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VII.

ZPŮSOBY VYUŽÍVÁNÍ MAMUTŮ A PŮVOD JEJICH KOSTÍ V MILOVICÍCH (KROMĚ SEKTORU G)

Alexis Brugère – Laure Fontana

Objevem předmosteckého sídliště na konci 19. století vyvstala otázka původu akumulací mamutích kostí, již se po dlouhou dobu nepodařilo zodpovědět. K dosud prezentovaným vysvětlením (lov, mrchožroutství, sběr) může rozhodující měrou přispět studium náleží z gravettienského sídliště u Milovic. Počtem 62 694 zbytků (NR) však tato lokalita mírně zaostává za ostatními (Předmostí, Dolní Věstonice a Pavlov), a to i když se jejich počet započtením sektoru G (*Péan 2001b*) zvýší na 65 tisíc (obr. 1 a 2). To je ovšem způsobeno tím, že v Milovicích chyběly rozsáhlé sídlištní plochy s převládající menší (nemamutovou) faunou. Způsob výzkumu však slibuje, že vzorek z Milovic je bližší původní situaci než rozsáhlejší kolekce z výše zmíněných lokalit (tab. 1).

Překrytí vrstvou sedimentu po krátké době působení suchého prostředí a „efekt skořápky“ zabránily vážnějšímu narušení kostí, které by na stanici pod širým nebem bylo možno očekávat (obr. 5). Postdepoziciční faktory tedy jen málo zkreslily vyváženost vzorku co do zvířecích druhů a zastoupených tělesných částí. Ty jsou v obou hlavních akumulacích (A+B, K) podobné a homogenní je i poměr zastoupení pravých a levých kostí (obr. 3 a 4). Podreprezentované jsou pouze pozůstatky malých zvířat. Žádná dochovaná kost lišky nebo zajíce není menší než 2 cm, jsou však zastoupeny takto malé zbytky mamutů, poněkud zlomky slonoviny (obr. 6). Každý sektor se zdá být nezávislý na ostatních. Akumulace kostí nepostihly žádné výrazné změny (srov. kosti v primární vodorovné pozici v sektoru K), dislokace svahovými pohyby se výrazněji projevují pouze v sektorech na vrcholu svahu (C,D,L,R). Konečně, izolovanost každé akumulace prokazuje i absence skládanek a reartikulací nebo párů kostí mezi sektory (projevují se nanejvýš v rámci jedné plochy, tab. 2–3 a obr. 7). Druhy asociované s mamuty poskytují jen málo doplňkových informací: tři hlavní býložravci (sob, kůň, los) byli využíváni zejména na maso a morek. Lovení mohli být i vlci a lvi, původ jiných druhů neznáme (obr. 8).

Jaký je původ akumulací mamutích kostí? Milovice jsou jedním z mála sídlišť, jež neleží nad řekou. Navíc se tu nenachází žádné jezírko, stálý pramen či zdroj minerálních látek, zkrátka nic, co by mohlo mamuty přitahovat, ani je ohrožovat jako např. nebezpečný sráz. Tím můžeme vyloučit hypotézu o přirozeném úhynu mamutů na místě samém. Nepřítomnost říčních sedimentů a mohutných svahových perturbací vylučuje i existenci druhotné nahromaděny pozůstatků. Mamuti tudíž nezahynuli přirozenou cestou. Demografický rozbor bere v úvahu věkové profily, z nichž dva nejdůležitější vycházejí z rozboru dolních (celkem 159) a pro sektor K i horních stoliček. Věkové třídy (podle *Law 1966*) jsou prezentovány po 12letých intervalech, navržených *G. Haynesem (1991)*. V obou hlavních akumulacích jsou zastoupeny všechny věkové třídy s výjimkou té poslední (obr. 9–11). Nejlépe zastoupení jsou dospělí jedinci (*adultus*),

zejména v sektoru A+B. Mladí jedinci jsou v A+B početnější na úkor subadultních, jež jsou dobře zastoupeni v sektoru K. Tyto profily neodpovídají přirozené mortalitě, takže zde musíme uvažovat o činnosti nějakého predátora. Přítomnost dospělých a nedostatek mladých zvířat neukazují na aktivitu hyen. Ostatně jen 0,1% kostí vykazuje ohryzy od masožravců, zhusta na částech přístupných až po rozpadu mršiny (obr. 12; tab. 4). Zdá se tedy, že akumulace jsou dílem člověka. Výčet typů kostí navíc prokázal relativní nedostatek klů a stoliček: jak ukazuje obr. 13, chybí 90% mamutoviny, a to i když uvažujeme jen jedince starší 12 let, tj. s pořádnými kly. Gravettienci tedy mamutovinu asi odebírali a odnášeli. Sběr kostí čerstvých, suchých nebo fosilních je asi vyloučen, neboť zastoupení tělních částí je vyrovnané (sběr by měl totiž probíhat selektivněji), a nenavědčuje mu ani homogenní stav povrchu kostí. Lov dokládá selektivní struktura věkových tříd s vyšším zastoupením dospělých a adolescentních jedinců na úkor mláďat a starých zvířat. Z demografických a etologických pozorování u současných afrických slonů vyplývá, že jsou to hlavně samice z matriarchálních stád (jež tvoří 15 až 30 jedinců), na něž se soustřeďuje pozornost lovců. Pět mamutů v Milovicích zahynulo na jaře, jak dokládají dva ještě nepoužívané dp2, více kostí embryí a novorozenců (tab. 5) a tibie ročního mláďete (*Maschenko 2006*). Jestliže doklady o sezonalitě poskytlo jen 10 zbytků ze 7% jedinců, týkají se min. tří sektorů (A+B, K a R). Akumulace mamutích kostí v Milovicích je tedy výsledkem lovecké aktivity skupin lidí během (minimálně) jara kdy se rodila mláďata.

Maso bylo odřezáváno, jak svědčí jediná kost s dekarminizačními řezy (obr. 14). Dle nedostatku jiných taxonů lze předpokládat, že chobotnatci gravettiencům poskytovali důležitou složku stravy. Využíván byl rovněž morek, ale s ohledem na omezenou fragmentaci kostí (obr. 15) asi jen příležitostně (srov. kritéria in *Biberson – Aguirre 1965*). Jiní býložravci byli na maso a morek využíváni systematictěji.

Asi stovka žeber svědčí o otevírání hrudníku ohýbáním. Kostí bývají vskutku lámány podobným způsobem, a to spirálovitě, někdy s jazýčkem naznačujícím ohýbání směrem ven (obr. 16). Kostí se rovněž využívaly k technickým účelům. Dva femury byly oštípány, snad kvůli odbití úštěpů (obr. 17). Podobně opracované kosti jsou známé z i jiných jihomoravských a sousedních lokalit. Dvě žebra se používala jako „hladidla“, jiné žebro, dlouhé 60 cm, nese dvě rýhy provedené několikanásobnými hlubokými řezy (obr. 18). Jestliže jsou rýhovaná žebra známá i z jiných sídlišť (*Grub-Kranawetberg a Krakow-Spadzista*), patří tam k jinému typu předmětů a mají odlišný význam (*Antl – Fladerer 2004; Wojtal – Sobczyk 2005*). Kly jsou v Milovicích (kromě G) fragmentované přirozeně, neboť se nenašel se žádný výrobní odpad. Lebky jsou sice zcela zničené, nikoli však údery lidskou rukou. Nemůžeme určit, zda mamutovina byla

odebírána ve stavu čerstvém (řezáním, lámáním, žlábkováním surového bloku, štípáním) nebo suchém (Khlopatchev 2006 ; Christensen 1999). Chybí i mnoho stoliček, patrně rovněž odnesených (obr. 20). Zájem gravettienců o moláry je doložen v Dolních Věstonicích („drasadla/škrabadla“, *Klíma 1963*) a zpracovávány byly i kořeny stoliček (*Oliva 1991; Valoch 2003 ; Antl – Fladerer 2004*). Odebírání mamutích zubů mohlo tudíž v Milovicích představovat jednu z nejdůležitějších činností. Základem

potravy bylo mamutí maso, což doložil *S. Péan (2001b)* pro sektor G. Tyto dva faktory asi vysvětlují preferenční lov dospělých mamutů. Milovice (vyjma G) se tak jeví jako místo získávání mamutoviny, zatím co exploatace a konzumace produktů se odehrávala jinde (obr. 21). Tomu by nasvědčovalo malé množství štípané industrie, absence umění a nedostatek kostěných nástrojů. Konečně, jarní lov v podpálavském regionu lze vysvětlit tím, že zde byla přiváděna na svět mamutí mláďata.

VII. ORIGIN AND EXPLOITATION PATTERNS OF MAMMOTH AT MILOVICE (AREA G EXCEPTED)

Alexis Brugère – Laure Fontana

VII.1 Introduction

In the Moravian area, many Gravettian-Pavlovian sites delivered mammoth bone accumulation. Since the discovery of Předmostí in the late XIXth century, the question of the origin of proboscidian remains is discussed. If human groups have worked mammoth bones and ivory, their way of procurement is still not solved. Twenty years ago, O. Soffer brought up the question when working on the “Epigravettian” of the Central Russian Plain and the numerous sites containing mammoth bones remains. She suggested that big and heavy mammoth bones, exploited as raw material for dwelling construction on open-air sites, were used dry *in situ* or collected not far away and brought back to the sites (Soffer 1985; 1993). She also proposed the same for Central European mammoth sites despite many differences. Several Russian scientists accept this idea of exploitation of natural death site by human groups, especially for mammoth bone accumulations found on riverbanks associated with a scarce industry (Soffer 1985; 1993). However, different situations are documented: in North America Clovis culture, mammoth procurement and exploitation never affected dozens of animals but only one or two, and hunting was the main way of procurement (Frison – Todd 2001). According to S. C. Münzel (2001; 2004), the Aurignacian and Gravettian sites of the Souabian Jura (Germany) that delivered numerous mammoth’s remains, result from hunting episodes. F. Fladerer proposed the same for the Austrian Gravettian settlements that never delivered more than few individuals (Antl – Fladerer 2004; Fladerer 2001a; Fladerer – Salcher 2004).

Concerning the Moravian area and the Gravettian-Pavlovian culture, the procurement pattern is still discussed. Central European scientists proposed mammoths have been hunted, even if it has never been demonstrated (Klima 2000; Musil 1994; 1997; 2000; Oliva 1997b; 2000b; 2000c; 2003a; Svoboda et al. 1996). Some others disagree and proposed an exploitation of dead animals (Péan 2001b), not excluding a human involvement (see Svoboda et al. 2005). Finally, some authors also plead for hunting and scavenging could have coexisted at a same site, like at Krakow-Spadzista (Wojtal 2001; Wojtal – Sobczyk 2005).

Studying Milovice faunal sample was absolutely necessary to document this question. We focused on two main questions: the origin of mammoth bone accumulations and mammoth exploitation pattern. We tried to compare all the results to the scarce data of other Gravettian sites that deliver a lot of mammoth remains, to identify possible distinctive characteristics of Milovice.

VII.2 Characterization of the collection and questions

A. Characteristics of the faunal collection

1. Sample size

The 12 areas yielded 62 694 faunal remains (NISP). Even including remains from area G (Péan 2001b), there are few remains comparing to other Moravian sites, Předmostí, Dolní Věstonice (I and II) and Pavlov (Figure 1).¹ On the contrary, the other sites (the Polish site of Krakow-Spadzista street B and the Austrian sites of Krems-Hundssteig and Krems-Wachtberg) delivered only less than 10 000 remains (Antl – Fladerer 2004; Fladerer – Salcher 2004; Wojtal – Sobczyk 2005).

Is it meaningful to compare collections without knowing preservation conditions, digging practices and counting methods that may have been very different from one site to another? If we can evaluate these different parameters for every site, we will be able to know if some assemblages are under represented. Then it will be possible to compare the assemblages’ size, to know if it is related to the digging area. Figure 2 demonstrates that there is no obvious connection between the excavated area and the number of faunal remains. Indeed, at Milovice, 64 000 faunal remains have been excavated out of nearly 700 square meters, whereas at Pavlov and Dolní Věstonice, out of only 300–400 square meters, at least twice as many remains were found out.

Moreover, considering data related to preservation conditions, sieving and counting methods, it appears that Pavlov and Dolní Věstonice are highly under represented whereas Milovice faunal assemblage seems to be the most representative of the original deposit. That implies the difference between Milovice and the other Moravian sites is more important than the first view indicates. Does it necessarily mean that Milovice sample is totally representative of the original deposit, considering the excavated area, the bone preservation and the methodology used?

2. Sample’s representativeness

Are the faunal remains representative of the species and the skeletal parts originally present at the whole site? Only a part of the site has been excavated (M. Oliva, *this volume*) and even if the 500 square meters represent around 80% of the original site, 20% have been destroyed. What is the consequence of this missing part in terms of sample’s representativeness? Considering the identified species, as the mammoth remains represents 98,58%, it is very difficult to analyze the spatial distribution of the other species (Table 1). We just notice that reindeer (0,38%) and horse (0,65%) remains distribution is not

1) The only published data comes from Dolní Věstonice II (1986/87 excavation), which delivered at least 5400 NISP (West 2001a).

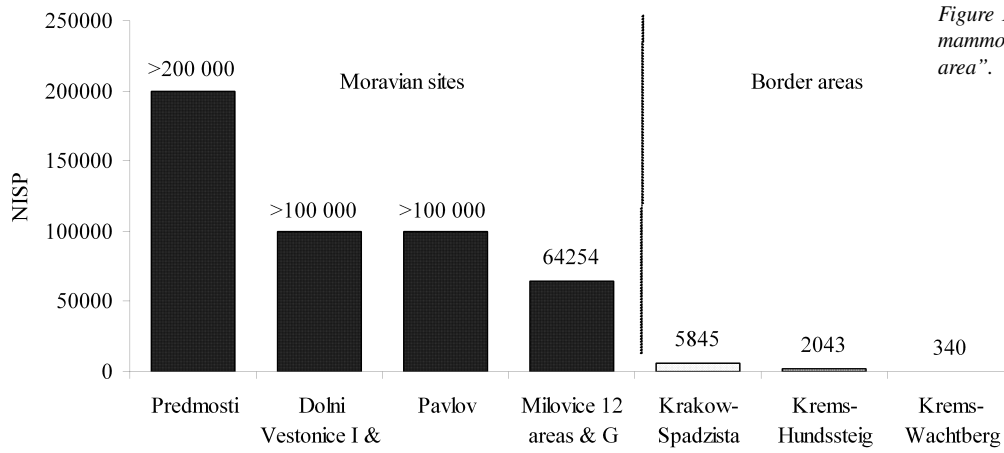


Figure 1 Real or estimated NISP of the main mammoth sites of the "Pavlovian-Gravettian area".

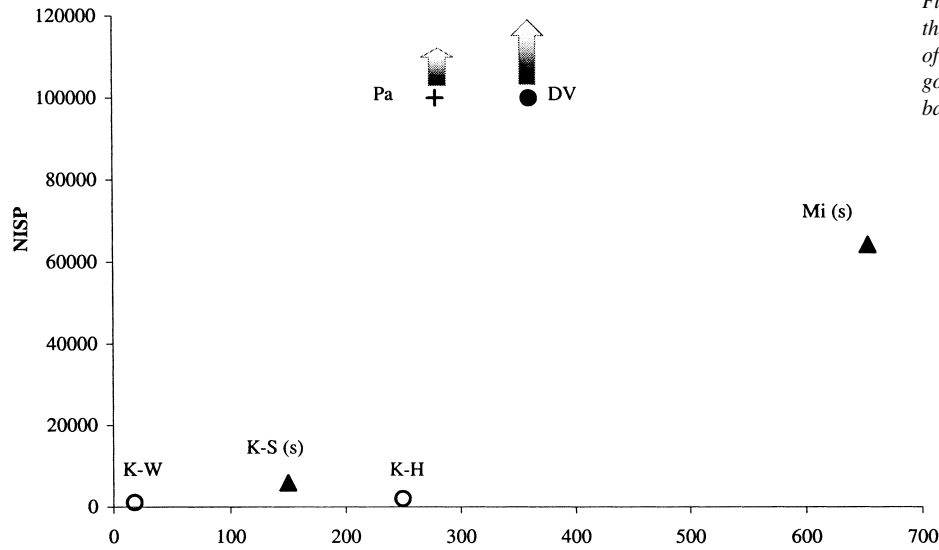


Figure 2 Correlation between the NISP and the excavated area of different sites. (Quality of preservation of the faunal remains: ?: good; +: good enough; -: not so good; -: bad; s: sieving).

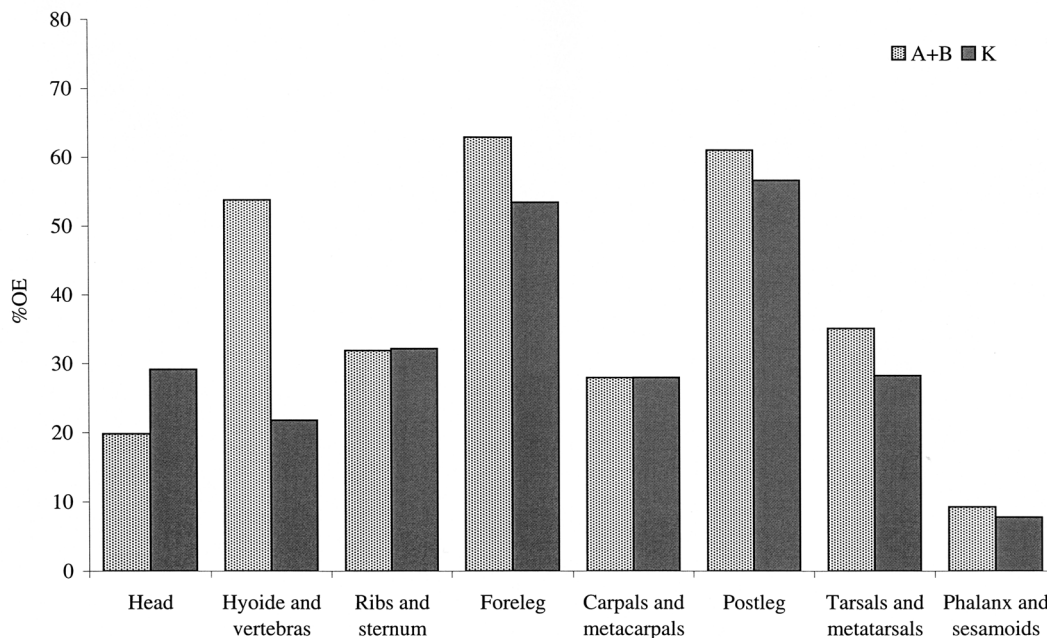


Figure 3 Body part distribution in areas A+B (MNE=2267) and K (MNE=1054).

related to the sample size of each area. That means that it is not possible to be sure that any other species was originally present in the truncated areas, specially if we consider that some species

are, in some totally excavated areas, represented by a few remains (as horse in area D) or in a single area (as the rhinoceros). So, even if some species originally present at the

site are now missing because of the truncated areas, it is highly unlikely that it would have represent a lot of remains.

Considering skeletal parts representation, can we be quite sure that the actual data of each area are representative of the original deposit? If assemblages from entire areas have been more important, we could have compared the data from truncated and entire areas, to see if the skeletal parts distribution was the same. As these areas delivered a few remains (cf. table 1), we only compared the data from the four main truncated areas (A+B, K, L, R). Figure 3 proves that the anatomical parts distribution is very similar between areas A+B and K, as in the areas L and R (Appendix I). This homogeneity appears also clearly in the ratio right/left of the main areas as area K (Figure 4 & Appendix Ia).

The overall homogeneity of anatomical parts distribution inside the truncated areas permits to conclude that the 20% missing parts did not hold a different distribution. That means the whole faunal sample of the 12 areas is representative of the original deposit.

The sample representativeness also depends on the preservation conditions that could have affected strongly the faunal remains and so modified the NISP. That is why we have to know if the remains were preserved in the same way in every area and how the preservation conditions have affected bones and teeth. Even if among the identified bones, there are a few bones of small species (fox, hare) and some fragile bones of horse and mammoth (sternum, very small foetal bones of mammoth), that is not enough to conclude that the preservation is rather good. More precisely, which types of alteration have affected the bones and what were the consequences on the faunal remains preservation from each area?

