the use of bone tools as knives would imply a reduced number of cut-marks (Hannus 1997). Actual African societies exploiting elephants with metal knives and tools leave none or very few cut-marks (Crader 1983, Fisher 2001). Thus, although cut-marks are still the most direct evidence demonstrating butchering activity, their frequency and intensity are in no way a reflection of butchering intensity, moreover on such a big mammal.



Figure 11: Rib showing butchering cut-marks (area K) (Photo A. Brugère)

Further indication to assess the part of meat procurement can be found in the type of carnivore action. As said above, most of the gnawed bones are long bone epiphysis. But these bone parts are easily reached only once soft tissues (muscles and tendons) have been sufficiently removed or damaged to make disarticulation possible. It means carnivore action would only have happened when the dislocation process of carcass was advanced. Moreover, the gnawing activity at Milovice does not match the classical scheme of gnawing pattern by carnivores which indicates their late access to fresh bodies. If carnivores (mainly Wolf) had gnawed systematically fresh carcass, bones like ribs, tarsals, carpals and metapodials, would be the most frequently chewed and in a higher rate than the ones observed at Milovice. Indeed no rib was gnawed and only 37.5% of the compact bones were concerned. Then various types of bones were affected like long bones (humerus, radius, ulna, femur, tibia, fibula), or the scapula and the axis. During the excavation, several light hearths

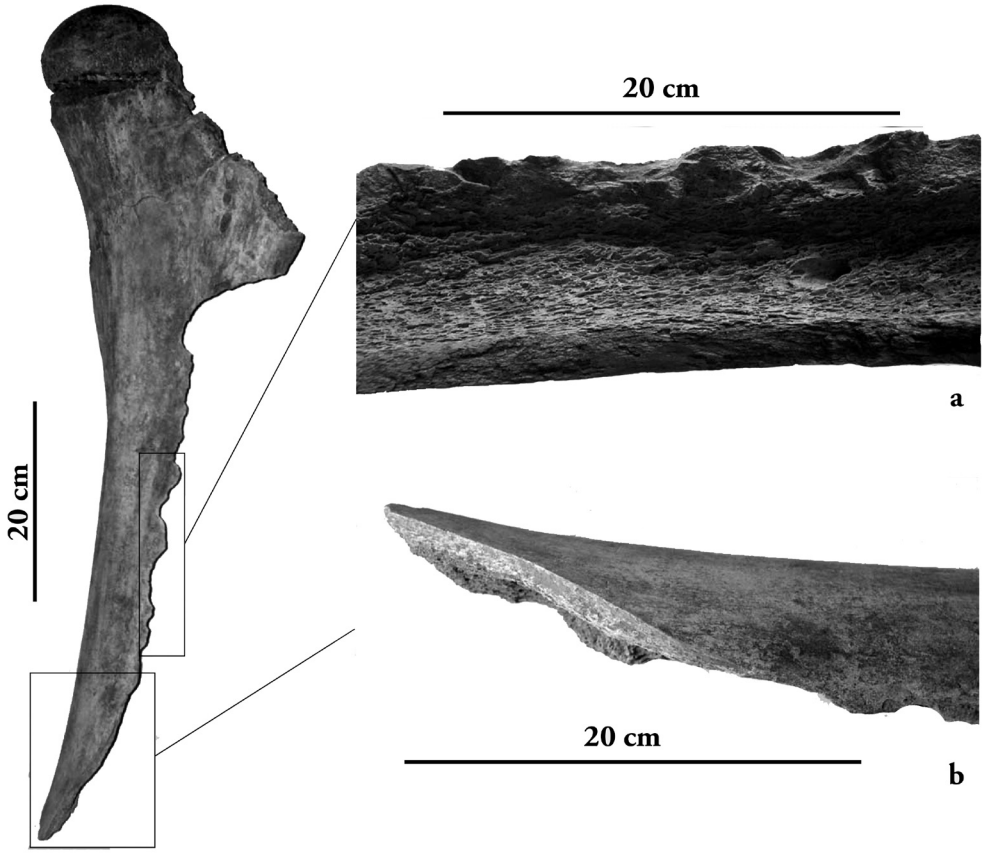


Figure 12: Mammoth bone industry: femur showing several impact points (Milovice A+B), and details of the impact points (a) and the distal end with spiral fracture (b) (Photo A. Brugère)

were found (around the bone deposits) wich seem to have been low calorific hearths, in use for a short time. So a partial meat-smoking or drying activity practiced at these places is not excluded.