Figure 5 presents the most important types of alteration. Among the destructive agents, the root attack, pointing out a slight overlaying of sediment above bones, is the dominant damage. The withering indicates that some bones were exposed for a long time under dry conditions before being covered. These two values are rather low in a context of open-air site related to the site extension and the mammoth bones size. Moreover, we noticed different degrees of alteration and a lot of bones bear only slight modifications. All these elements could be the result of a "shell effect" (bones can produce when piled up) but the lack of a precise spatial three-dimensional recording does not allow us to conclude. Smoothing and dissolution are two other superficial damages. Smoothing seems to be the consequence of loess dirt strikes under windy conditions (undisturbed areas) and doubled with sediment movements as the rate is high in the disturbed slope areas. Smoothing had an impact before and after the remains have been buried. The dissolution is a consequence of underground water presence, occurring after the covering period and during a more humid episode. Confirming this post-covering presence of humidity, iron and manganese oxidation rates are very high. So it is clear that none of the recorded natural alterations have been highly destructive for the faunal remains. All of these taphonomical agents acted softly: bones and teeth have not been deeply affected, especially the largest remains. If remains from areas R,

N, H and L look more deteriorated than the others (cf. Appendix II & Appendix III), preservation conditions were nevertheless rather good and did not affect bone representativeness (species and skeletal parts). All of these observations indicate that bones have been accumulated in a short enough time-span whatever the area, and that the representativeness of species and skeletal parts is rather similar on each area.

The excavation methods can modify the sample's representativeness: as described above (and *Oliva, this volume*), some parts of the site have been destroyed in the context of a rescue excavation and the floated sieving has been practiced only for area G. That implies a lower representation of small remains. As we do not know the precise data related to area G bones size, we compared the data of the 12 areas, specially the part of the smallest remains (< 2 cm). As we can notice on Fig. 6, there are some small remains (< 2 cm) and their representation reaches 22%, which indicate that the smallest bones (all species included) have been collected. If we cannot know in which proportion, this size class is in second position in four areas. So it is likely that the great part of the smallest remains has been collected. Concerning species representativeness, we notice that the remains of the smallest species (hare, fox) are longer than 2 cm (Appendix IV), so it is likely that the smallest bones have not been collected: the bones of small species are less representative than the mammoth one's.

3. Separate areas?

We have concluded that the faunal assemblage was representative of the original deposit in terms of mammoth skeletal parts and species. Now we have to know if the identified areas were different parts of a same (or many) occupation(s) or if they were separate from each other (distinct occupations)? First we need to know if the entire site has not been affected by many movements that could have modified spatial "organization" of the site. Stratigraphic data and some bones localization indicate that a part of the slope slid down², affecting areas R, L, C, D. These field movements were soft and did not mix up the remains of the different areas. In the most disturbed areas of this part of the site, sediments overlapped the subjacent ones (*Oliva and Havlíček, this volume*) but the layers' homogeneity has been preserved the best-preserved area (K) even delivered faunal remains in horizontal position. So we can conclude that and each area was originally separate from each other, as they were discovered. Were some areas connected with other ones? To answer this question we have looked for direct evidence: anatomical associations (noticed during the excavation), bone and teeth refitting³ and symmetrical association.

The biggest samples (areas A+B, K, L) delivered the highest number of refittings and symmetrical associations inside a same area (Table 2) and some have been realized even between remains remote from several meters. But we did not succeed in any refitting between areas (Figure 7). As observed in Table 3, refits have been realized on mammoth many skeletal parts and some bones of some other species (horse, lion, woolly rhinoceros, wolf). So we can conclude the absence of any refitting between bones and teeth of distinct areas indicates each area was separate from each other.

2) Only half of the area R moved down.

3) We call refitting the act of joining together two anatomically successive bones of a same individual and two parts of a single bone.

Figure 4 Right and left ratio of mammoth skeletal parts at Milovice K (black: right, grey: left).

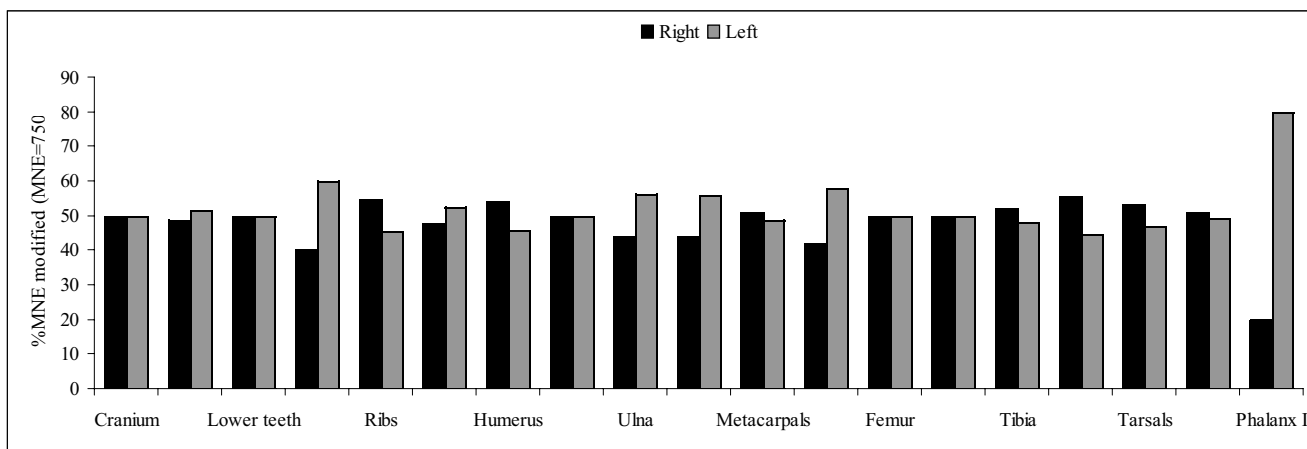
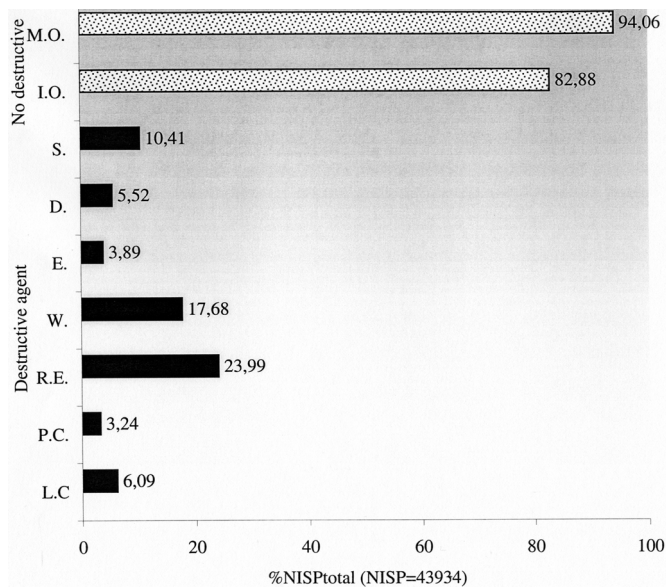


Figure 5 Bone modification – for detailed numbers see Appendix II. Legend: Longitudinal cracking (L.G.); Perpendicular cracking



B. The main problematic

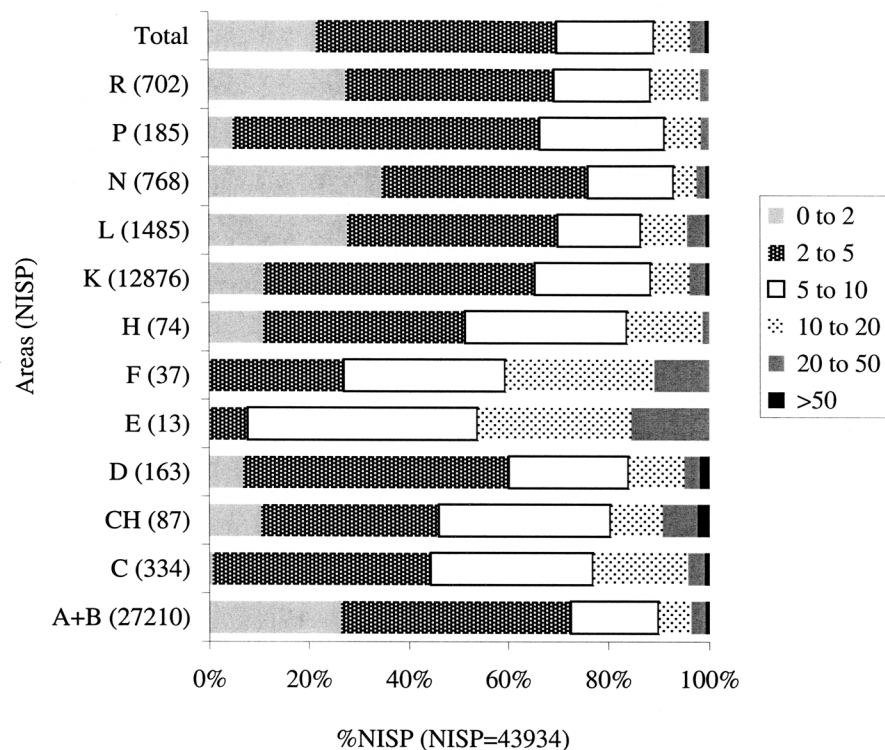
1. Origin of the assemblage: bone-accumulating agents and processes

The numerous Gravettian-Pavlovian sites that delivered a lot of mammoth bones set the question of the origin of these accumulations. Hunting is directly attested only in Siberia where a piece of flint was found inside a vertebra (Zenin et al. 2003). Actually, a part of the prehistoric community stands up

for “active scavenging” or/and fresh bone collecting (Péan 2001b; Soffer 1985; 1993; West 2001a) while another part is rather in favour of hunting (Antl – Fladerer 2004; Münzel 2001; Fladerer – Salcher 2004; Frison 1989; Frison – Todd, 2001; Klima, 1995; 2000; Oliva 1989b; 2000a; 2000c; Svoboda et al., 1996), maybe with a concomitant scavenging (Wojtal 2001; Wojtal – Sobczyk 2005). Nevertheless, these ideas are rarely documented by precise data (only for Aurignacian and Gravettian Souabian Jura sites – Münzel 2001 – and Austrian Gravettian settlements – Antl – Fladerer 2004; Fladerer 2001a; Fladerer – Salcher 2004). No age profile is known for Dolní Věstonice I and Předmostí, as Pavlov profiles need to be adjusted with actual methods. In the same way, no detailed account of mammoth skeletal parts is published for the same sites. Moreover, some available “arguments” in the literature are not always real arguments, as the local environment described as “favourable” or not to mammoth hunting. Concerning the Pavlovian sites, mammoth hunting is admitted (Maška 1889; 1894a; Kříž 1891; 1896; and Soergel 1922, all cited in Oliva 1997a; 1997b; Klima 2000; Musil 1994; 1997; 2000; Oliva 2003a; Svoboda et al. 1996). It is based on many ideas, the great quantity of remains, the great number of young individuals, the bone deposits, which would reflect several short and repeated occupations and an in situ hunting, and the similar location of wide Gravettian Moravia sites (between 200 and 300 meters (a.s.l) near river valleys (Kozłowski et al. 1974; Svoboda et al. 1996; Oliva 1998a).

Have the mammoth from Milovice been hunted by gravettian groups? We consider Milovice faunal remains as a good sample for the zooarchaeological study, so we tried to identify the data that could be considered as real arguments. Some researchers

Figure 6 Class size proportion of bones (in cm).



consider that the only data that can document the origin of the assemblage are demographic data; e.g. *sex ratio* data and age profiles (Haynes 1987b; 1991; Louquet Lefebvre 2005; Speth 1991) as some others use these data with skeletal parts analysis (Münzel 2001; 2004; Fladerer – Salcher 2004). Then for some others, the diversity of profiles makes it difficult at present to unambiguously infer human predation from age profiles alone.” (Soffer 1993, 35). To identify the origin of Milovice mammoth accumulation, we analysed in detail demographic data, skeletal parts representation and seasonality data, all these information being interpreted in the light of taphonomic data.

What about the origin of the ten other identified species? Reindeer and horse, the main species (Figure 8), have probably been killed not far from the site, as almost all the skeletal parts are represented (*cf.* Appendix IV). More over, some long bones of elk, horse and reindeer have been broken for marrow extraction as spiral breakage pattern and impact point witness. Then, a few waste products indicate that reindeer shed and unshed antlers have been worked. If we are sure these species have been hunted, it is maybe also the case of the wolf (and the lion), which is represented by many different skeletal parts and in a great number, as in the neighboured sites. On the contrary, it is not possible to conclude concerning the three remains of woolly rhinoceros and the two bones of fox and hare, all species usually discovered in other sites. We only can be sure that the shed antler of red deer has been collected (or exchanged). So, at least four species have probably been hunted but the scarcity of their remains does not allow us to study their exploitation pattern.

2. Mammoth exploitation pattern

The numerous bone and ivory artefacts, the use of bones in dwelling reinforcement or its association with burials indicate this proboscidian was deeply involved in the Gravettian-Pavlovian everyday life and economic system. But we do not really know

what the precise part of the mammoth was, because we do not know if all the mammoth settlements are representative of the whole Gravettian subsistence economy. Indeed, as we do not have any seasonal data on mammoth, we do not know when the sites were occupied: we do not know if mammoth was or not a seasonal resource and if its products were exploited all year round. So we will have to know which were products required and consumed and when in the course of the year. Zooarchaeological study of Milovice will try to answer three main questions. Was the mammoth first exploited for the meaty products or for technical ones? If we can suggest that the meaty products came from mammoth, as there is just a few number of reindeers and horses remains, we tried to identify the part of ivory procurement and exploitation. Which were the consequences of this choice on the procurement strategy (in terms of individuals)? Finally, have Gravettian groups exploited mammoths at Milovice at the same season or at different moments in the year? This question is also important because Milovice differs from Dolní Věstonice and Pavlov, and seems, for now, to look like more a kill or butchering site than a residential site.

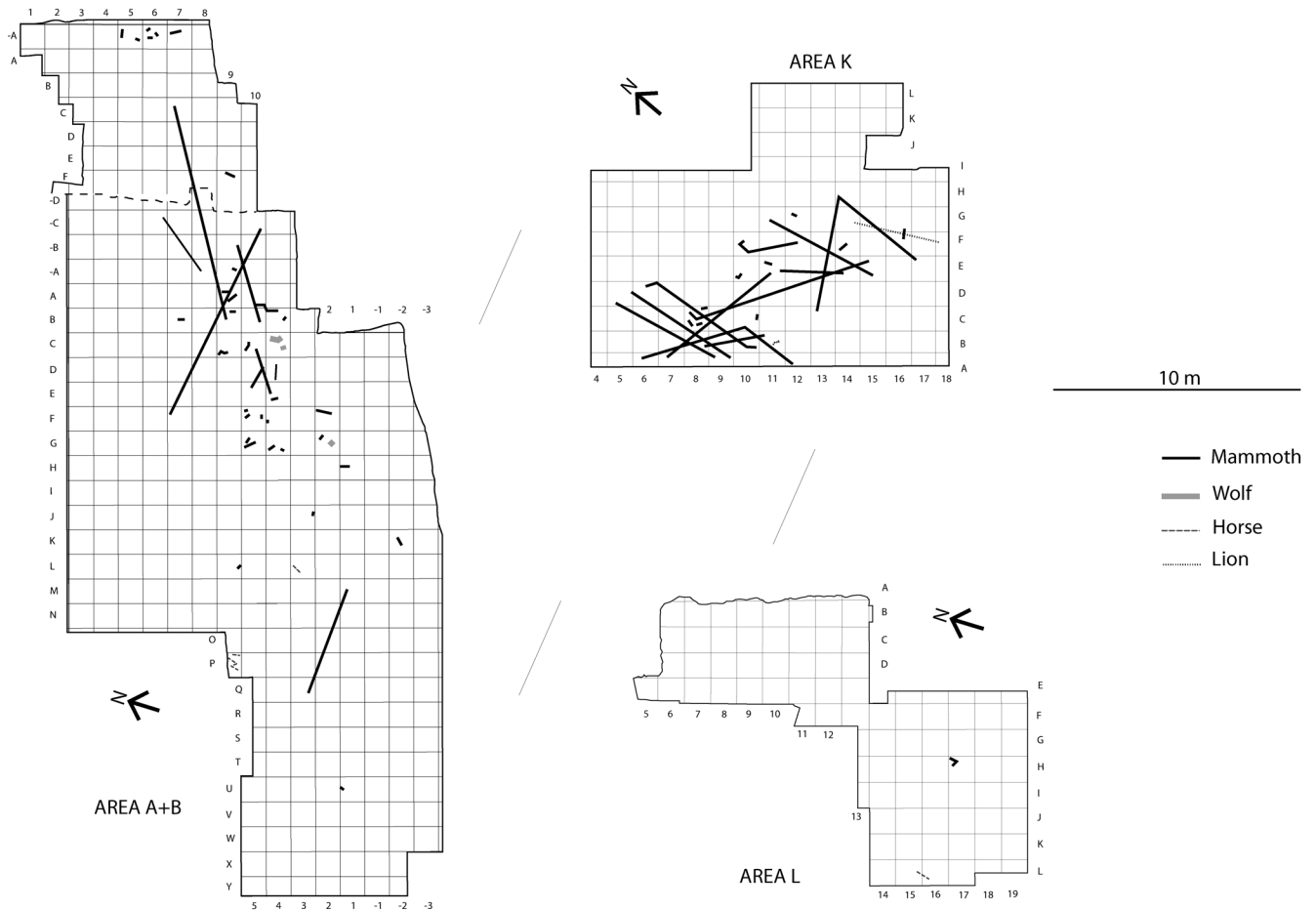
VII. 3 Origin of the faunal remains

Milovice is an open-air site with “independent” areas that, moreover, delivered different radiocarbon dates. So, we considered all the faunal remains as many assemblages (areas) that we have studied in a separate way.

A. Bone-accumulating agents

Bone accumulations may result from two agents: the “natural” processes (geological or not) and the biological processes (humans and carnivores). Two kinds of natural processes can produce a bone accumulation of dozens of mammoths in a delimited area. The first one is a catastrophic

Figure 7 Map of the successful refits in the concerned areas.

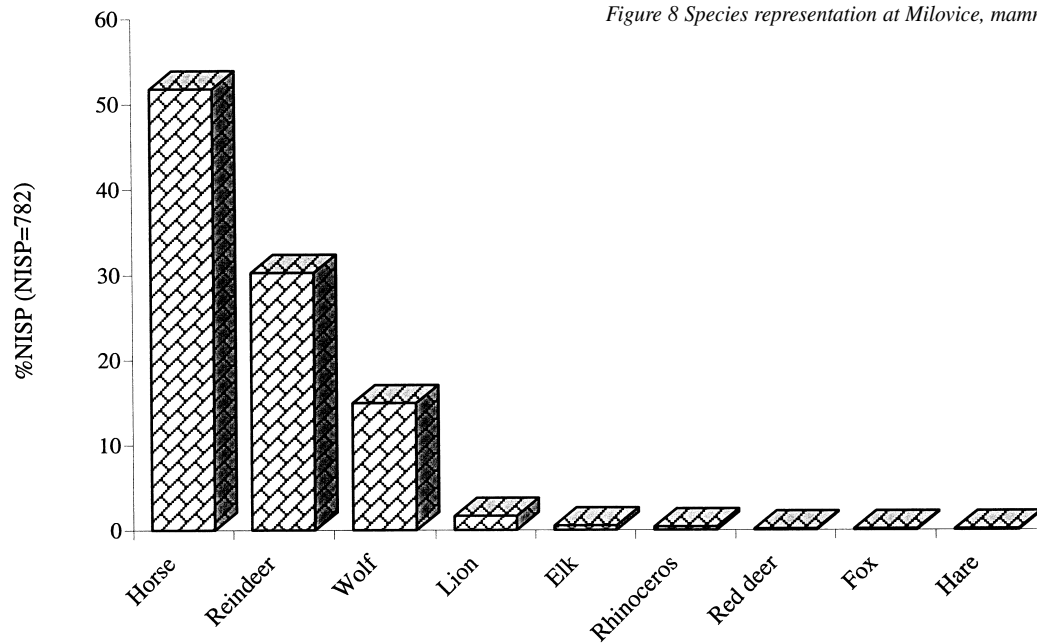


event (like drowning or getting stuck in a bog, at swallow hole, waterhole, or due to lightning): the death of many individuals at the same moment, at the same place (considered as “aggregating points” like water place or mineral resource place, *Soffer 1993*), or the natural death at the same place for a longer time span and related to an environmental stress. If accumulations are not disturbed, we should expect to a non-selective skeletal parts representation. But we cannot expect any typical age profile, which depends of the social group(s) where the individuals come from (isolated individuals, small bands of adult, familial groups): it could be a catastrophic mortality profile as a selective profile representing the age structure of the dead group. And as the kind of the social group whose individuals died at this place depends on the season, it is imperative to identify the season of death to analyse the mortality profiles. Natural death could produce special bone dispersal: amount of bones in a swallow hole, individuals with vertical skeletal elements when animals died in a bog. The most important idea is that scattering occurred from the central point – the full skeleton – at the death place (*Lyman 1994*). Then the body position of several individuals at site is also indicative. The presence of articulated skeletal elements is also a good clue for getting information about the natural death pattern. The second type of natural bone accumulation is a secondary deposit due to a fluvial transport or sediment movements. In the first case, the site is located on riverbanks, dried bones have been

moved by flotation and, because of the bone and teeth density difference, the representation of skeletal parts is selective. In the second case, carcasses or dried bones are disturbed but accumulated because of a sediment movement. This process can occur several times, affecting a same assemblage until the complete stability point is reached. Spatial records, when existing, are useful, like the vertical position of bones or some specific carrion damages on axial skeletal part of individuals who died in a swampy spot (*Weigelt 1989*). In the case of a fluvial dispersal of remains, the bones are sometimes in a unidirectional deposition that corresponds to the river current (*Brugal 1994*).

Can carnivores accumulate such bone assemblages? Actually, hyena is the only carnivore that accumulates large animals bones, at open-air places as well as into caverns. Hyena that lived 25 000 ago, could have accumulated some young mammoth skeletal bones, as Lister demonstrated for a middle Palaeolithic English site (Lister, 2001). In the same way, G. Haynes (1987b) indicates actual african hyena and lion accumulate elephants bones. Nevertheless, several hyena open-air dens sites existed during upper Pleistocene, delivering bone accumulation. But usually these sites are situated along rivers (Morava River and Vltava River in Czech Republic) and hyena carcasses belong to the faunal sample (*Diedrich 2006*). rhinoceros is sometimes indicated. In the case of carnivore

Figure 8 Species representation at Milovice, mammoth excepted.



accumulation, skeletal parts representation is very selective (uncompleted skeletons) and age profiles are selective in favour of individuals under 12 years old (Haynes 1987b).

Bone accumulations can also result from different human procurement pattern: collecting of dried bones of animals that died many years ago (natural death or not), scavenging on fresh carcasses, hunting. It is very difficult to get evidence of a human origin only from an age profile because it depends on the procurement pattern. It is first necessary to be sure it is not a natural accumulation and we need many kinds of data to argue. In the same way, skeletal parts representation is different, according to procurement and exploitation pattern. Then the dispersal of remains, associated with human artefacts can reveal different human behaviour and site specificities: bone accumulation can reflect butchering activity, ritual deposits, dwelling construction or consolidation, or raw material exploitation area. In many cases, the bone dispersal reveals a human behaviour, different of a natural scattering process, as describe above.

The different criteria do not have the same importance and efficiency. Some criteria permit to rule out hypothesis but are still not sufficient used alone (site location, skeletal parts distribution). On the contrary, some criteria, in special case, can immediately answer the origin of the bone accumulation (age profile).

B. The Milovice data

Does the mammoth bones assemblages result of a natural death origin? As described above (*cf. supra*) natural causes of mortality are related to special geomorphological, geological context and/or resources distribution, in other words to peculiar places. Milovice is one of the only sites that is not located in such special place. Indeed, Milovice bone accumulation is situated about one and half kilometres from the Dyje River, in a dry and blind small valley. Geomorphological study indicates the Dyje River was (27 000 years ago) at the same level and almost in the same position than today (Oliva, pers. com.). Moreover, on this slope of the Pavlov hills, no cliff, no waterhole, no spring water and no mineral resource did not

exist. So, we can exclude the hypothesis of a natural death pattern (primary deposit) related to a dangerous aggregating point. The absence of surface water also allows us to exclude the hypothesis of a secondary bone deposit. This is confirmed by the geomorphologic study that indicated the main part of the site did not moved, a unique original deposit.

There is no doubt concerning the origin of Milovice mammoth bone accumulation: it is not due to natural causes.

Does the demographic data analysis confirm this conclusion? In case of an origin that is not due to natural factors, the age profiles should not look like living profile (also named “catastrophic”) that represents the whole living proboscidian population in terms of age and sex (Figure 9, Haynes 1987b; 1991).

The Milovice mammoth age profiles were realised thanks to the 159 identified molars and based on lower teeth (74). We established age profiles for the two largest areas (A+B and K) that delivered the largest number of teeth and individuals. We used the minimum number of individuals (MNI) for a better comparative data with ever published age profiles, specially the MNIc because it is the closest of the real number of individuals of the preserved dead population (Poplin 1976). We first used the Law’s classes (1966) in African Elephant Years (AEY) for age determination and we established the age profiles following the G. Haynes (1991) 12 years age interval. As area K delivered a great number of upper teeth, the age profile we analysed is based on lower and upper teeth.

In the profiles of area K, all age classes are represented, the 49–60 excepted (Figure 10). 60% of individuals are adults, 30% are subadult, and there are only two young (10%) individuals: the youngest animal is a newborn or a foetus identified thanks to a bone remain. The area A+B profile is similar: the oldest individuals are missing and adults account for more than 70% (Figure 11). There are also some differences: subadults are less represented and young individuals are more numerous (considering two early newborns identified on upper teeth). We can conclude that Milovice age profiles clearly do not correspond to the “catastrophic” living structure: that confirms

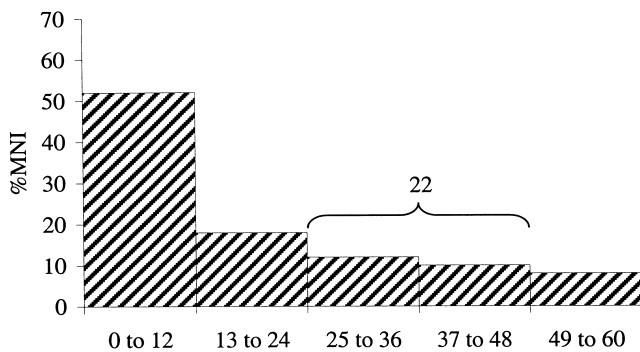


Figure 9 Proboscidian living age profile, after Haynes, 1991; age classes in AEY after Laws, 1966.

the death was not natural. Now raises the question of the predator that is responsible for such a bone accumulation.

As any carnivore is able to kill and remove an adult mammoth, it is clear that Milovice mammoth bone accumulation is not due to a carnivore. Adults are the most represented in the age profile that is very different from a hyena accumulation (young only: see Chap. ?II.A.). Moreover, all the skeletal parts are represented at the site, even the biggest and the heaviest ones, and no bone has been selected up (see Appendix I, V & VI and *cf.* Figure 3 & 4). Then, bone accumulation reaches up to 40cm thick, which is absolutely not characteristic of hyenas' accumulations. All these data exclude hyena as responsible for Milovice bone accumulation. Nevertheless, some marks indicate a gnawing activity related to carnivores

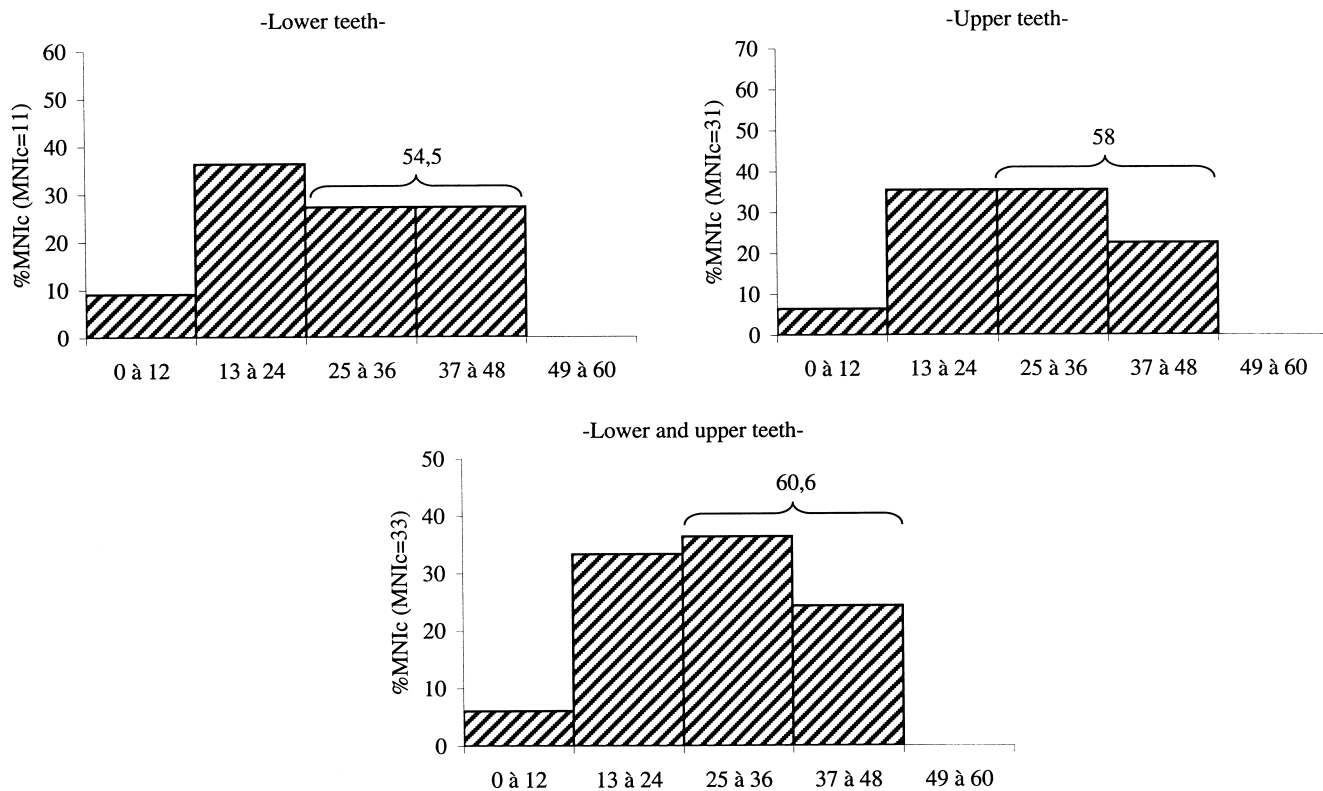
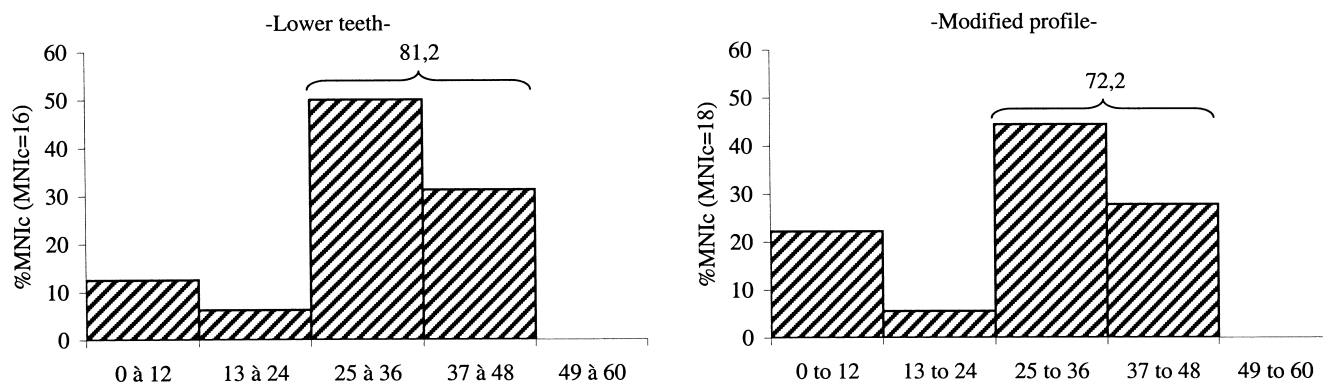


Figure 10 Mammoth age profiles of area K; age classes in AEY after Laws, 1966.

Figure 11 Mammoth age profiles of area A+B; age classes in AEY after Laws, 1966.



(mainly wolf), but even if some bones may have been completely consumed or removed by carnivores, the gnawing activity was very limited, affecting 0,1% of the faunal remains (Table 4). The carrion activity practiced by carnivores is very low face to the abundant attractive meat and bone remains, even if we consider some bones have disappeared (completely consumed or removed). How to explain it? Looking at the detailed bone parts gnawed, we noticed the long bone epiphysis were the most concerned and always chewed by their internal part (cf. Table 4 and Figure 12). That demonstrates the greatest part of the epiphysis sample was not fused and that carnivore action took place after meat has disappeared and bones were slacked.

A gnawed and chewed femur's head confirms it. Indeed, as the femur has to be out of the acetabulum, it means that all the muscles and tendons were altered and slack enough to be separated. These data confirm carnivores were not involved in Milovice bone accumulation process.

Now we demonstrated neither a natural death nor a carnivore was responsible for the mammoth bone accumulation, we have to confirm that it is related to human groups. The most striking point we have to emphasize is the very low proportion of upper teeth (one of the most resistant body parts), specially the tusks. Thought thousands of pieces have been collected, we know it represents only a few tusks broken in situ. If we consider the 48 mammoths (at least) older than 12 years old (wearing the heaviest and longest tusks) and identified thanks to the molars coming from areas K (MNIc=31) and A+B (MNIc=17) only, we should expect to find at least 96 tusks. As only 9 have been identified, it means 90,7% of ivory is missing. This lack of ivory is too important to be due to a natural cause and we know that in natural sites, tusks are represented following the MNI (Maschenko et al. 2006).

As it is clear that human groups are responsible for Milovice mammoth bone accumulation, we have to identify the procurement pattern: collecting or hunting?

C. Procurement pattern

1. Collectors or hunters?

To identify the two main ways to get bones, collecting and hunting, it is necessary to use taphonomic data, age profiles and skeletal parts representation. Indeed, as we demonstrated that the mammoth accumulation is not due to natural causes, scavenging hypothesis is conceivable. In the case of collecting, a heterogeneous body part representation would be expected, human groups selecting some skeletal parts. Moreover, if bones collected came from several individuals, dead at different places and moments, bones that form the heaps should not be altered in the same way. The hypothesis of collecting can easily be rejected for Milovice thanks to the homogeneity of bone preservation and skeletal parts representation (cf. Chapter I) that indicates an *in situ* death: bones have not been collected on dried or fossilized mammoth carcasses.

Do the data confirm the last hypothesis of mammoth hunting? The age profiles clearly indicate that individuals have been selected, (at least for area A+B): the great part of adults and subadults, as the scarcity of young, does not correspond to

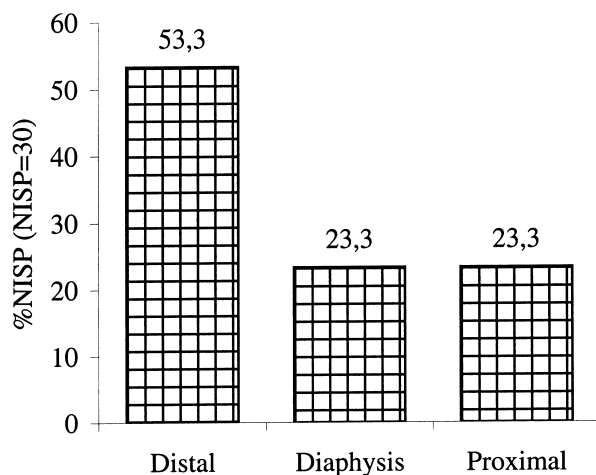
natural profiles and the absence of the oldest ones cannot be explained in another way. Considering the actual demographic data (*sex ratio* and age profile) of elephant, we can get some information related to hunting strategies. The matriarchal herds (15 to 30 individuals) are composed of old, adult and subadult females and young of both sex. Males leave the herds when they reach sexual maturity, from 12 years old and live alone or in small bands all year round, mustering females only during mating period.⁴ At least one bull younger than 29 years old has been identified in area A+B thanks to an unfused distal epiphysis of femur. It indicates at least one individual, isolated or coming from a small male band, has been killed. In the two main areas, six females have been identified (Sedláčková, this volume) and the presence of very young (foetus close to birth or/and newborns) also indicates matriarchal herds have been hunted.

Considering these results, it seems that human groups have hunted adults coming from matriarchal herds and at least, one adult male. The cultural remains do not contradict the hunting procurement pattern: presence of lithic points, sometimes fractured, corresponds to used weapon. The quantity of weapons and their size is not related to success in hunting mammoths as shown with actual proboscidian experimental or at Clovis sites (Frison 1989; Frison – Todd 2001).

2. Season of hunting

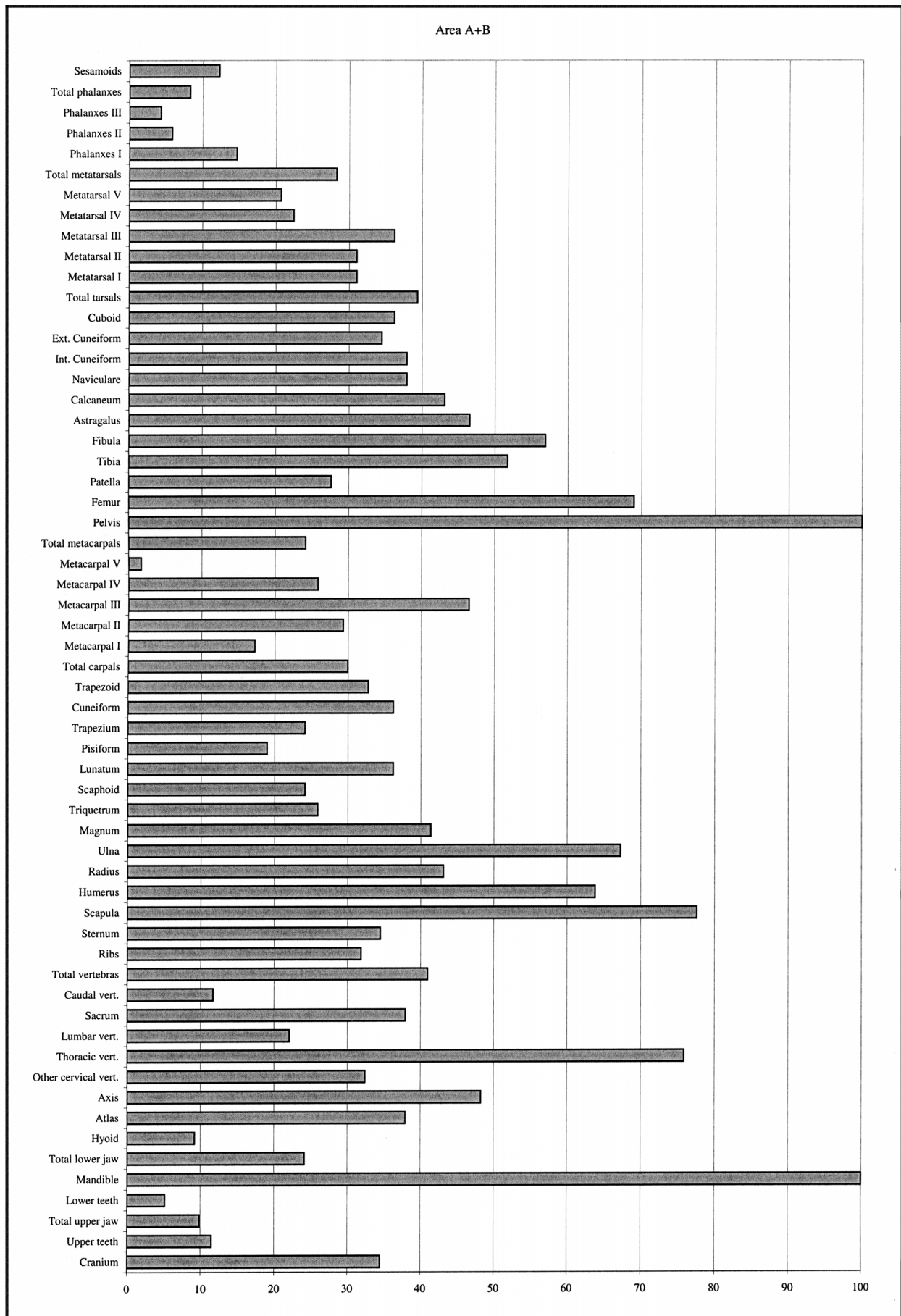
Is there any indication about season of mammoth hunting? Was mammoth hunting a seasonal activity, or was it practiced all year round? Direct seasonal data on mammoth are scarce. There are very few indicators compared to other species: teeth are useless, the first one excepted (dp2 or M1), and it is difficult to use tusks growth (Fischer 2001). The best indicator of season is the presence of newborns. Indeed, in periglacial environment, it is admitted that herbivores give birth at the beginning of the warm season to increase the survey chances of their young (Guthrie 1990). Thus, the published seasonal data often concern only faunal remains associated with mammoth (Péan 2001b; Musil 1994; West 2001a) or other analysis like anthracology (Opravil 1994) or micro-usewear analysis (Tomášková 1994). Only F. A Fladerer (Gravettian of Lower-Austria) and S.C.

Figure 12 Part of long bone affected by carnivores gnawing.



4) In arctic context and for Palaeolithic times, it is admitted mating period occurred in summer time, as the birth period occurred in spring (Guthrie 1990).

Figure 13 Skeletal parts distribution in areas A+B (MNE=1968) and K (MNE=1054).