A few indicators document marrow removal. Among the different fragmentation types, spiral fracture accounts for 3% of the total NISP, far behind sawtoothed and perpendicular breakage, representing respectively 62 and 34% of the total NISP: post-depositional fragmentation is clearly dominant. By contrast, spiral breakage pattern is systematic for Reindeer, Horse and Elk bones in area R where Mammoth represents "only" 86% of the faunal remains. The different kinds of typical human fragmentation on Proboscidian bones detailed by Biberson and Aguirre (1965) are present in some areas (A+B and K), but this breakage pattern is not systematic. These few observations indicate that marrow was not systematically extracted and did not represent an attractive product for the human groups at Milovice. It could be due to the fact that the animals killed at Milovice during Springtime were not so healthy at this period, leaving the Winter in poor conditions, making marrow not so interesting to obtain.

Meat exploitation was not the only activity practiced at Milovice. Indeed, we also identified a Mammoth bone industry. Two femurs (area A+B) are notched in a longitudinal direction, in a linear series of eight and eleven impact points (Fig. 12). These impacts affected the anterior face of a left and a right femur. The opposite face presents a full longitudinal spiral fracturation covering 90% of the diaphysis length. The distal end of the diaphysis looks like a point. The bone "point" does not seem to have been used (to be confirmed by a microscopic study), no more than the sawtoothed diaphysis (obtained by knapping). Thus, we suggest these bones were exploited for bone flake production, even if no bone flake was identified in the faunal collection. Big mammal bone flakes have been used as knives in the Middle and Upper Palaeolithic (*e.g.* Hannus 1997, Antl & Fladerer 2004, Gaudzinski *et al.* 2005). With a similar femur at Krems-Wachtberg (Austria) and a similar applied technique over an ulna at Krems-Hundssteig (Austria), such a bone exploitation is not an isolated case in the Gravettian of Moravia and its borders (*e.g.* Fladerer 2001, Fladerer & Salcher 2004). At Dolní Věstonice, the notched long bone seems, in this case, to be the final object and its morphology is a little bit different,

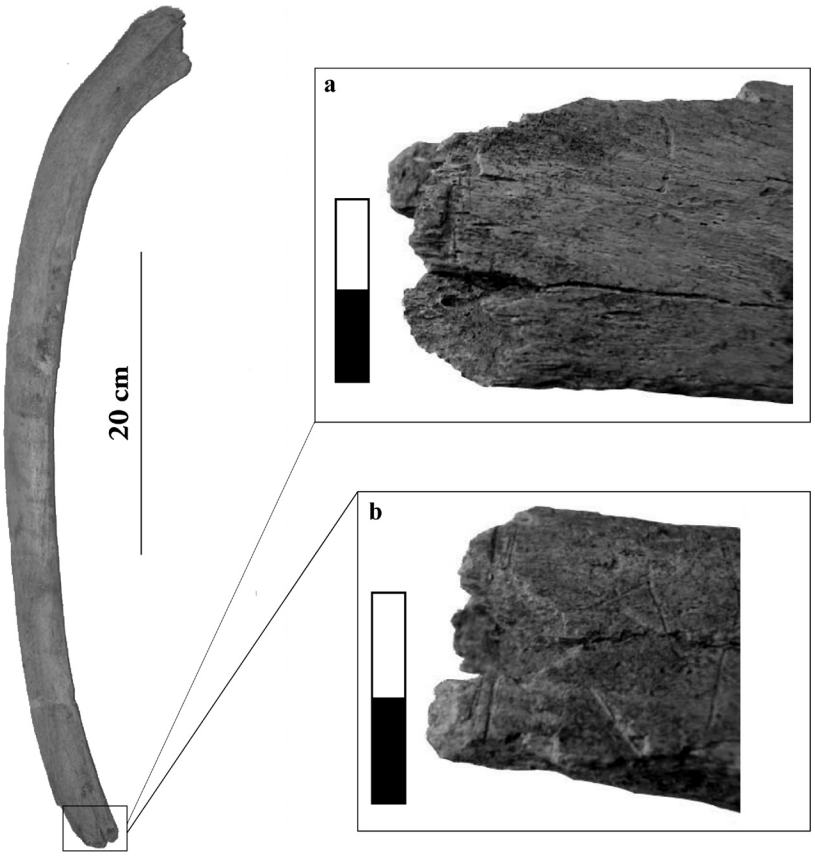


Figure 13: Rib wearing intentional grooves on both faces of its distal part (Milovice A+B). Close-up on both faces showing the grooves (a) and (b) (Photo A. Brugère)



Figure 14: Two fractured Mammoth ribs resulting of a human activity (Milovice A+B) (Photo A. Brugère)

keeping only a long flat part of the bone diaphysis. Ribs were also exploited if we consider some remains probably used as smoothers. A rib from area R is heavily smoothed on its distal part and all over the diaphysis section, resembling the smoothers made in Reindeer antlers and ribs at other sites. Another similar rib, in area K, may also have been used as a smoother. Once again, these tools are isolated, indicating that bone exploitation was not important at the site. Bone industry with unknown function is also present at Milovice like in area A+B where a rib clearly shows deep intentional grooves on its distal part (Fig. 13). The 60 cm long middle-thoracic cage rib wears several superimposed deep incisions on both anterior and posterior sides. The broken edge has damaged the incisions and we do not know if they were peripheral or just applied on these two faces. The rib may have been used as a cutting board but several bones present more suitable flat surfaces, even ribs like the first one. It is difficult to relate these cut-marks to a butchering practice or an activity requiring the use of an anvil, so we tend to suggest an intentional production. Similar ribs are known at other sites like Grub/Kranawetberg (Antl & Fladerer 2004) and Krakow-Spadzista (Wojtal & Sobcyzk 2005), but all of these artefacts present more incisions on a wider surface. An artistic or more symbolic motivation could also drive this production. Some ribs could have been used in a different way. Indeed, 100 of them, coming from areas A+B, K and L, have been broken in spiral about 17-23cm away from the head. Sometimes, the spiral edge is associated with a fragmented strip *en sifflet/languette* (Fig. 14). Humans could have broken the ribs during the butchering process while trying to reach the viscera or open the thoracic cage for example. In that case, the fracture would result from a flexion movement, which would be coherent with the presence of the few strips. Prehistoric people could have also needed these ribs as a technical support that remains unclear, as no analogous rib exists. We know Mammoth ribs were useful to human groups exploiting Proboscidians like in the German Gravettian of Geißenklösterle (Münzel 2004) and at many other sites, even those yielding very few Mammoth bones, whatever the period (Gaudzinski 1999).

Until now, we focused on meat procurement and bone tool manufacture. What about ivory, one of the most useful raw materials in the Gravettian of Moravia (Oliva 1995)? Early in our study, we noticed the low number of tusks. All of the remains are partial sections of tusks or small pieces, depending on the area, and representing a minimum of 19 elements. Compared to the number of 86 individuals (based on bones and teeth) and the 172 tusks expected, it means 89% of ivory is missing. If we only focus on adults bearing the biggest tusks, the MNIc (based on molars) is reduced to 27 individuals and 54 tusks should be represented; in that case, 64% of ivory is still missing (Fig. 15). Tusks are well preserved and there is no reason for their disappearance, especially for the biggest ones: there are too many missing tusks and we attribute this absence to a human activity related to ivory exploitation. None of the 12 areas yielded worked ivory, finished items,