Area K

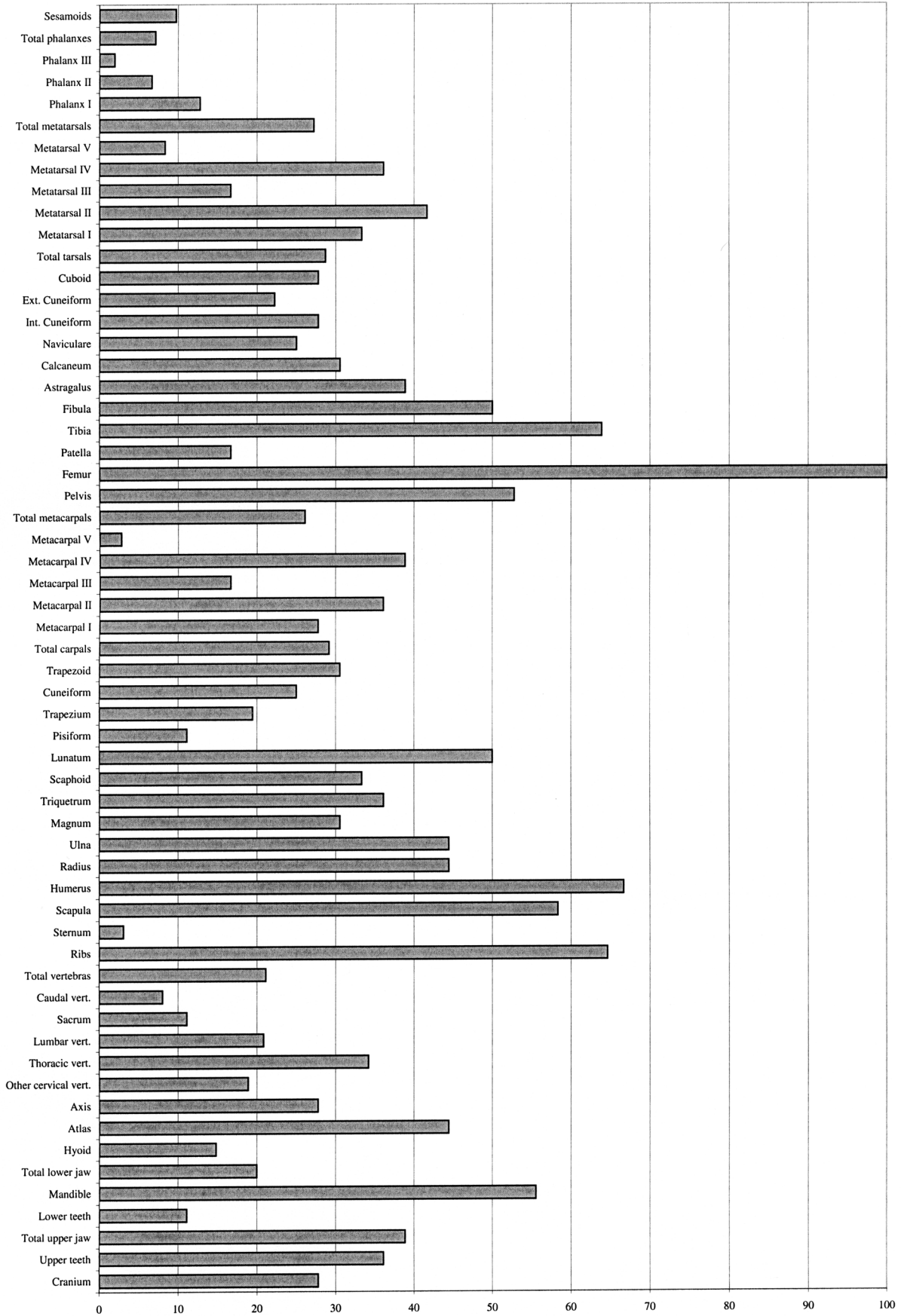
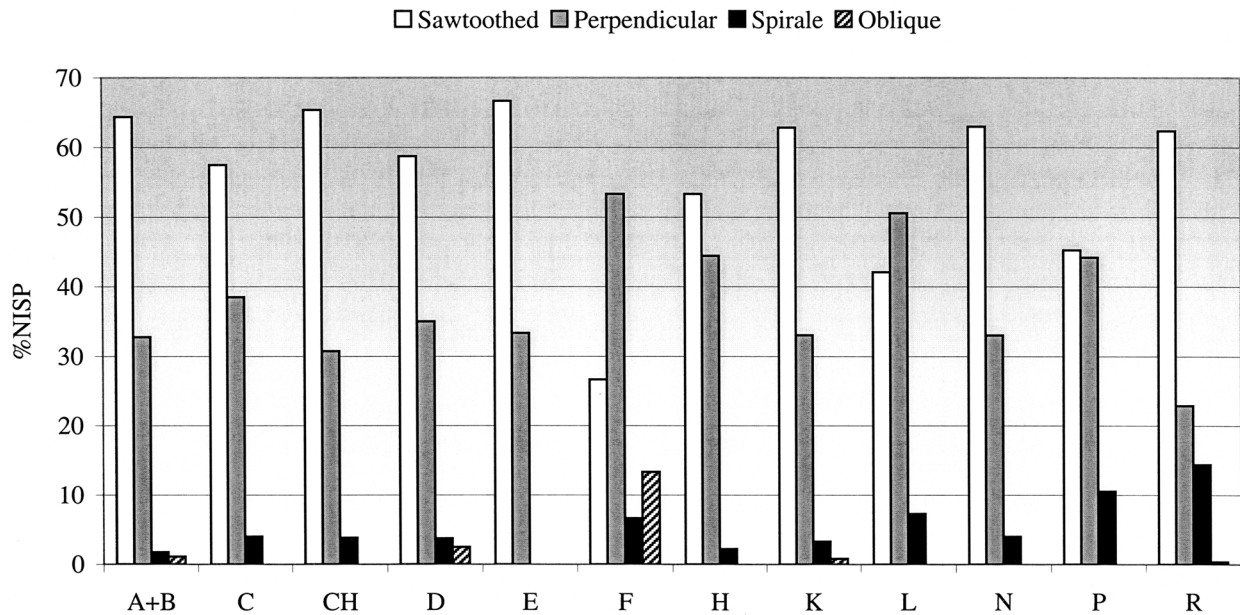


Figure 15 Fragmentation types recorded at Milovice.



Münzel (Aurignacian and Gravettian of Souabian Jura) identified seasons of mammoth hunting from suckling mammoths' study (Fladerer – Salcher 2004; Münzel 2001). Milovice faunal collection (G excepted) contains at least one foetus and three early newborns: two teeth (unused dp2), a femur (A+B), a half part of an axis (A+B), two humerus (K and A+B), two ulna (R and K), a zygomatic (A+B) and a pelvis (A+B). We compared the two humerus size with the data published by E. Maschenko (2006), (Table 5): mammoths were very close to the birth date or very recently newborn. A humerus of 245 mm length (A+B) also indicates this individual is a little bit older. Still in area A+B, one calf is one year old according to a tibia diaphysis length of 190mm. If we consider the size variation of individuals at a same age and a time span of birth for mammoth, the death period of these six individuals would be at the beginning of “warm” season (spring). So we propose a death period (at least for some mammoths) at the beginning of spring, at least for pregnant females and some newborns. The presence of a one-year-old calf also indicates this individual and its mother (not pregnant) were also in the area at this period. So at least six individuals have been killed in the early spring/beginning of the warm season. If this seasonal indication is fragile because of the few individuals involved (accounting for 7% of the total MNIC based on teeth and bones), we notice it concerns three different areas (A+B, K and R).

So, at least some of the mammoths coming from family herds have been killed around the birth period at Milovice. If this season cannot be extended to other individuals, the fact that it is the same for at least in three different areas indicates a recurrent hunting pattern.

It is clear that Milovice bone accumulation is related to human groups who hunted mammoth, at least during the spring when females gave birth in the area.

VII.4 Mammoth exploitation

A. Butchering activities and meat procurement

mammoth died at Milovice, as demonstrated by complete carcasses and the homogeneity of the right/left ratio (cf. figure 4). To understand how the carcasses have been exploited, skeletal parts distribution have been analysed in detail. In areas K and A+B (Figure 13), all the bones were identified and their rates are not very similar. Are only bone density and size responsible for this representation? Pelvis and mandible are the best represented in area A+B (100%) as the femur in area K, like in natural death sites where pelvis, femur and scapula are the best preserved (Haynes 1991). For every body part, a bone is always represented between 60 and 80 % (Femur, Scapula, Thoracic vertebrae or ribs) and the representation of the bones inside every body part is homogeneous. Finally, leg extremities and other vertebrae are the less represented, especially phalanges and metacarpal V that are the smallest bones. The size of cervical, caudal and lumbar vertebrae also explains its low representation compared to large thoracic ones (that are more numerous in a skeleton). Density of these bones is also the lowest, as for patella, sternum, and metapodials. So the only parts whose low representation cannot be explained by size or density criteria are molars and tusks. It means human groups could have selected these teeth and taken it away, as we have no evidence of such a behaviour for bones. This lack of teeth, tusk especially, concerns the whole site of Milovice, as it has also been demonstrated by S. Péan (2001b) but not for any other Moravian sites. So the natural processes is responsible for a great part of bone destruction and human groups only removed ivory. If carnivores and carrion crow removed and gnawed some parts (axis in area A+B), it affected very few bones.

Mammoth kill offers a great amount of meat and marrow immediately available for the human groups. Have the Milovice mammoths been exploited for their nutritive contribution? To identify the butchering activity, classical clues are accidental cut-marks let on bones, or the breakage pattern related to

marrow removal. Whatever the Palaeolithic period, it has been noticed that when proboscidian carcasses exploitation have been identified, cut-marks were always scarce (*Gaudzinski et al. 2005*). It has also been noticed on actual elephant butchering practice by African societies who do not leave any or very few cut-marks, even using metallic knives and tools (*Crader 1983*). Cut-marks may have been scarce or may have disappeared because of their superficial position: thickness of tissues rises, as the cutting tools' sizes are not. Experimental studies demonstrated that it is easily possible to butcher a proboscidian without leaving any cut-mark, even for dismembering operation (*Frison 1989; Frison – Todd 2001*). And, as known in some Palaeolithic sites, the use of bone tools as knives can also reduce the cut-marks frequency (*Hannus 1997*). Considering these points, whatever the quantity of cut-marks, even none, it is not conceivable to evaluate the importance of meat removal. Difficulties for identifying butchering pattern also concerns marrow exploitation. Breaking a mammoth bone is not so easy as for a middle size mammal. The bone fragments produced by a human breakage pattern look different and have been detailed by *Biberson and Aguirre (1965)*. Because of the size, used as hammer less efficiency and much more difficult than throwing a bone over an anvil (*Louquet – Lefebvre 2005*).

Did some indications about meat and marrow removal exist at Milovice? Over the thousands of bone remains, only one rib (area K) clearly wears parallel butchering cut-marks (Figure 14).⁵ Face to the low number of other species' individuals associated with the proboscidian ones, we nevertheless suggest meat exploitation was one of the main procurement. Butchering clues also exist in area G, with more evidence (*Péan 2001b*).

Concerning marrow removal, indications are also scarce: the spiral fragmentation is the less frequent one, among the four type recorded (Figure 15). But added to the fragment types described by *Biberson and Aguirre (1965)*, it can be distinguished from the natural fresh state natural fragmentation. It also indicates marrow removal had been practiced very occasionally, which is different to the reindeer and horse long bones, systematically broken on the same areas. Finally, another kind of object has been recognized. One hundred ribs coming from areas A+B, K and L, are systematically broken affecting the middle thoracic cage section only at 17–23 cm away from the head. These longest ribs are freshly fractured by flexion, sometimes producing a “*languette/sifflet*” on their spiral edges (Figure 16). This pattern could be the result of a human butchering process while trying to reach the viscera or to open the thoracic cage. The fracture would result from a flexion movement, which is coherent with the occasional strips observed. These ribs could also have been used, as a technical support that remains unclear, as no analogous rib exist. Ribs have always been useful for human groups like in the German Gravettian of Geißenklösterle (*Münzel 2004*), or in older sites like in Salzgitter-Lebenstedt (*Gaudzinski 1999*).

So we suggest meat removal has been one of the main goals of mammoth procurement.

B. Raw material exploitation

Mammoth exploitation was not only focused on nutritive products. The Gravettian-Pavlovian of Moravia is famous for its mammoth bone industry and Milovice is also concerned: we identified for the first time several mammoths worked bones. No ivory items or wastes fragments have been identified, as area G delivered a single worked piece of ivory wearing grooves (*Péan 2001b*). What was the part of this organic exploitation in the 12 areas? What was the contribution of Milovice mammoths to the bone industry of the human groups of Moravia?

1. Bone use (see also *Oliva – Zelinková?????*, this volume)

The technical use of mammoth bones is for now demonstrated at Milovice. Two femurs (area A+B, Figure 17) are notched longitudinally by a linear series of eight to eleven impact points. These impacts concern the anterior face of two femur. The opposite face presents a full longitudinal spiral breaking pattern running for 90% of the diaphysis length. The distal end of the diaphysis thus presents a pointed morphology. This part has not been active (as a stake – to be confirm with microscope study), no more for saw-toothed diaphysis resulting from the notches series (as a big knife). That is why we think these bones were used for bone flake production. But such bone flakes have not been recognized in the collection. Some splinters do exist in area K but do not result from femur exploitation no more than any other. Bone flakes are known in Palaeolithic sites from Middle and Upper Palaeolithic and some of them may have been used as knives (*Hannus 1997; Antl – Fladerer 2004; Gaudzinski et al., 2005*). This exploitation is not isolated in the Gravettian area: a similar femur is known at Krems-Wachtberg (Austria), and a similar technique was applied on an ulna at Krems-Hundssteig (Austria), (*Fladerer 2001a; Fladerer – Salcher 2004*). At Dolní Věstonice, the long bone notched seems to be the final object and its morphology is different with a long flat part of the bone remaining.

Other bones have been worked. Indeed, ribs may have been used as smoother. One (in area R) is very smoothed on its distal end and all over the diaphysis section. This extremity is very similar to the “*lissoir*” made with reindeer bones and antlers in other Palaeolithic sites. Another one (area K) has to be confirmed. At last, the high potential of heavy bones was not so exploited at the site by the human groups: only one circular structure is known in area G (*Oliva 1989b*; this volume) while none have been identified in other areas. The spatial analysis does not show any clear spatial organization of the mammoth deposits. M. Oliva noticed some possible long bones intentional disposition in few areas (see this volume) but this is still unclear.

Finally, some of the worked bones are more problematic. In area A+B, a nearly complete rib (60 cm) wears intentional grooves (Figure 18) made of several deep incisions on the anterior and posterior sides. Unfortunately, the edge is broken and we do not know if these incisions are peripheral or not. Two “incised ribs” are known at other sites but present a wider area of transversal incisions resulting from a longer utilisation or a multiple utilisation; they probably belonged to another type of object. One is known at Grub/Kranawetberg (*Antl – Fladerer*;

5) Among the numerous bones wearing “excavating tools cut-marks”, we checked with a binocular some of the most problematical ones: all were rejected. Also this rib is the only remain of the 12 areas wearing cut-marks, all species considered.

Figure 19 Mammoth tusk deficit at Milovice.

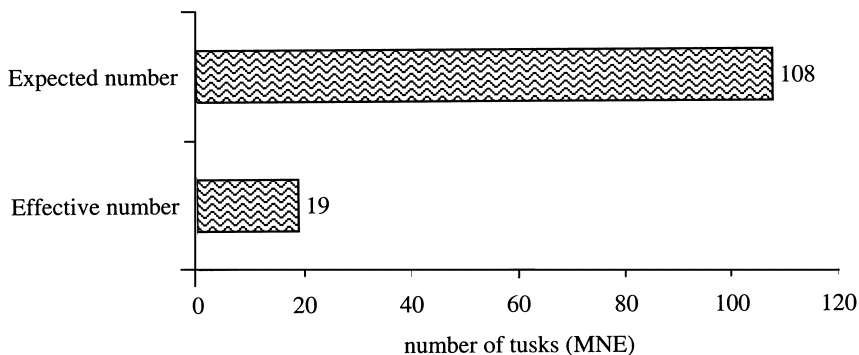
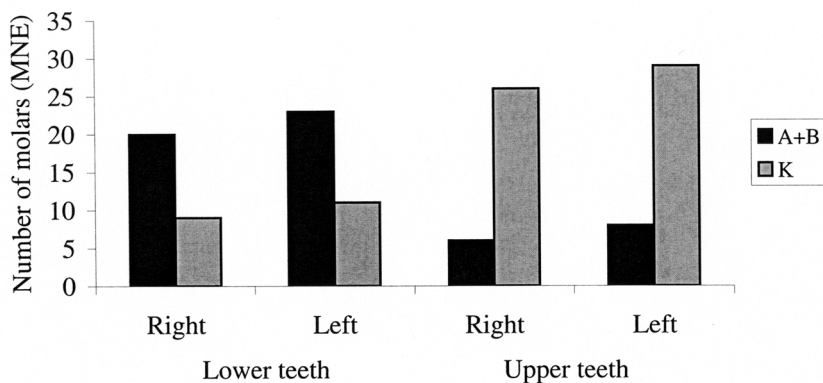


Figure 20 Difference between upper and lower molars (area A+B and K).



2004), and one at Krakow-Spadzista (Wojtal – Sobczyk 2005). These marks are more relevant of a technical or symbolic behaviour than butchering activities. The rib may have been used as a cutting board. But in this case, many bones present a better flat surface even other ribs closer to the first one model. The cutting area is narrow and intentional production of these grooves is more conceivable.

2. Missing ivory

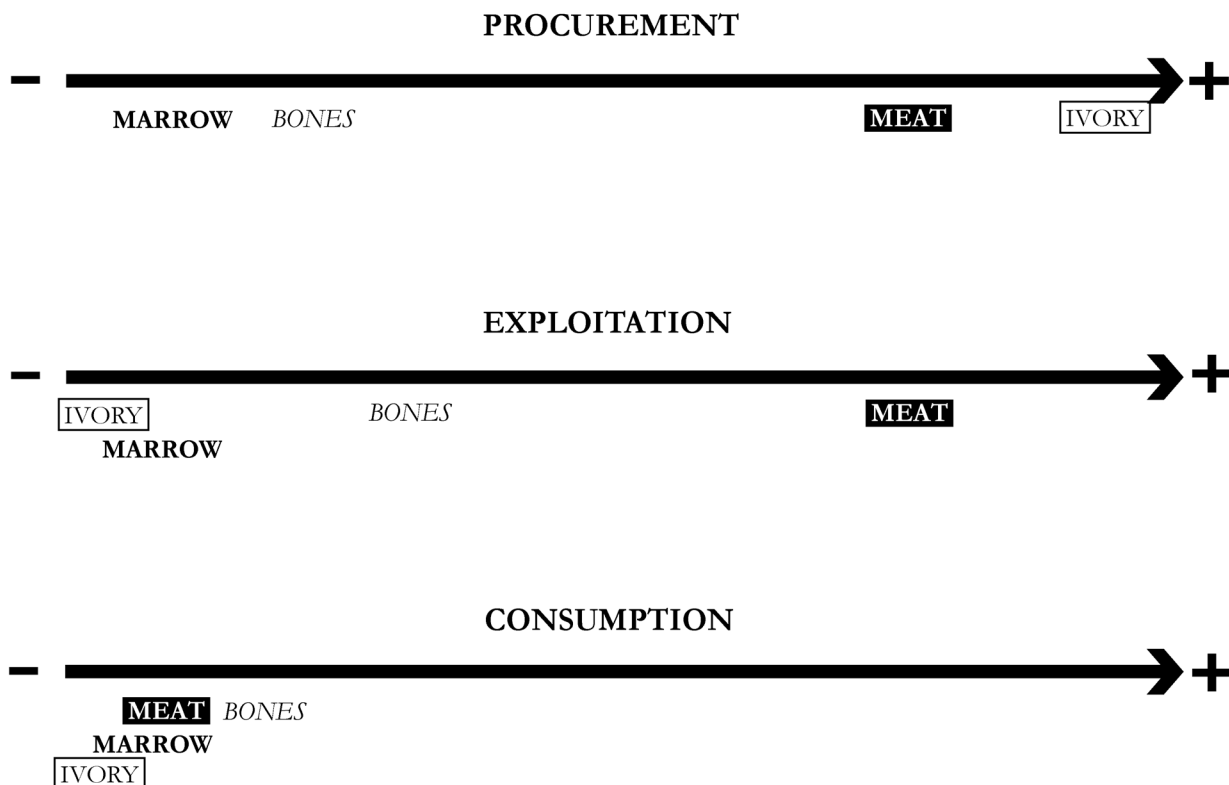
In the Gravettian-Pavlovian society of Moravia, mammoth ivory was one of the greatest requested raw materials, with mammoth bones and reindeer antlers. This commodity makes mammoth very attractive as well as reindeer antlers or the fur of small games. What was Milovice ivory procured for? We noticed (????????? cf. Chap. II) ivory was missing when compared the expected number of tusks to the effective one. Considering the whole areas⁶, ivory is still missing. Among the 54 individuals older than 12 years old, only 19 tusks (at least) have been counted, which only represent 17,5% of the total ivory (Figure 19). This lack is not due to natural preservation (as demonstrated in Chap. I) but to a human procurement. Tusks' removing is possible following two different techniques (Khlopatchev 2006; Christensen 1999). First, by sawing, grooving or breaking fresh ivory, but it directly affects the raw material. Another operation consists in cutting around the incisive bone then to destroy it that preserves the raw material. Finally, an easier possibility is to

remove dry tusks. At Milovice, any of the 12 areas delivered worked ivory and three middle-sized tusks were naturally broken (Christensen, pers. com.). If most of the skulls are crushed into pieces, we did not recognize any impact point, so smashing maxillaries and incisive bone to get ivory is not proved. There is also a deficit of tusks in area G (Péan 2001b) that can be explained by the importance of young animals in the assemblage. It seems clear that the major part of Milovice mammoths' tusks have been removed, carried away maybe in a fresh state.