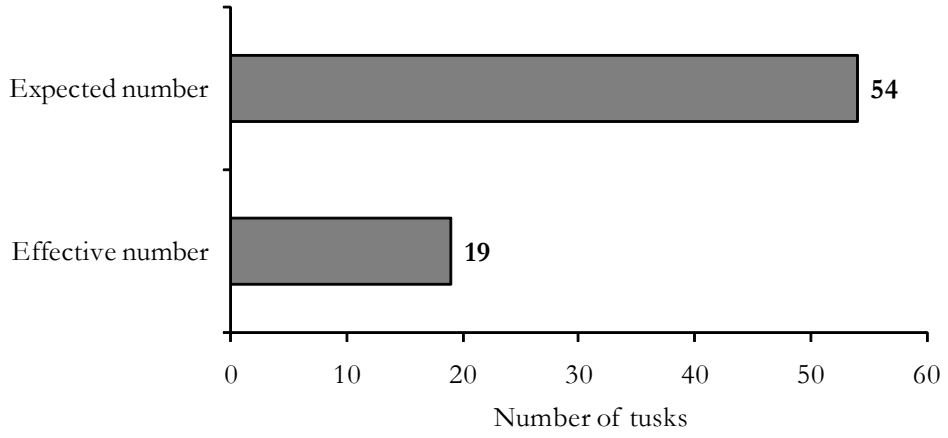


Figure 15: Number of sub-adult and adult tusks in Milovice, related to expected number (12 areas)

beads or any waste remain. In area G, only one fragment shows grooves, indicating an anthropic work (Péan 2001), and ivory is equally missing. To remove tusks, three alternate operations can be followed (Christensen 1999, Khlopatchev 2006). First, in a fresh state, a direct action on ivory by sawing, fracturation, or grooving is possible. Another possibility, not affecting the raw material, is to cut around the incisive bone, then destroy it. Finally, tusk removal is made easier when collecting it in a dry state. At Milovice, the few fracture edges we observed on the rare tusk fragments all show a natural breakage pattern (M. Christensen personal communication), so ivory is not directly affected by the fresh removal technique. Therefore, if all the skulls were mostly crushed to pieces, we could not find any impact point, so the hypothesis of human groups smashing maxillaries and incisive bone to get tusks cannot be proved. We cannot document if tusks were removed in a fresh or dry state. Exploiting tusks on dry carcasses would imply at least a two-step Mammoth exploitation with a first stage for meat and marrow procurement -and fresh products- and a second stage for ivory procurement. Ivory items present at neighbouring sites (*e.g.* Pavlov and Dolní Věstonice) are made on heavy ivory, excluding the work of this raw material at a dry or sub-fossil stage (Delporte 1995, Garcià Diez 2005, Klima 1963, 1964). Unfortunately the complete ivory *chaîne opératoire* is unrecognized in Moravia.

In a better state of preservation than tusks, molars are also missing and there is a differential pattern between upper and lower teeth, depending on the area. Molars are heavy and may have been used in different ways. People used them as scrapers at Dolní Věstonice, and their roots were sometimes worked at Austrian sites (Antl & Fladerer 2004). Their very high number at Předmostí (giving a MNIc close to 1000 individuals) also raises questions about their origin. Molars seem to be less attractive than tusks since 10 mandibles of subadult and adult animals are still wearing their teeth. It means that molar procurement was not systematic and there is no argument for a fresh or dry extraction. Ivory exploitation at Milovice is clearly attested: tusks and molars were removed, taken away to be exploited and used at other places. Considering that Mammoth would have been the main food resource at Milovice, the preferential choice of adults that wore the biggest tusks and heaviest molars tends to be confirmed.