Is tusk ivory the only one to have been exploited? Some lower molars are missing in area K and upper molars are missing on area A+B (Figure 20). Once again, considering the good enough preservation of the remains, the only human exploitation can be responsible for this deficit. We noticed less than ten mandibles worn their molars, which indicates the removal of teeth was not systematic and nothing argue for a fresh or a dry extraction. Some molars were used as scraper at Dolní Věstonice and they are numerous at Předmostí (close to 1000). Roots have been also worked in Lower Austria (Antl – Fladerer 2004).

Ivory exploitation at Milovice was undoubtedly one of the main activities at the site. Most of the tusks was removed and taken away. Finally, even if mammoth was the main food resource at Milovice, it is highly probable that the preferential hunt of the biggest animals of matriarchal herds could have been directly related to ivory exploitation.

6) Other areas delivered isolated teeth or mandibles allowing to establish MNIc: H=2 (13-24 y.= 1, 25-36 y.=1); C=2 (13-24 y.= 1, 25-36 y.=1); N=1 (37-48 y.); D=1 (13-24 y.); L=1 (0-12y.)



At Milovice, meat and ivory looked to be the most attractive commodities (Figure 21). We suggest part of the meat removal was important and part of marrow was occasional. We got more evidence for ivory removal (more than 80% of deficit), affecting tusks of adult mammoths. A few bones were slightly used at the site in a technical goal. We also note the absence of any burnt mammoth bone, a rib fragment excepted (in area R). The lack of sieving (area G excepted) does not explain such an absence: human groups did not use bone as a combustible.

VII. 5 Conclusions

Milovice mammoth bone accumulations are the result of hunting episodes. The Gravettian-Pavlovian groups hunted mammoth, selecting adults and subadults among family herds. It seems mammoth procurement was motivated at least by ivory, meat, and, a lower part, marrow. The main evident exploitation is ivory: the high deficit of tusks, and in smaller part, molars, indicates this raw material was lusted after. Ivory was procured and removed but not worked or used at Milovice. As *S. Péan (2001b)* concluded in the same way for area G, it appears Milovice was a killing and a butchering place. The low density of lithic remains, the absence of art and the scarcity of bone industry suggest Milovice was a short-time occupation place (*Oliva, this volume*), that our study confirms and makes Milovice an atypical Moravian site (*Musil 1997; Oliva 1989b*). Finally, if mammoths were in Milovice area during springtime,

it means it could have been a part of a birthplace area that could maybe explain the choice of such a place by human groups. It could be reported as a “complementary” site related to the Pavlovian culture but the lack of data about subsistence patterns in Pavlovian sites is cruelly missing. Moreover, as we do not know if we have a selected or a complete view of the Gravettian cultural complex of the wide Moravia, it is not possible to characterise the Pavlovian economy, especially if some kinds of sites are missing. Jarošov II-Podvršťa is maybe such a kind of different site, where mammoth is missing, the great majority of game being small animals (*Musil 2005*). The lack of seasonal data also prevents to conclude and characterise mammoth exploitation over a complete annual cycle. We just know mammoths were killed in winter at Krems-Wachtberg (*Fladerer – Salcher 2004*) and at the end of winter/beginning of spring at Grub-Kranawetberg (*Antl – Fladerer 2004*).

In the same way, even though the mammoth bone (and lithic) industry from Milovice shares some characteristics with sites in Lower Austria, more evidence is necessary to understand the cultural links between Moravia and its border areas.

Acknowledgment

We are grateful to Dr. Oliva for his confidence and his help to make the work easier at Brno and Budisov. We also thank M. Christensen for her help and discussion about tusk ivory breakage pattern.

Table 1 Species representation at Milovice.

Taxa	A+B	C	CH	D	E	F	H	K	L	N	P	R	Total	%NISP
<i>Mammuthus primigenius</i>	31642	417	86	2312	98	5966	75	15625	3251	769	166	1398	61805	98,59
<i>Coelodonta antiquitatis</i>	3												3	0,005
<i>Rangifer tarandus</i>	58	5				4		53	14		1	102	237	0,38
<i>cf. Cervus elaphus</i>	1												1	0,002
<i>Alces alces</i>								4					4	0,01
<i>Equus caballus</i>	307	2	1	11			1	29	19	1	3	31	405	0,65
<i>Canis lupus</i>	89							23	3			2	117	0,19
<i>Alopex/Vulpes/Lepus sp.</i>												1	1	0,002
<i>Alopex/Vulpes</i>								1					1	0,002
<i>Panthera leo</i>								6	7				13	0,02
<i>Lepus sp.</i>	1												1	0,002
Undet. species	11			6			1	37	5		15	29	104	0,17
TOTAL	32112	424	87	2329	98	5970	77	15778	3299	770	185	1563	62692	100

Table 2 Detail of the different bones and teeth refitting at Milovice.

		Areas (NISP)												Total (62690)
		A+B (32112)	C (424)	CH (87)	D (2329)	E (98)	F (5970)	H (77)	K (15779)	L (3296)	N (770)	P (185)	R (1563)	
MAMMOTH	Bone refitting	34		1			1							36
	Bone symmetric association	16							9					25
	Teeth refitting (Up. & Low.)	5							10	1				16
	Teeth symmetric association (Up. & Low.)	11	1						24	1	1			38
OTHER SPECIES	Bones refitting	6								1				7
	Teeth refitting	2								1			1	4
GENERAL	Anatomic connection noticed during excavation	2											1	3
	Total	76	1	1			1		43	4	1		2	129

Table 3 Detail of the successful refitting.F

TAXA	REFFITING	SYMMETRICAL ASSOCIATION
Mammoth	Cervical vertebrae, thoracic vertebrae, thoracic & cervical, ribs, radius & ulna, femur & tibia, metacarpals, metatarsal, carpals, phalanx, lower teeth, upper teeth	Radius, pelvis, femur, patella, tibia, metatarsal, carpals, tarsals, fibula, lower teeth, upper teeth.
Wolf	Cranium & atlas & axis, lower teeth	
Horse	tarsals, phalanx, lumbar vertebra, lower teeth	
Rhinoceros	Radius & ulna	
Lion	Metatarsal & phalanx	

Table 4 Number remains gnawed by carnivores.

	A+B	C	K	R	Total
Axis	2				2
Scapula	5				5
Humerus	4		5		9
Radius	1				1
Ulna			1		1
Metacarpal	1		1		2
Carpal	3		2		5
Femur	7	1			8
Patella		1	1		2
Tibia	2	1			3
Fibula			1		1
Metatarsal			1		1
Tarsal	4		3	1	8
Total	29	3	15	1	48

Table 5 Compared measurements of foetus and calves mammoth humerus of Milovice to E. Maschenko's data (2006).

Sites	Eliseevichi	Shestakovo	Eliseevichi	Eliseevichi	Eliseevichi	North Russia	Milovice K	Milovice A+B
References	ZIN 32572 (Humerus)	IAE Sh-77, 4B (Humerus)	ZIN 31744 (1) (Humerus)	ZIN 34419 (17) (Humerus)	ZIN 20564 (54) (Humerus)	PIN 4353-2658 (Humerus)	OK 48510 (Humerus)	OK 69764 (Humerus)
Diaphyseal length		168(?)				204	>150 (=200)	>18 (=22-24)
Mediolateral diameter of the distal end of diaphysis	62	80	78	80	70(?)	98	72	78
Shortest mediolateral diameter of diaphysis	20	26.5	30	25	24	34	32	34
Mediolateral diameter of the proximal end of diaphysis		48				61		
Individual âge	Fœtus (beginning (?) of the second year of pregnancy)	Fœtus (last period of pregnancy)	Newborn 1 week (?)	Newborn 1 week (?)	Newborn 1 week (?)	Newborn 1 week (?)	Newborn	Newborn

APPENDIX I

Detail of body parts distribution (areas A+B, K, L & R).

A+B (MNIf=29)	R	L	A	Total	IS	%OE	K (MNIf=18)	R	L	A	Total	IS	%OE
Head	30	34	13	69	12	19.83	Head	28	31	4	63	12	29.17
Hyoide and Vertebras	4	4	2	8	27	53.81	Hyoide and Vertebras				208	53	21.80
Ribs and sternum	160	147	57	364	39	31.92	Ribs and sternum	88	77	61	226	39	32.19
Foreleg	70	69	14	153	8	62.93	Foreleg	37	39	1	77	8	53.47
Carpals and metacarpals	100	115	3	218	26	27.98	Carpals and metacarpals	61	70		131	26	27.99
Hindleg	82	88	20	190	10	61.03	Hindleg	49	49	4	102	10	56.67
Tarsals and metatarsals	113	104	7	224	22	35.11	Tarsals and metatarsals	58	53	1	112	22	28.28
Phalanx and sesamoids	29	18	104	151	80	9.27	Phalanx and sesamoids				112	80	7.78
Total	588	579	220	1387			Total	321	319	71	1031		
L (MNIf=4)	R	L	A	Total	IS	%OE	R (MNIf=2)	R	L	A	Total	IS	%OE
Head	3	1	4	6	12	12.50	Head			2	2	12	8.33
Hyoide and Vertebras				24	53	11.32	Hyoide and Vertebras				11	53	10.38
Ribs and sternum	8	7	33	48	39	30.77	Ribs and sternum	6	3	9	18	39	23.08
Foreleg	8	6	1	15	8	46.88	Foreleg	3	4	1	7	8	43.75
Carpals and metacarpals	13	9		22	26	21.15	Carpals and metacarpals	3	3		6	26	11.54
Hindleg	8	7	3	16	10	40.00	Hindleg	1	2	1	4	10	20.00
Tarsals and metatarsals	4	3		7	22	7.95	Tarsals and metatarsals	2	3		5	22	11.36
Phalanx and sesamoids			2	3	80	0.94	Phalanx and sesamoids			6	6	80	3.75
Total	44	33	43	141			Total	15	15	19	59		

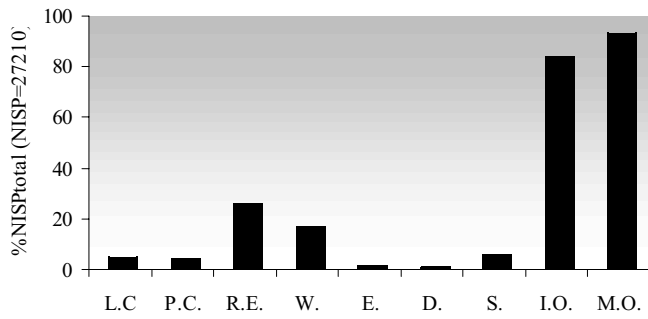
APPENDIX Ia
Left/right ratio (area K).

Skeletal part	NISP				MNE				Total after distribution			%MNE	
	R	L	A	Total	R	L	A	Total	R	L	Total	R	L
Cranium	7	10	1675	1695	5	5		5	5	5	10	50	50
Upper teeth	26	29	975	1030	18	20	1	39	19	20	39	48.7	51.3
Lower teeth	6	8	3	17	4	4		8	4	4	8	50	50
Mandible	3	4	280	287	3	4	3	10	4	6	10	40	60
Ribs	92	95	1537	1724	88	77	56	221	121	100	221	54.8	45.2
Scapula	16	17	46	79	10	11		21	10	11	21	47.6	52.4
Humerus	31	25	33	89	13	11		24	13	11	24	54.2	45.8
Radius	11	12	2	25	7	8	1	16	8	8	16	50	50
Ulna	13	15	8	36	7	9		16	7	9	16	43.8	56.3
Carpals	37	48	1	86	37	47		84	37	47	84	44	56
Metacarpals	22	21	1	44	22	21		43	22	21	43	51.2	48.8
Pelvis	10	13	7	30	7	9	3	19	8	11	19	42.1	57.9
Femur	28	50	35	113	18	18		36	18	18	36	50	50
Patella	2	3	1	6	2	3	1	6	3	3	6	50	50
Tibia	21	29	11	61	12	11		23	12	11	23	52.2	47.8
Fibula	16	14	3	33	10	8		18	10	8	18	55.6	44.4
Tarsals	39	29	2	70	33	29		62	33	29	62	53.2	46.8
Metatarsals	25	24		49	25	24		49	25	24	49	51	49
Phalanx I	1	4	42	47	1	4	41	46	11	34	45	24	76
Total	406	450	4662	5521	322	323	106	746	370	380	750	49.3	50.7

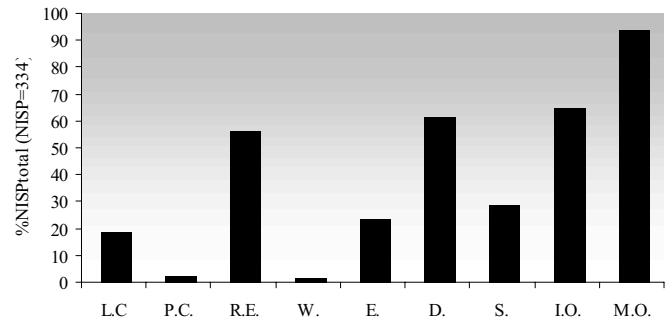
APPENDIX II Left/right ratio (area K).

Area (NISP)	Destructive agents							No destructive	
	Longitudinal cracking	Perpendicular cracking	Root etches	Withering	Exfoliation	Dissolution	Smoothed bones	Iron oxide	Manganese oxide
	<i>NISP affected by each damage for the area</i>								
A+B (27210)	1280	1207	7134	4602	434	245	1625	22780	25392
C (334)	63	7	187	6	79	206	96	215	314
CH (87)	13	10	44	17	3	3	22	15	87
D (163)	35	16	52	25	45	59	28	63	65
E (13)	9	1	13		2	9	3	11	13
F (37)	10	2	21	3	8	5	10	14	23
H (74)	36	8	63	30	48	35	4	58	69
K (12876)	839	139	1386	2571	801	474	2341	11878	12468
L (1485)	229	20	626	52	137	662	348	890	1373
N (768)	106	11	501	373	112	479	6	44	715
P (185)	11	1	141	6	12	108	10	106	164
R (702)	49	3	374	86	30	143	82	341	643
TOTAL (43934)	2680	1425	10542	7771	1711	2428	4575	36415	41326

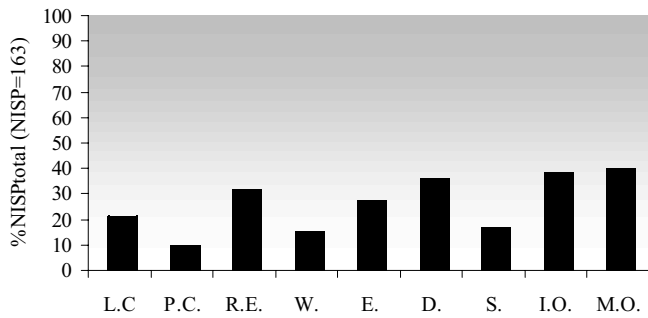
Area A+B



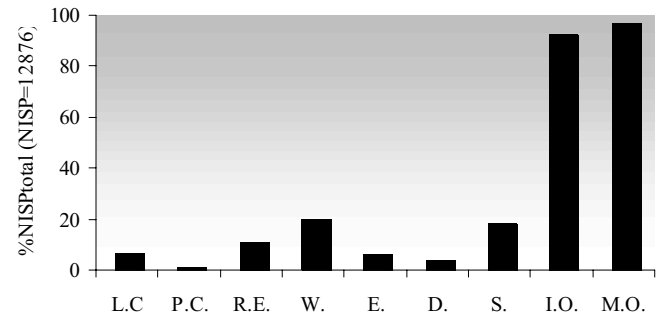
Area C



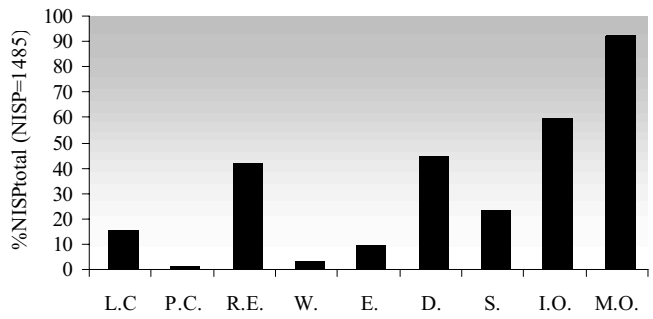
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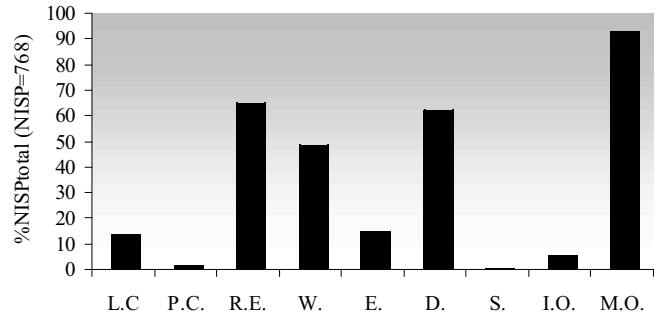
Area K



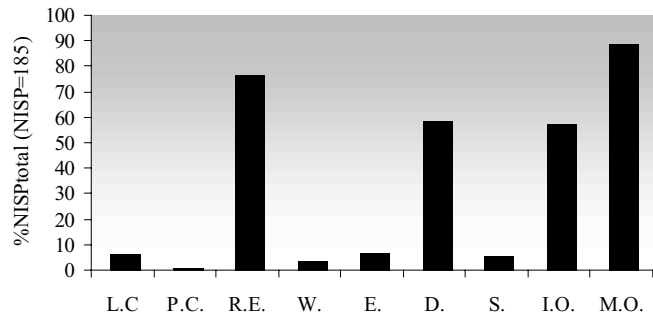
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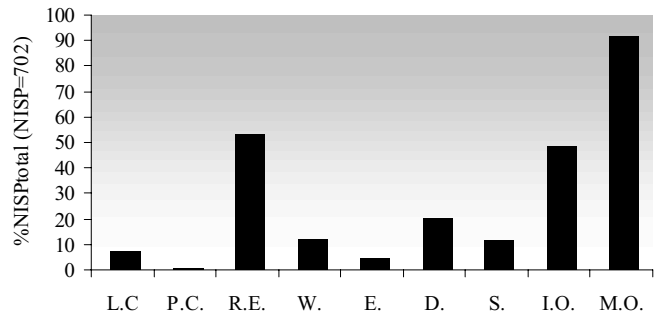
Area N



Area P

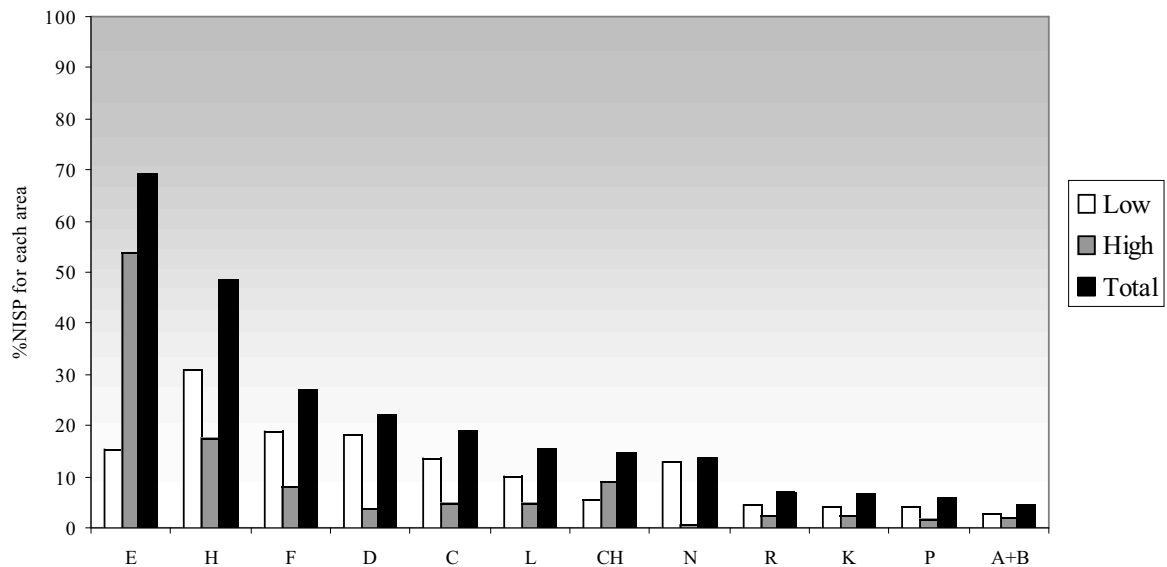


Area R



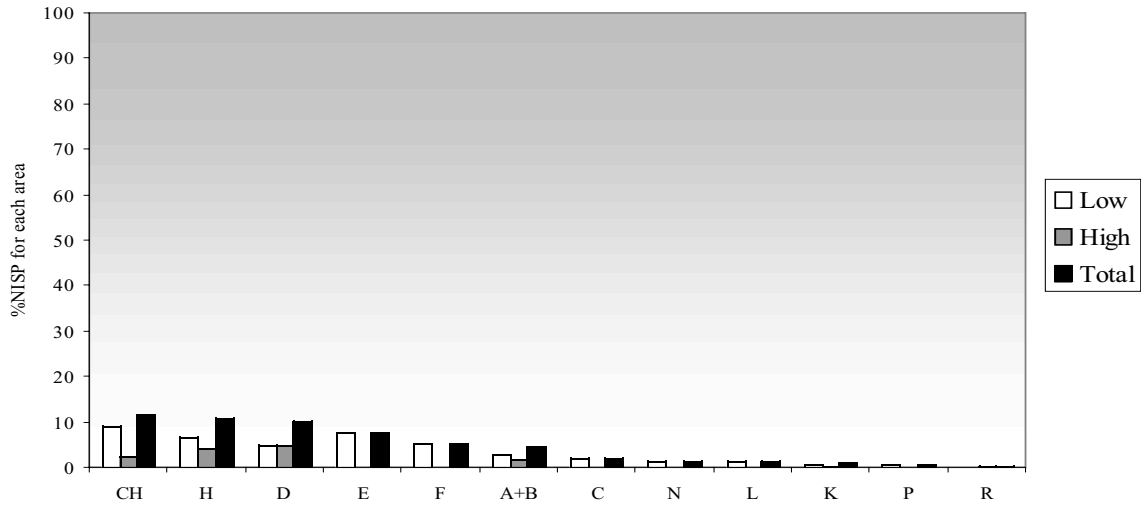
Areas	NISPTotal	Longitudinal fissuration			%NISP Long. fissuration			%NISP area total
		Low	High	Total	Low	High	Total	
E	13	2	7	9	15.38	53.85	69.23	0.02
H	74	23	13	36	31.08	17.57	48.65	0.08
F	37	7	3	10	18.92	8.11	27.03	0.02
D	163	29	6	35	18.47	3.82	22.29	0.08
C	334	46	17	63	13.77	5.09	18.86	0.14
L	1485	154	75	229	10.36	5.05	15.41	0.52
CH	87	5	8	13	5.75	9.20	14.94	0.03
N	768	101	5	106	13.15	0.65	13.80	0.24
R	702	31	18	49	4.42	2.56	6.98	0.11
K	12876	527	312	839	4.09	2.42	6.52	1.91
P	185	8	3	11	4.32	1.62	5.95	0.03
A+B	27210	728	552	1280	2.68	2.03	4.71	2.92
TOTAL	43934	1661	1019	2680	3.79	2.32	6.11	6.11

Longitudinal crackings



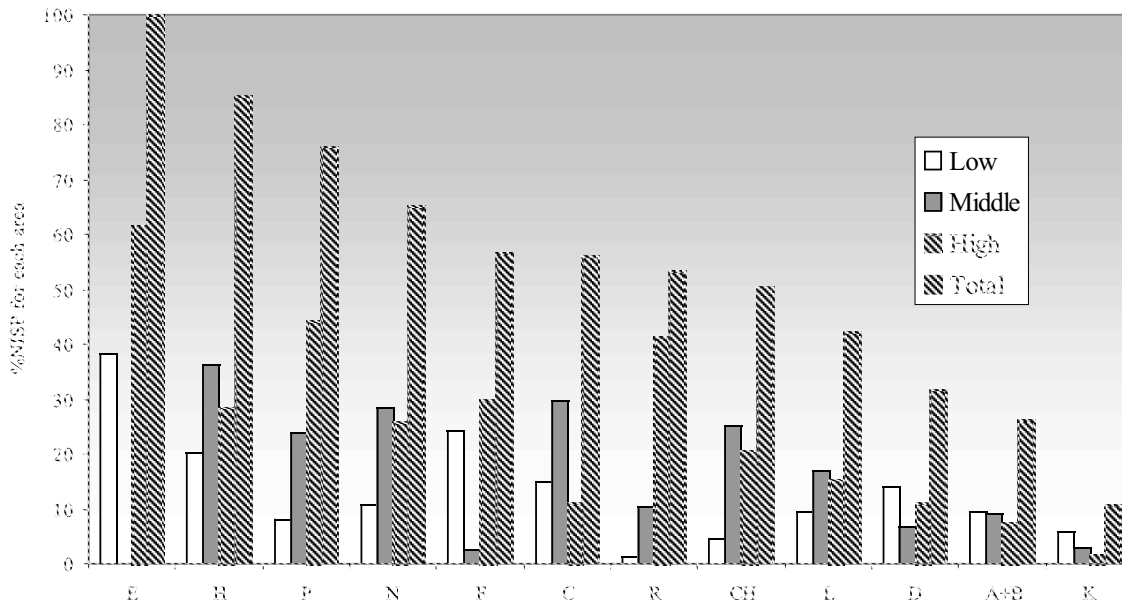
Areas	NISPTotal	Longitudinal fissuration			%NISP Long. fissuration			%NISP area total
		Low	High	Total	Low	High	Total	
CH	87	8	2	10	9.20	2.30	11.49	0.02
H	74	5	3	8	6.76	4.05	10.81	0.02
D	163	8	8	16	5.10	5.10	10.19	0.04
E	13	1		1	7.69		7.69	0.00
F	37	2		2	5.41		5.41	0.00
A+B	27210	741	466	1207	2.73	1.72	4.45	2.75
C	334	7		7	2.10		2.10	0.02
N	768	11		11	1.43		1.43	0.03
L	1485	20		20	1.35		1.35	0.05
K	12876	112	27	139	0.87	0.21	1.08	0.32
P	185	1		1	0.54		0.54	0.00
R	702	1	2	3	0.14	0.28	0.43	0.01
TOTAL	43934	917	508	1425	2.09	1.16	3.25	3.25

Perpendicular crackings



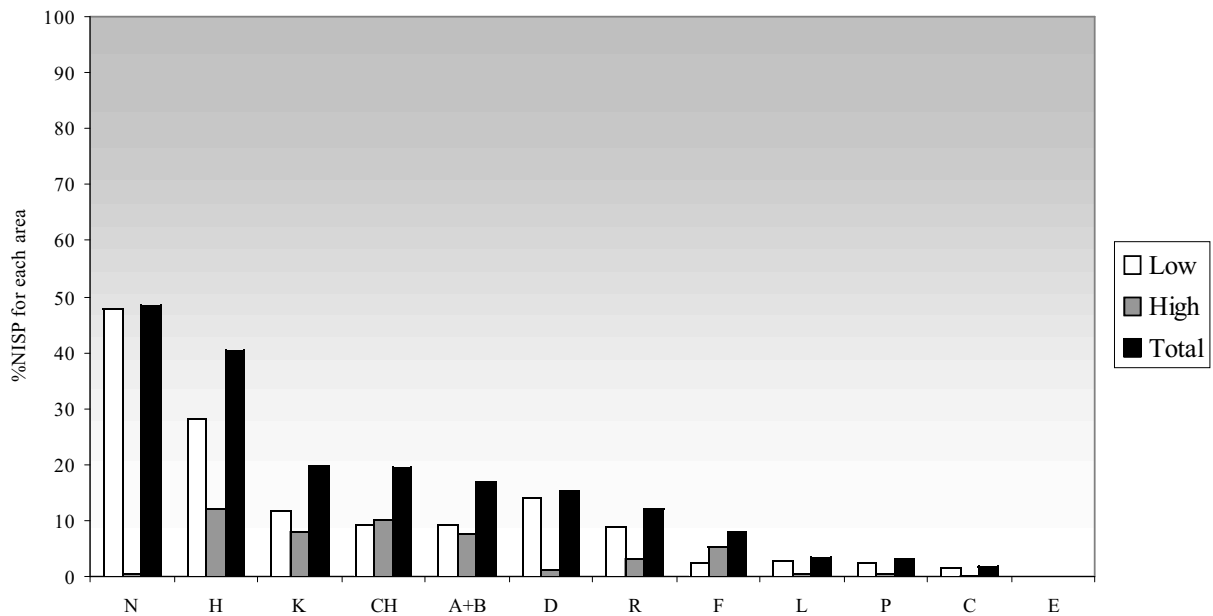
Areas	NISP Total	Root action				%NRTotal				%NR area total
		Low	Middle	High	Total	Low	Middle	High	Total	
E	13	5		8	13	38.48		61.54	100.00	0.03
H	74	15	27	21	63	20.27	36.49	28.38	85.14	0.14
P	185	15	44	82	141	8.11	23.78	44.32	76.22	0.32
N	768	83	219	199	501	10.81	28.52	25.91	65.23	1.14
F	37	9	1	11	21	24.32	2.70	29.73	56.76	0.05
C	334	50	100	37	187	14.97	29.94	11.08	55.99	0.43
R	702	10	74	290	374	1.42	10.54	41.31	53.28	0.85
CH	87	4	22	18	44	4.60	25.29	20.69	50.57	0.10
L	1485	142	253	231	626	9.56	17.04	15.56	42.15	1.42
D	163	23	11	18	52	14.11	6.75	11.04	31.90	0.12
A+B	27210	2602	2520	2012	7134	9.56	9.26	7.39	26.22	16.24
K	12876	777	381	228	1386	6.03	2.96	1.77	10.76	3.15
TOTAL	43934	3735	3652	3155	10542	8.50	8.31	7.18	24.00	24.00

Root etches



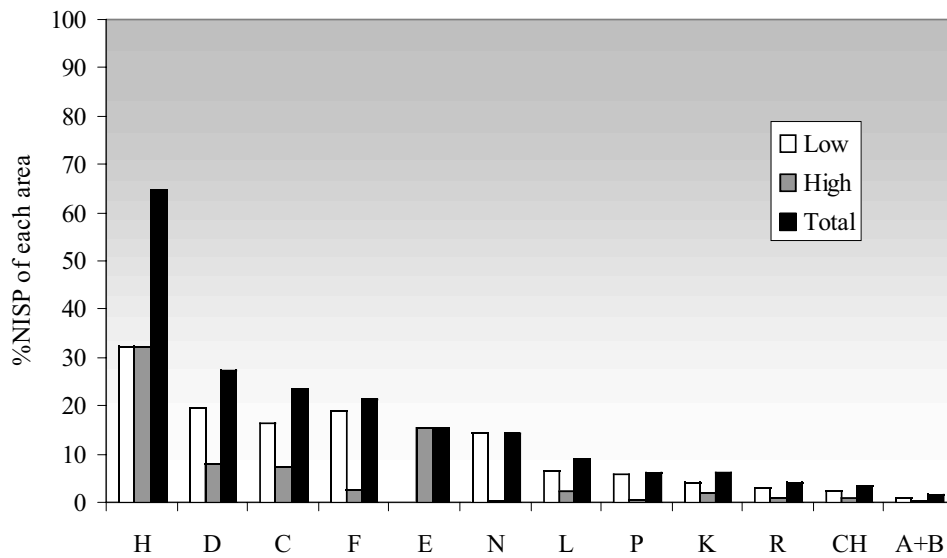
Areas	NISP total	Dessication			%NR dessiqués			%NR area total
		Low	High	Total	Low	High	Total	
N	768	367	6	373	47.79	0.78	48.57	0.85
H	74	21	9	30	28.38	12.16	40.54	0.07
K	12876	1545	1026	2571	12.00	7.97	19.97	5.85
CH	87	8	9	17	9.20	10.34	19.54	0.04
A+B	27210	2542	2060	4602	9.34	7.57	16.91	10.47
D	163	23	2	25	14.11	1.23	15.34	0.06
R	702	63	23	86	8.97	3.28	12.25	0.20
F	37	1	2	3	2.70	5.41	8.11	0.01
L	1485	42	10	52	2.83	0.67	3.50	0.12
P	185	5	1	6	2.70	0.54	3.24	0.01
C	334	5	1	6	1.50	0.30	1.80	0.01
E	13							
TOTAL	43934	4622	3149	7771	10.52	7.17	17.69	17.69

Withering



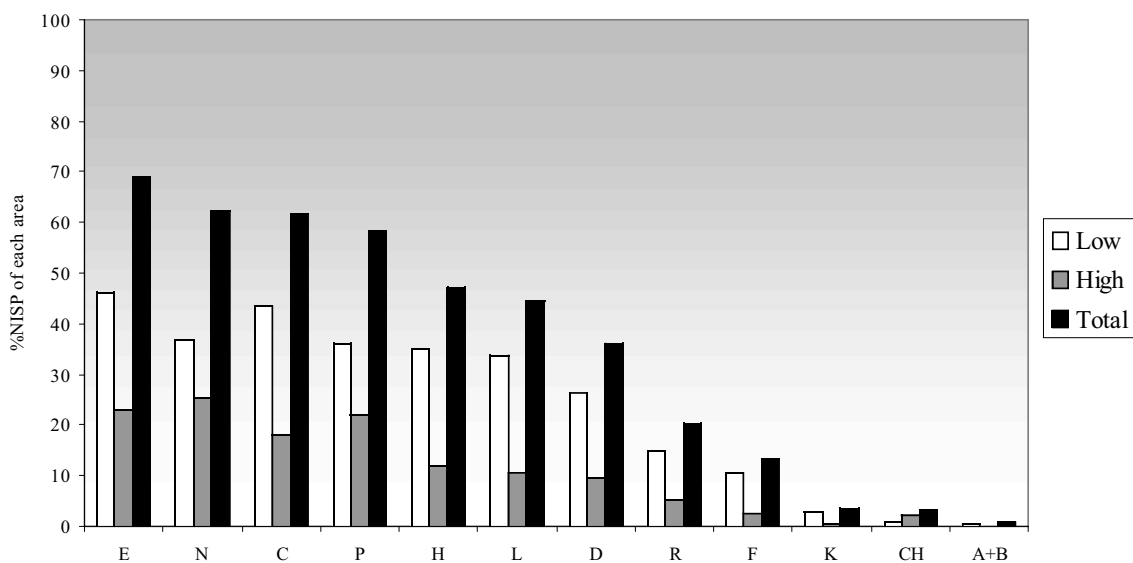
Areas	NISP total	Dessication			%NR dessiqués			%NR area total
		Low	High	Total	Low	High	Total	
H	74	24	24	48	32.43	32.43	64.86	0.11
D	163	32	13	45	19.63	7.98	27.61	0.10
C	334	55	24	79	16.47	7.49	23.65	0.18
F	37	7	1	8	18.92	2.70	21.62	0.02
E	13		2	2		15.38	15.38	0.00
N	768	110	2	112	14.32	0.26	14.58	0.25
L	1485	101	36	137	6.80	2.42	9.23	0.31
P	185	11	1	12	5.95	0.54	6.49	0.03
K	12876	538	263	801	4.18	2.04	6.22	1.82
R	702	23	7	30	3.28	1.00	4.27	0.07
CH	87	2	1	3	2.30	1.15	3.45	0.01
A+B	27210	306	128	434	1.12	0.47	1.60	0.99
TOTAL	43934	1209	502	1711	2.75	1.14	3.89	3.89

Exfoliation



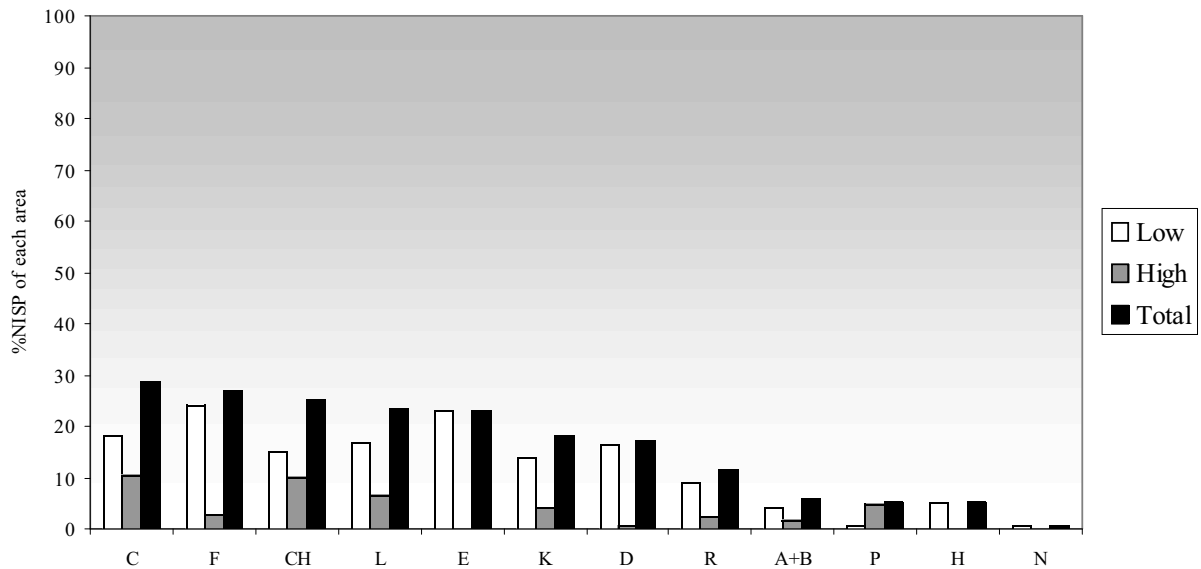
Areas	NISP total							%NR area total
		Low	High	Total	Low	High	Total	
E	13	6	3	9	46.15	23.08	69.23	0.02
N	768	283	196	479	36.85	25.52	62.37	1.09
C	334	146	60	206	43.71	17.96	61.68	0.47
P	185	67	41	108	36.22	22.16	58.38	0.25
H	74	26	9	35	35.14	12.16	47.30	0.08
L	1485	504	158	662	33.94	10.64	44.58	1.51
D	163	43	16	59	26.38	9.82	36.20	0.13
R	702	105	38	143	14.96	5.41	20.37	0.33
F	37	4	1	5	10.81	2.70	13.51	0.01
K	12876	393	81	474	3.05	0.63	3.68	1.08
CH	87	1	2	3	1.15	2.30	3.45	0.01
A+B	27210	207	38	245	0.76	0.14	0.90	0.56
TOTAL	43934	1785	643	2428	6.56	2.36	8.92	5.53

Dissolution



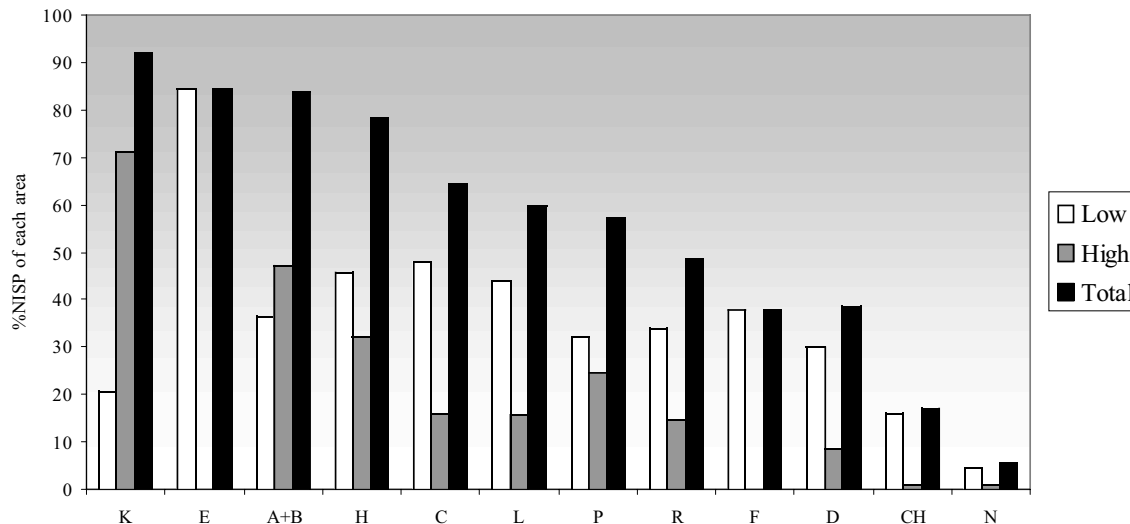
Areas	NISP total	Smooth			%NISP smoothed			%NR area total
		Low	High	Total	Low	High	Total	
C	334	61	35	96	18.26	10.48	28.74	0.22
F	37	9	1	10	24.32	2.70	27.03	0.02
CH	87	13	9	22	14.94	10.34	25.29	0.05
L	1485	250	98	348	16.84	6.60	23.43	0.79
E	13	3		3	23.08		23.08	0.01
K	12876	1817	524	2341	14.11	4.07	18.18	5.33
D	163	27	1	28	16.56	0.61	17.18	0.06
R	702	64	18	82	9.12	2.56	11.68	0.19
A+B	27210	1182	443	1625	4.34	1.63	5.97	3.70
P	185	1	9	10	0.54	4.86	5.41	0.02
H	74	4		4	5.41		5.41	0.01
N	768	6		6	0.78		0.78	0.01
TOTAL	43934	3437	1138	4575	7.82	2.59	10.41	10.41