It appears that Mammoth bone accumulation at Milovice is due to human activity. Its origin results from a selective hunting strategy affecting the largest animals. The exploitation process indicates that meat and marrow were removed at the site in different ways: probably intensively for the first one and only very episodically for the second (Fig. 16). Part of the meat could have been «prepared» directly *in situ*, in order probably to take it away. Mammoth

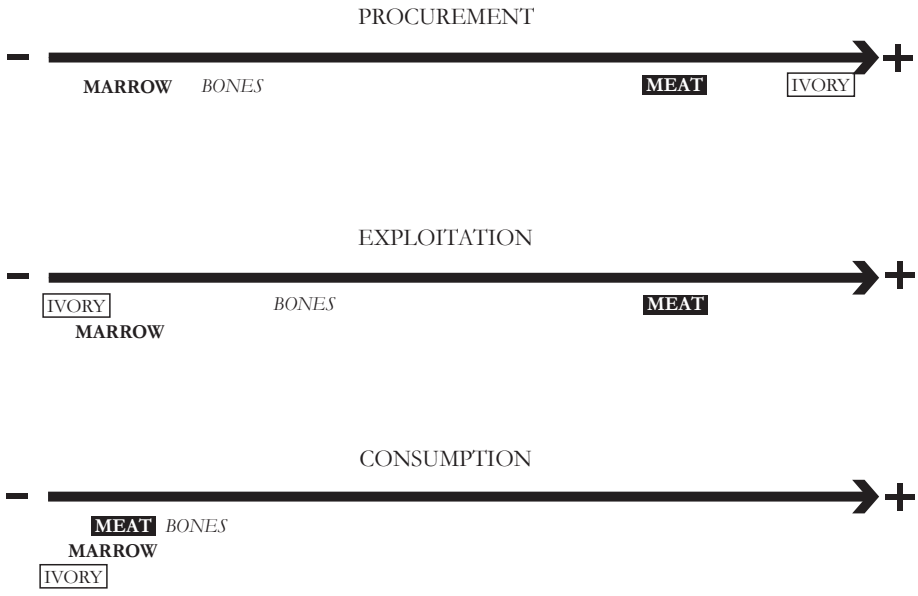


Figure 16: Global view of the intensity (from lower to higher) of each stage of the Mammoth exploitation at Milovice 12 areas.

exploitation also involved a minimal bone processing, especially some long bones and ribs. We also noticed the complete lack of burned Mammoth bones and the very low number of other animals (Reindeer-Horse class size). The most important exploitation concerned ivory. As shown, tusks were collected in a fresh state by cranium destruction or in a dry state by easy extraction. It implies the entire Mammoth carcass was treated in one or at least two phases if delayed procurement of dry tusks existed. A delayed collection is not excluded, explaining the several tusks at the site, which might have been too damaged for their final purpose. Unfortunately, we cannot discuss the site position in the annual cycle as we only have a partial view of it. So now we will try to better understand Milovice in the Moravian context, discussing several scenarios about Mammoth economy during the Gravettian period.

Mammoth economy in the Moravian Gravettian

Mammoth economy through Milovice analysis

Which information can our study provide to the knowledge of Mammoth exploitation in the Gravettian society of Moravia? We have seen that Mammoth exploitation was the main activity at Milovice. Human groups were highly involved during the whole Springtime in Mammoth hunting, with a preference for adult individuals coming from matriarchal groups. We suppose that meat procurement was intensive as opposed to marrow extraction. Then the presence of some worked bones gives a technical and maybe a symbolic aspect to that site, for the first time. Ivory procurement, highly favoured in the Gravettian context, appears to be one of the main purposes of Mammoth exploitation, along with meat. The lack of ivory waste fragments and an equally scarce indication of a long stay at the site make Milovice an "event site" related to Mammoth hunting and exploitation and a very limited consumption, reflecting the short time span at the site. If the study of area G allowed S. Péan to conclude that Milovice was a "killing-butchering" site (Péan 2001), the procurement pattern he documented appears different from the one we identified for the 12 other areas. As the spatial distribution does not indicate any connection between the areas, this could mean different procurement strategies were practiced, related to different periods of occupation, for example during different seasons. Different economic objectives or even an occupation of the site by different human groups may also be suggested. However, the meat exploitation and the missing ivory are a common pattern to the whole site.

The Pavlovian culture is well known, thanks to the large sites of Dolní Věstonice, Pavlov and Předmostí. If the importance of Mammoth is a common feature with Milovice, other common cultural points also exist: shell ornaments and circular structure in area G, rounded molar root, smoothers, grooved and knapped bones in other areas. Regarding the lithic industry, similarities and differences (radiolarite industry from area G) can be observed. Flint tools from all areas are close to the ones known at Dolní Věstonice and overall at Pavlov. But the dominating radiolarite makes the Milovice (especially area G) different from those sites. Thus, it shows more similarities with the Mediterranean Gravettian complex, especially with the presence of small shouldered points without ventral retouch (Oliva 1999). Moreover, some strong affinities have been noticed with the lower Austrian sites of Grub/Kranawetberg and Aggsbach. Of course, the contrast between the large amount of accumulated Mammoth bones and the low intensity of human occupation makes Milovice very different from the two largest settlements agglomerations situated directly above the Dyje river (DV I and Pavlov I). Differences can also be found in the non-cultural field, for example its geographical position: in a blind valley away from the Dyje river. Is that particularity enough to make this site non-Pavlovian? As it represents the only site located far from a water point or running water, it is difficult to answer this question. We notice that another site, Krakow-Spadzista -street B- (in Southern Poland and dated to 24-23,000 BP) is not located in the bottom of a valley, but at the edge of a hill (Kubiak & Zakrewska 1974, Wojtal 2001, Wojtal & Sobczyk 2005). There are many similarities between the two sites, concerning Mammoth bone accumulation and cultural remains. At first glance Milovice could be a peculiar site, focused on Mammoth exploitation, complementary to the other sites of the Pavlovian culture. But as said above, many accumulated details (the lack of specific Pavlovian lithic tools - *e.g.* microdenticulates, Kostienki knives - the different lithic raw material areas of procurement, the lack of ceramics, the atypical site status, without real art, bone tools and younger radiocarbon dates for area D and area K around 22,000 BP go against this idea and place Milovice at the heart of an organised Mammoth exploitation focused on ivory and meat procurement. This exploitation could have produced different complementary sites, in terms of seasonality and faunal exploitation. A thorough and new study of Pavlovian sites is now necessary to better understand the relation between each other. Each site could have been a

special spot in the territory, for Mammoth exploitation. At Milovice, the purpose was probably to procure, remove, treat their carcass and move away. As seen before, some individuals died during the Spring, but we cannot be sure human groups did not live here at other seasons. Was the meat consumed quickly after its removal or did it receive a treatment allowing a delayed consumption? We just notice the presence of hearths beside the carcass deposits and the very limited presence of cultural remains that would have made a first treatment possible. Concerning ivory, once human groups took it away, it was probably worked and used and also maybe exchanged. By crossing data from different sites of the wide Moravia, we may identify the role of Milovice in the Gravettian context and the Mammoth economic status in Moravia.

Mammoth economic part and role in the Moravian area

What does the study of Milovice bring to the knowledge of Mammoth exploitation in the Gravettian society of Moravia? Milovice has been described early as an atypical site (Musil 1997, Oliva 1989b), and considering the result of our zooarchaeological study, we agree with that assertion. The lack of a real Pavlovian lithic industry, of a rich bone and ivory industry, of human remains, of the overwhelming presence of Mammoth, and of evidence for an extended occupation makes Milovice a special site in the regional culture and not typically Pavlovian. If Milovice is not a residential site in the Pavlovian context, it is difficult to know if the Milovice Mammoth exploitation took part in the "true" Pavlovian (Mammoth) economy. Some arguments tend to indicate Pavlovian people occupied the site. But, what about the similarities with the Gravettian sites of Austria, in southern direction? Milovice is considered as a "killing-butchering" site (Oliva 1999, 2001, Péan 2001, Svoboda *et al.* 2005). Have all the different kinds of sites of the regional Gravettian been found, or do we have a selected view because some sites are missing? Are we considering complementary sites or independent ones (in a wide Moravia and further?) and for which territory size? The demonstrated relation between this kind of sites, the cultural context, their contemporaneousness around 26,000-24,000 BP and their geographical position could mean the Pavlovian sites would be the only type exploited by the Gravettian (Svoboda *et al.* 1996, 2000). But it is not possible to confirm that hypothesis because of the current lack of seasonal data. Mammoth was a nomadic species, the herds being forced to move because of their strong diet impact on the environment (Velichko & Zelikson 2005). So they could not stay in a same area during a long time and we can suppose their presence during the Summer around the Pavlov Hills area was not so permanent. Looking for new nutritive areas, they probably moved towards northern directions and they were maybe back at the end of Summer or early Autumn, looking for southern territories to spend Winter. Until the full annual cycle is known, the complete meaty exploitation cannot be definitively characterized. Mammoth seems to have represented the main part of this economy, at least for the Springtime in Moravia, in Winter at Krems/Wachtberg (Fladerer & Salcher 2004) and also at the end of Winter/beginning of Spring at Grub/Kranawetberg (Antl & Fladerer 2004). We also do not forget that the mobility pattern may have changed as the Pavlovian-Gravettian society was present there over 4,000 years.