Smoothing



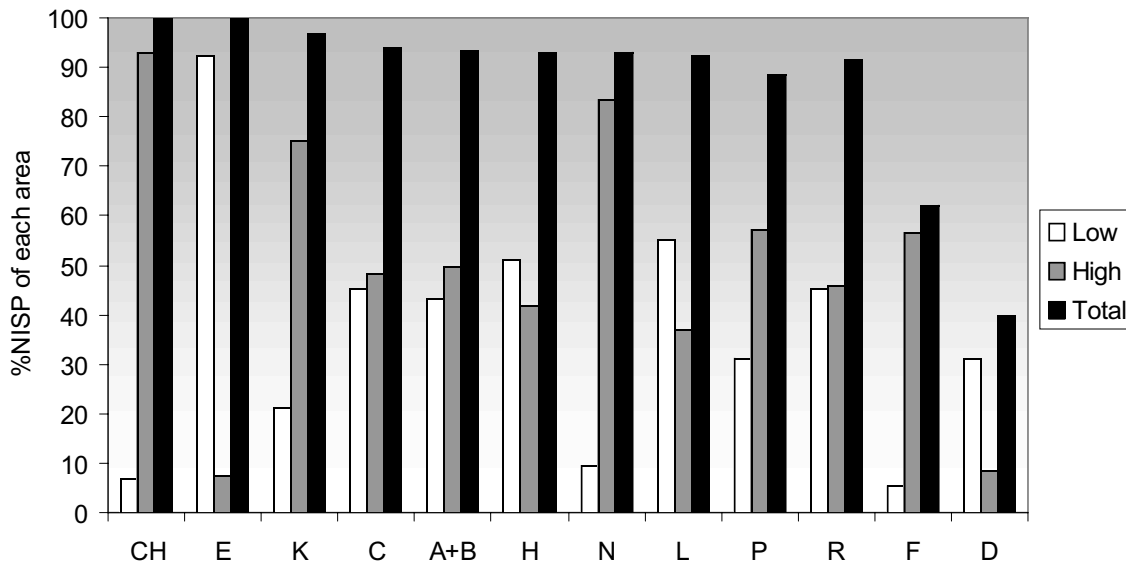
Areas	NISP total	Iron oxide			%NISP of iron oxide			%NR area total
		Low	High	Total	Low	High	Total	
K	12876	2674	9204	11878	20.77	71.48	92.25	27.24
E	13	11		11	84.62		84.62	0.03
A+B	27210	9920	12860	22780	36.46	47.26	83.72	51.85
H	74	34	24	58	45.95	32.43	78.38	0.13
C	334	161	54	215	48.20	16.17	64.37	0.49
L	1485	657	233	890	44.24	15.69	59.93	2.03
P	185	60	46	106	32.43	24.86	57.30	0.24
R	702	239	102	341	34.05	14.53	48.58	0.78
F	37	14		14	37.84		37.84	0.03
D	163	49	14	63	30.06	8.59	38.65	0.14
CH	87	14	1	15	16.09	1.15	17.24	0.03
N	768	35	9	44	4.56	1.17	5.73	0.10
TOTAL	43934	13868	22547	36415	31.57	51.32	82.89	82.89

Iron oxide



Areas	NISP total	Manganese oxide			%NISP of Manganese oxide			%NR area total
		Low	High	Total	Low	High	Total	
CH	87	6	81	87	6.90	93.10	100.00	0.20
E	13	12	1	13	92.31	7.69	100.00	0.03
K	12876	2764	9704	12468	21.47	75.37	96.83	28.38
C	334	152	162	314	45.51	48.50	94.01	0.71
A+B	27210	11821	13571	25392	43.44	49.88	93.32	57.80
H	74	38	31	69	51.35	41.89	93.24	0.16
N	768	74	641	715	9.64	83.46	93.10	1.63
L	1485	822	551	1373	55.35	37.10	92.46	3.13
P	185	58	106	164	31.35	57.30	88.65	0.37
R	702	320	323	643	45.48	46.01	91.60	1.46
F	37	2	21	23	5.41	56.76	62.16	0.05
D	163	51	14	65	31.29	8.59	39.88	0.15
TOTAL	43934	16120	25206	41326	36.69	57.37	94.06	94.06

Manganese oxide



APPENDIX IV
Skeletal parts representation
(mammoth excepted).

Horse

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Cranium	2	2	257	259	1	1	2	2	2	2
Mandible	1	2		2	1	1		2	1	1
Thoracic vertebrae			1	1			6	1	1	1
Lumbar vertebrae			6	6			6	5	2	2
Ribs			3	3			1	1	1	1
Radius-Ulna	2			2	2			2	2	2
Scaphoid		1		1		1		1	1	1
Pyramidal		1		1		1		1	1	1
Metacarpal III	1			1	1			1	1	1
Metacarpal IV	1			1	1			1	1	1
Phalanxes I ant.	2	1		3	2	1		3	2	2
Phalanxes II ant.	2	1	1	4	2	1	1	3	2	2
Phalanxes III ant.			2	2			2	2	1	1
Pelvis			1	1			1	1	1	1
Femur	4	4		8	2	2		4	2	2
Tibia	1	1		2	1	1		2	1	1
Calcaneum	2			2	2			2	2	2
Talus	1			1	1			1	1	1
Large Cuneiform	1			1	1			1	1	1
Naviculare	1			1	1			1	1	1
Phalanx III			1	1			1	1	1	1
Metapodials			3	3			1	1	1	1
Long bone undef.			1	1			1	1	1	1
Total	21	13	276	307	18	9	22	40	2	2

Reindeer

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Antlers	1		11	12	1		2	3	2	2
Cranium	2	2	32	35	1	1	1	1	1	1
Ribs	1		3	4	1		3	3	1	1
Humerus		2		2		1		1	1	1
Calcaneum		1		1		1		1	1	1
Phalanx I			1	1			1	1	1	1
Phalanx III			1	1			1	1	1	1
Long bone undef.			1	1			1	1	1	1
Bone undef.			1	1			1	1	1	1
Total	4	5	50	58	3	3	10	13	2	2

cf. Red deer

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Antler			1	1			1	1	1	1
Total			1	1			1	1	1	1

Rhino

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Humerus	1			1	1			1	1	1
Radius	1			1	1			1	1	1
Ulna	1			1	1			1	1	1
Total	3			3	1			3	1	1

Hare

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Scapula	1			1	1			1	1	1
Total	1			1	1			1	1	1

Wolf

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Cranium	3	3	24	30	1	1	1	3	2	3
Maxillary	1	1	3	4	1	1	1	3	1	2
Upper teeth	3			3	1			1	1	1
Lower teeth	2	5		7	1			1	1	1
Mandible	1	1	9	11	1	1	1	2	3	3
Atlas			1	1			1	1	1	1
Axis			1	1			1	1	1	1
Cervical vertebrae			4	4			8	8	1	2
Thoracic vertebrae			2	2			4	4	1	1
Vertebrae undef.			15	15			3	3	1	1
Ribs			3	3			2	2	1	1
Scapula		1		1		1		1	1	1
Humerus		1		1		1		1	1	1
Ulna	1			1	1			1	1	1
Tibia		2		2		2		2	2	2
Phalanx I			1	1			1	1	1	1
Total	10	14	63	89	6	7	23	35	3	3

Horse

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Humerus	2			2	2			2	2	2
Total	2			2	2			2	2	2

Reindeer

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Antlers			2	2			1	1	1	1
Humerus		1		1		1		1	1	1
Tibia		1		1		1		1	1	1
Long bone undef.			1	1			1	1	1	1
Total		2	3	5		2	2	4	1	1

Horse

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Patella		1		1		1		1	1	1
Total		1		1		1		1	1	1

Horse

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Ribs			11	11			2	2	1	1
Total			11	11			2	2	1	1

Reindeer

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Vertebrae undef.			2	2			2	2	1	1
Radius	1			1	1			1	1	1
Long bone undef.			1	1			1	1	1	1
Total	1		3	4	1		3	4	1	1

Horse		NISP				MNE				NMIf	NMIC
	Skeletal part	R	L	A	Total	R	L	A	Total		
	Mandible	1			1	1			1	1	1
	Total	1			1	1			1	1	1
Horse		NISP				MNE				NMIf	NMIC
	Skeletal part	R	L	A	Total	R	L	A	Total		
	Axis			5	5			1	1	1	1
	Ribs			10	10			1	1	1	1
	Humerus	1			1	1			1	1	1
	Radius		4		4		2		2	2	2
	Ulna	1			1	1			1	1	1
	Metacarpal II			1	1			1	1	1	1
	Femur	1			1	1			1	1	1
	Tibia	1			1	1			1	1	1
	Talus		1		1		1		1	1	1
	Phalanxes III			2	2			2	2	1	1
	Long bone undef.			2	2			1	1	1	1
	Total	4	5	20	29	4	3	6	13	2	2
Reindeer		NISP				MNE				NMIf	NMIC
	Skeletal part	R	L	A	Total	R	L	A	Total		
	Antlers			48	48			2	2	1	1
	Ribs	1		1	2	1			1	1	1
	Metatarsal			1	1			1	1	1	1
	Femur		1		1		1		1	1	1
	Long bone undef.				1				1	1	1
Total	1	1	50	53	1	1	3	6	1	1	
Elk		NISP				MNE				NMIf	NMIC
	Skeletal part	R	L	A	Total	R	L	A	Total		
	Lower teeth		1		1		1		1	1	1
	Humerus		1		1		1		1	1	1
	<i>cf.</i> thoracic vertebrae				1				1	1	1
	<i>cf.</i> long bone undef.				1				1	1	1
Total		2		4		2		4	1	1	
Wolf		NISP				MNE				NMIf	NMIC
	Skeletal part	R	L	A	Total	R	L	A	Total		
	Mandible	2			2	1			1	1	1
	Scapula	6			6	1			1	1	1
	Thoracic vertebrae			1	1			1	1	1	1
	Lombar vertebrae			3	3			3	3	1	1
	Sacrum			1	1			1	1	1	1
	Ribs		2	2	4		2	1	3	1	1
	Pelvis	1	4		5	1	1		2	1	1
Tibia		1		1		1		1	1	1	
Total	9	7	7	23	3	4	6	13	1	2	
Lion		NISP				MNE				NMIf	NMIC
	Skeletal part	R	L	A	Total	R	L	A	Total		
	<i>cf.</i> rib			1	1			1	1	1	1
	Sacrum	1			1				1	1	1
	Metatarsal II	1			1	1			1	1	1
	Phalanx I	1			1	1			1	1	1
	Phalanx II	1			1	1			1	1	1
	Phalanx III	1			1	1			1	1	1
Total	5		1	6	4		1	6	1	1	

Fox

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Humerus	1			1	1			1	1	1
Total	1			1	1			1	1	1

Lion

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Rib			1	1			1	1	1	1
Metacarpals		1	1	2		1	1	2	1	1
Talus		1		1		1		1	1	1
Calcaneum		1		1		1		1	1	1
Metatarsal IV		1		1		1		1	1	1
Total		4	2	6		4	2	6	1	1

Undefined

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Ribs	1		3	4	1		3	4	1	1
Undef.			1	1			1	1	1	1
Total	1		4	5	1		4	5	1	1

Horse

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Rib			1	1			1	1	1	1
Total			1	1			1	1	1	1

Horse

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Scapula	1		1	2	1		1	2	1	1
<i>cf.</i> femur			1	1			1	1	1	1
Total	1		2	3	1		2	3	1	1

Reindeer

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
<i>cf.</i> femur			1	1			1	1	1	1
Total			1	1			1	1	1	1

Undefinedet

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Vertebra undef.				1				1	1	1
Total				1				1	1	1

Horse

Partie du squelette	NR				NMPS				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Lower teeth	5			5	5			5	1	1
Mandible	2	2		4	1	1		2	1	1
Ribs			2	2			2	2	1	1
Humerus	1	1	1	3	1	1	1	2	1	1
Radius	1			1	1			1	1	1
Femur	2	2		4	2	1		3	2	2
Tibia	1	2	1	4	1	1	1	2	1	1
Metapodials	1		1	2	1		1	2	1	1
Long bone			5	5			1	1	1	1
Flat bone			1	1			1	1	1	1
Total	13	7	11	31	12	4	7	21	2	2

Reindeer

Partie du squelette	NR				NMPS				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Antlers			3	3			1	1	1	1
Lower teeth		6		6		6		6	1	1
Mandible	1			1	1			1	1	1
Metatarsal	1	1	5	7	1	1	1	2	1	1
Ribs			57	57				4	1	1
Radius	1		1	2	1		1	1	1	1
Lunatum	1			1	1			1	1	1
Metacarpal	2	2	4	8	2	1	1	3	2	2
Femur			1	1			1	1	1	1
Tibia		1	1	2		1	1	1	1	1
Patella	1			1	1			1	1	1
Metapodials			5	5			1	1	1	1
Bone undef.			8	8			6	6	1	1
Total	7	10	85	102	7	9	13	29	2	2

Wolf

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Humerus	1			1	1			1	1	1
Radius		1		1		1		1	1	1
Total	1	1		2	1	1		2	1	1

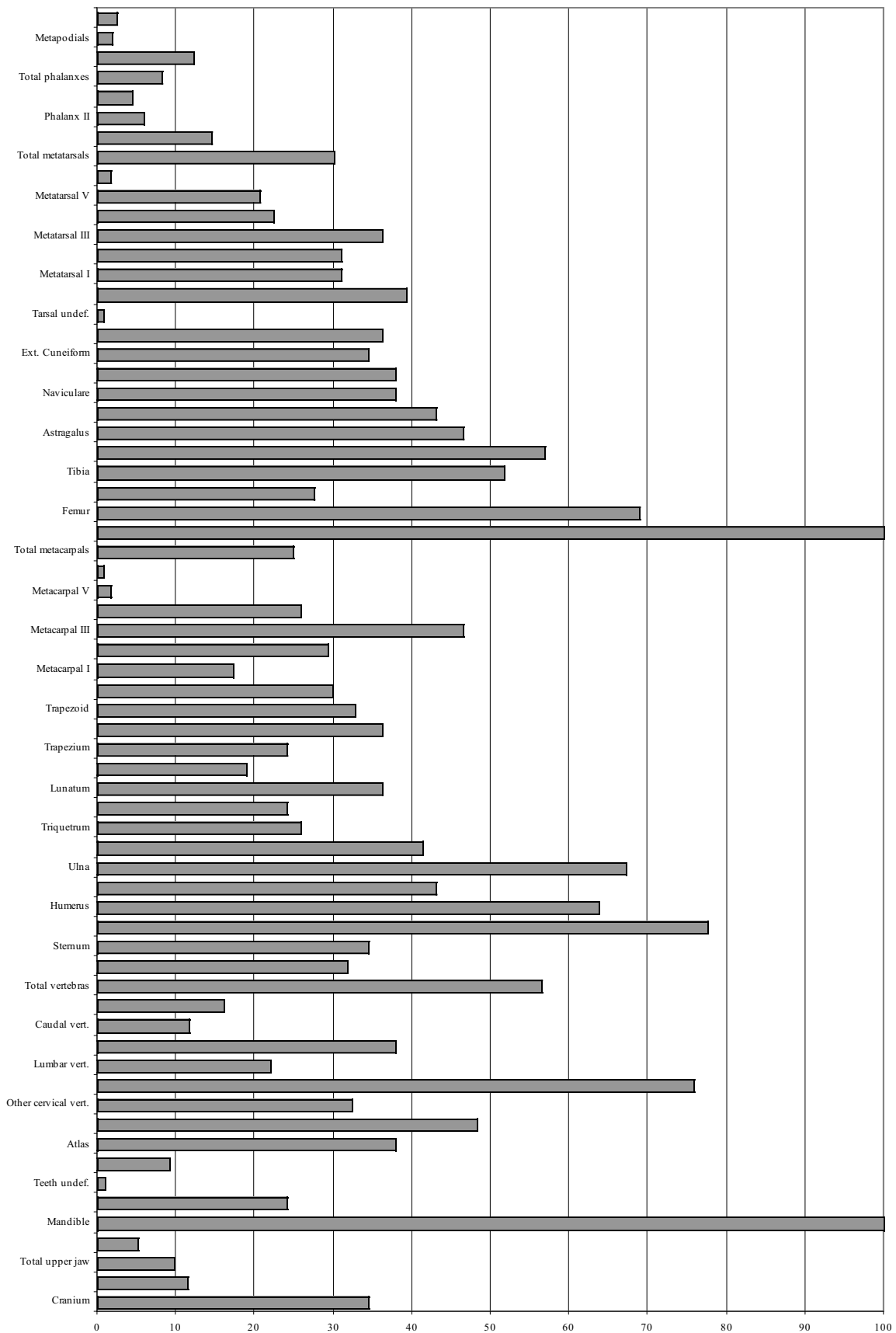
Hare/Fox

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Tibia	1			1	1			1	1	1
Total	1			1	1			1	1	1

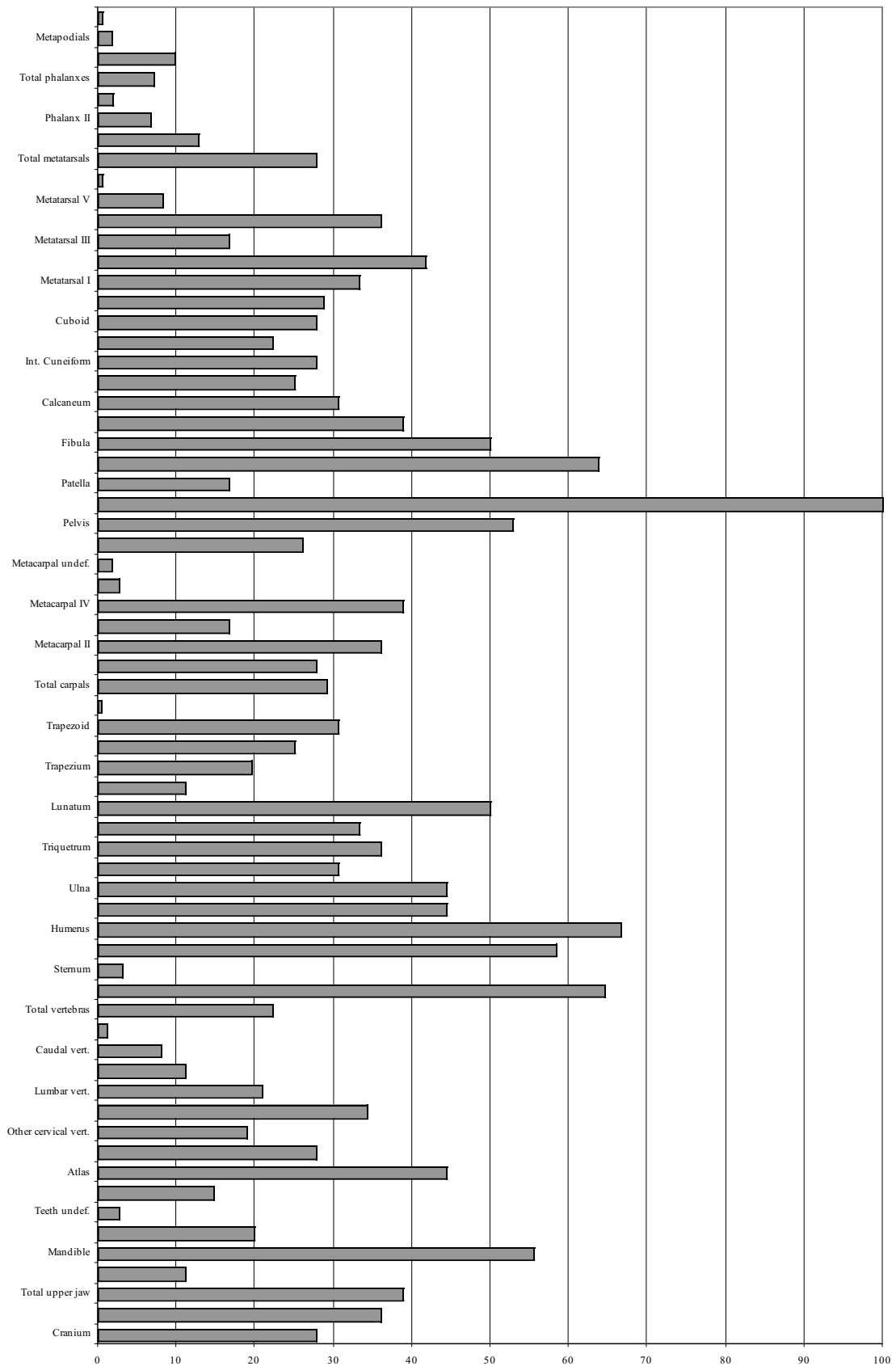
Undefined

Skeletal part	NISP				MNE				NMIf	NMIC
	R	L	A	Total	R	L	A	Total		
Teeth			2	2			1	1	1	1
Vertebra undef.			1	1			1	1	1	1
Small bone			1	1			1	1	1	1
Long bone			1	1			1	1	1	1
Flat bone			2	2			1	1	1	1
Bone undef.			22	22			11	11	1	1
Total			29	29			16	16	1	1