The presence of a site like Jarosov II (along the Morava River), where Mammoth is rare and small animals dominate, suggests another kind of sites may have existed. Thus, it may also result from an "accidental" meaty economy scheme (Musil 2005). Another dissimilarity concerns the spatial dispersal of sites. It appears the southern limit for the greatest Mammoth exploitation was close to the Danube area, where sites show a different and slighter Mammoth exploitation like at Krems-Hundssteig and Krems-Wachtberg. But Austrian researchers point out the influence and relations of Austrian sites to the "true" Pavlovian sites of Pavlov Hills. Milovice Mammoth bone industry also establishes links between southern Moravia and Lower Austria. This double influence rising up could be the result of Milovice position and site status in the Gravettian landscape. Another border could have existed on the western flank of Moravia with the complete lack of cultural connection toward this direction, as opposed to the eastern and north-eastern one, as exposed below.

We suggest Milovice could be atypical concerning Mammoth exploitation because of its position at the border of several geographical and cultural territories. Indeed, the different elements exposed above show some connections between Milovice and the Pavlovian culture, as well as contacts with the Danube area of Lower Austria. Milovice is the southern most site of the Pavlov Hills and the closest to the Danubian plain opening. The low rate

of northern flint, coming from Silesia and heavily used by Pavlovian groups, and the highest rate of radiolarite coming from the White Carpathian territories -about 120km East of Milovice- indicate a change in the main supplying territories. The overlapping influences documented at Milovice, added to the time span of frequentation and the different strategies affecting Mammoth procurement, could be the result of a mixed occupation by two Gravettian groups. Milovice would then represent a border, a meeting point, or a recurrent association of human groups for Mammoth procurement (at the interface of two groups). This idea could support what W.P. Alexandrowicz and his colleagues have proposed about territory exploitation modifications during Gravettian times (Alexandrowicz *et al*. 1999). The Morava River with a North-South orientation opens its basin to the Danubian one, oriented West-East. River confluences, as any other geographical point in the landscape as the Pavlov Hills or the Nepajedla gates, are always special places in the environment for settlements related to hunting activities. It is possible to consider that these river basins were also borders for human groups.

Conclusions

The zooarchaeological study of Milovice faunal remains was an opportunity to ask precise questions about Mammoth exploitation at this site and its economic role at the scale of the Gravettian of Moravia. Mammoth was omnipresent in the everyday life of Moravian hunters in the Gravettian period. Even if a complete knowledge of its global exploitation is prevented by the lack of seasonal information, we shed light on Mammoth procurement and exploitation patterns at Milovice. Human groups killed at least 86 mammoths, especially adult females. All the young mammoths (and probably their mother) were hunted during the Spring, around the birth period. The exploitation was focused on ivory procurement and a great part was brought out of the site. If meat procurement is likely, we are not able to tell how important it was, compared to ivory. All these elements confirm that Milovice was a place where mammoths were killed and their carcasses treated, before people went away with ivory and probably food products. Its atypical position, from a geographical and cultural point of view, makes Milovice a unique site and we suggest it is related to its location, at the limit of two Gravettian "entities".

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