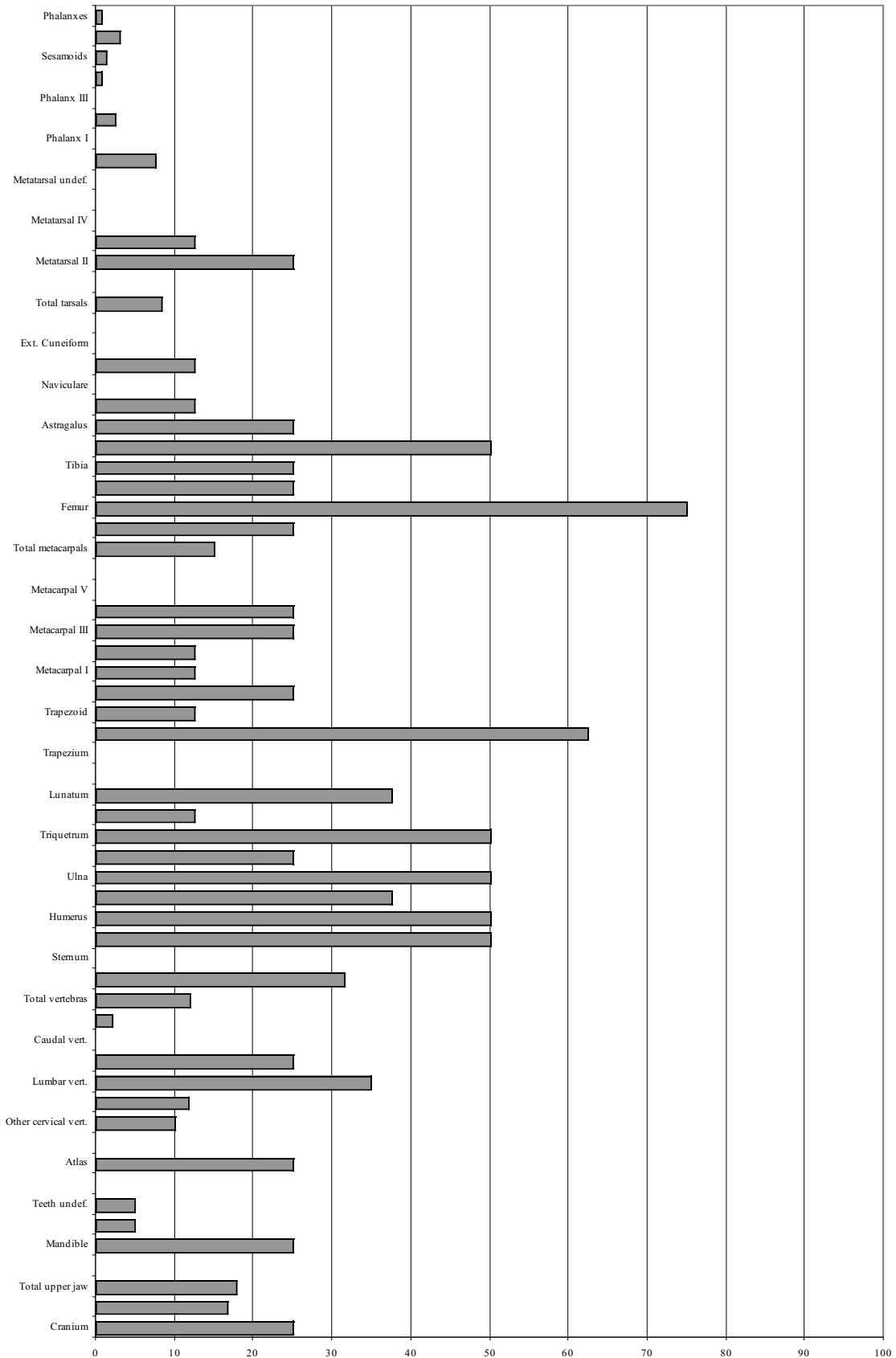
%Observed elements. Milovice area A+B (MNE=2267)



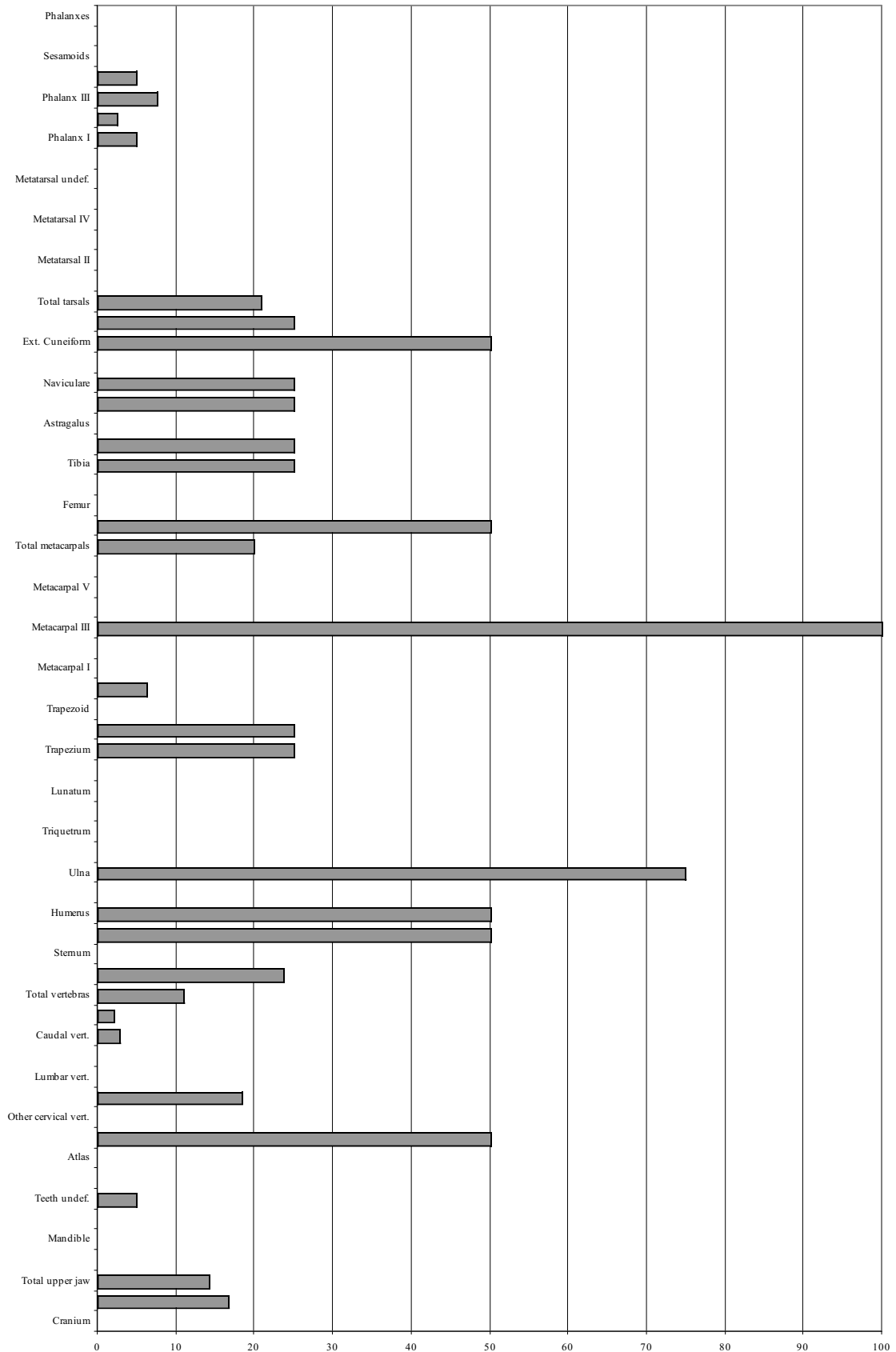
%Observed elements. Milovice Area K (MNE=1054)



%Observed elements. Milovice Area L (MNE=150)



%Observed elements. Milovice Area R (MNE=63)



APPENDIX VI Tables of the mammoth skeletal parts representation.

AREA A+B Skeletal part	NISP				MNE				MNIf	MNIc	IS	% OE
	R	L	A	Total	R	L	A	Total				
Cranium	6	13	2829	2907	10	8		10	6	9	1	34.5
Upper teeth	7	9	2720	2736	6	8	6	20	3	9	6	11.5
Total upper jaw	13	22	5549	5643	16	16	6	20	6	9	7	9.9
Lower teeth	7	9	7	23	5	6		6	6	8	4	5.2
Mandible	27	28	1548	1589	15	16	1	29	16	17	1	100
Total lower jaw	34	37	1555	1612	20	22	1	35	16	17	5	24.1
Teeth undef.			2129	2129				3	3		10	1
Hyoid	5	6	12	23	4	4	2	8	4	5	3	9.2
Atlas			12	12			11	11	11	11	1	37.9
Axis			20	20			14	14	14	14	1	48.3
Other cervical vertebrae			218	218			47	47	10	11	5	32.4
Thoracic vertebrae			2333	2333			418	418	11	11	19	75.9
Lumbar vertebrae			98	98			32	32	7	8	5	22.1
Sacrum			106	106			11	11	11	11	1	37.9
Caudal vertebrae			104	104			61	61	4	4	18	11.7
Vertebrae undef.			2596	2596			225	225			48	16.2
Total vertebrae			5487	5487			819	819			50	56.5
Ribs	300	284	3178	3762	160	147	57	351	19	21	38	31.9
Sternum			38	38			10	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
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
Total carpals	65	76	1	142	62	74	1	139	12	16	16	30
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
Metacarpal undef.			2	2			2	2	1	1	10	0.7
Total metacarpals	35	39	2	76	34	36	2	72	14	14	10	24.8
Pelvis	267	310	336	913	29	29	2	58	29	30	2	100
Femur	45	53	270	368	18	19	10	40	19	28	2	69
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
Int. Cuneiform	10	11	1	22	10	11	1	22	11	14	2	37.9
Ext. 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
Tarsal undef.			3	3			3	3	1	1	12	0.9
Total tarsals	76	63	8	147	72	61	4	137	16	17	12	39.4
Metatarsal I	10	9		19	9	9		18	9	9	2	31
Metatarsal II	10	8		18	10	8		18	10	10	2	31
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
Metatarsal undef.	1	1	5	7	1	1	3	5	1	1	10	1.7
Total metatarsals	43	43	5	91	41	43	3	87	12	12	10	30
Phalanges I	30	17	49	96	28	16	38	85	2	2	20	14.7
Phalanges II	1	2	31	34	1	2	31	34	2	2	20	5.9
Phalanges III			25	25			25	25	5	5	20	4.3
Total phalanges	31	19	105	155	29	18	94	144	5	5	60	8.3
Sesamoids			71	71			71	71	4	4	20	12.2
Metapodials			46	46			23	23	2	2	40	2
Phalanges			46	46			44	44	1	1	60	2.5
Total	1329	1203	19963	22540	590	578	1174	2267	29	30		

Skeletal part	NISP				MNE				MNIf	MN1c	IS	%OE
	R	L	A	Total	R	L	A	Total				
Cranium				14				1	1	1	1	33.3
Upper teeth	1	1	29	31	1	1	2	3	1	1	6	16.7
Total upper jaw	1	1	29	45	1	1	2	4	1	1	7	19
Lower teeth											4	
Mandible	1	1	21	22	1	1		2	2	2	1	66.7
Total lower jaw	1	1	21	22	1	1		2	2	2	5	13.3
Teeth undef.			59	59				1			10	3.3
Hyoid											3	
Atlas											1	
Axis			1	1		1		1	1	1	1	33.3
Other cervical vert.			6	6		2		2	1	1	5	13.3
Thoracic vert.			2	2		2		2	1	1	19	3.5
Lumbar vert.			10	10		4		4	1	1	5	26.7
Sacrum			1	1		1		1	1	1	1	33.3
Caudal vert.											18	
Vertebra undef.			1	1		1		1	1	1	48	0.7
Total vertebras			21	21		11		11			50	7.3
Ribs	3	5	51	59	3	4	9	14	1	1	38	12.3
Sternum											1	
Scapula	3		3	6	2		1	2	2	2	2	33.3
Humerus		3		3		3		3	3	3	2	50
Radius		1		1		1		1	1	1	2	16.7
Ulna	1	2	1	4	1	2	1	3	2		2	50
Magnum											2	
Triquetrum	1	1		2	1	1		2	1	1	2	33.3
Scaphoid											2	
Lunatum											2	
Pisiform											2	
Trapezium		1		1		1		1	1	1	2	16.7
Cuneiform	1	1		2	1	1		2	1	1	2	33.3
Trapezoid											2	
Total carpals	2	3		5	2	3		5			16	10.4
Metacarpal I											2	
Metacarpal II											2	
Metacarpal III	1			1	1			1			2	16.7
Metacarpal IV	1			1	1			1	1	1	2	16.7
Metacarpal V											2	
Metacarpal undef.											10	
Total metacarpals	2			2	2			2	1	1	10	6.7
Pelvis	1			1	1			1	1	1	2	16.7
Femur	2	2	1	5	2	1	1	3	2	2	2	50
Patella	2			2	2			2	2	2	2	33.3
Tibia		1		1		1		1	1	1	2	16.7
Fibula											2	
Astragalus											2	
Calcaneum	2			2	2			2	2		2	33.3
Naviculare		1		1		1		1	1		2	16.7
Int. Cuneiform											2	
Ext. Cuneiform											2	
Cuboid											2	
Total tarsals	2	1		3	2	1		3			12	8.3
Metatarsal I											2	
Metatarsal II											2	
Metatarsal III	1			1	1			1	1	1	2	16.7
Metatarsal IV											2	
Metatarsal V											2	
Metatarsal undef.											10	
Total metatarsal	1			1	1			1			10	3.3
Phalanx I											20	
Phalanx II			1	1		1		1			20	
Phalanx III											20	
Total phalanxes			1	1		1		1			60	0.6
Sesamoid											20	
Metapodials			3	3		3		3			40	2.5
Phalanxes			2	2		2		2			60	1.1
Total	21	20	192	246	20	35	14	64	3	3		

Skeletal part	NISP				MNE				MNIf	MNIc	IS	%OE
	R	L	A	Total	R	L	A	Total				
Cranium		1		1		1		1	1	1	1	100.0
Upper teeth											6	
Total upper jaw		1		1		1		1			5	20.0
Lower teeth											4	
Mandible											1	
Total lower jaw											5	
Teeth undef.											10	
Hyoid											3	
Atlas											1	
Axis											1	
Other cervical vert.			1	1			1	1	1	1	5	20
Thoracic vert.			1	1			1	1	1	1	19	5.3
Lumbar vert.											5	
Sacrum											1	
Caudal vert.											18	
Vertebra undef.			4	4			1	1	1	1	48	2.1
Total vertebrae			6	6			3	3			50	6
Ribs	2	3	23	28	2	3	6	11	1	1	38	28.9
Sternum											1	
Scapula											2	
Humerus		1		1		1		1	1	1	2	50
Radius											2	
Ulna											2	
Magnum											2	
Triquetrum											2	
Scaphoid											2	
Lunatum											2	
Pisiform											2	
Trapezium											2	
Cuneiform	1			1	1			1	1	1	2	50
Trapezoid											2	
Total carpal	1			1	1			1			16	6.3
Metacarpal I											2	
Metacarpal II											2	
Metacarpal III											2	
Metacarpal IV		1		1		1		1	1	1	2	50
Metacarpal V											2	
Metacarpal undef.											10	
Total metacarpal		1		1		1		1	1	1	10	10
Pelvis											2	
Femur											2	
Patella											2	
Tibia											2	
Fibula											2	
Astragalus											2	
Calcaneum											2	
Naviculare											2	
Int. Cuneiform		1		1		1		1	1	1	2	50
Ext. Cuneiform		1		1		1		1	1	1	2	50
Cuboid											2	
Total tarsals		2		2		2		2	1	1	12	16.7
Metatarsal I											2	
Metatarsal II											2	
Metatarsal III											2	
Metatarsal IV											2	
Metatarsal V											2	
Metatarsal undef											10	
Total metatarsal											10	
Phalanx I		1		1		1		1	1	1	20	5
Phalanx II			1	1			1	1	1	1	20	5
Phalanx III											20	
Total phalanges		1	1	2		1	1	2			60	3.3
Sesamoids			3	3			3	3	1	1	20	15
Metapodials											40	
Phalanges											60	
Total	3	9	33	45	3	8	13	14	1	2		

Skeletal part	NISP				MNE				MNIf	MNIc	IS	%OE	
	R	L	A	Total	R	L	A	Total					
Cranium												1	
Upper teeth	1		2149	2150	1		1	2	1	1		6	16.7
Total upper jaw	1		2149	2150	1		1	2				7	
Lower teeth												4	
Mandible		1	32	33		1	2	2	2	2		1	100
Total lower jaw		1	32	33		1	2	2				5	20
Teeth undef.			16	16								10	
Hyoid												3	
Atlas												1	
Axis												1	
Other cervical vert.												5	
Thoracic vert.												19	
Lumbar vert.												5	
Sacrum												1	
Caudal vert.												18	
Vertebra undef.												48	
Total vertebrae												50	
Ribs			3	3			2	2	1	1		38	2.6
Sternum												1	
Scapula	4	1	7	12	2	1	1	4	2	3		2	100
Humerus	1			1	1			1	1	1		2	25
Radius		3		3		2		2	2	2		2	50
Ulna		2	5	7		2	2	4	2	3		2	100
Magnum												2	
Triquetrum												2	
Scaphoid												2	
Lunatum												2	
Pisiform												2	
Trapezium												2	
Cuneiform												2	
Trapezoid												2	
Total carpals												16	
Metacarpal I												2	
Metacarpal II												2	
Metacarpal III												2	
Metacarpal IV												2	
Metacarpal V												2	
Metacarpal undef.												10	
Total metacarpals												10	
Pelvis												2	
Femur												2	
Patella												2	
Tibia												2	
Fibula												2	
Astragalus												2	
Calcaneum	1			1	1			1	1	1		2	25
Naviculare												2	
Int. Cuneiform												2	
Ext. Cuneiform												2	
Cuboid												2	
Total tarsals	1			1	1			1				12	4.2

Metatarsal I												2
Metatarsal II												2
Metatarsal III												2
Metatarsal IV												2
Metatarsal V												2
Metatarsal undef.												10
Total metatarsals												10
Phalanx I												20
Phalanx II												20
Phalanx III												20
Total phalanxes												60
Sesamoids												20
Metapodials												40
Phalanxes												60
Total	7	7	2212	2226	5	6	8	18	2	3		

Skeletal part	NISP				MNE				MNif	MNIc	IS	%OE
	R	L	A	Total	R	L	A	Total				
Cranium											1	
Upper teeth			85	85			1	1	1	1	6	16.7
Total upper jaw			85	85			1	1			7	14.3
Lower teeth											4	
Mandible											1	
Total lower jaw											5	
Teeth undef.											10	
Hyoid											3	
Atlas											1	
Axis											1	
Other cervical vert.											5	
Thoracic vert.			3	3			2	2	1	1	19	10.5
Lumbar vert.											5	
Sacrum											1	
Caudal vert.											18	
Vertebra undef.											48	
Total vertebrae			3	3			2	2			50	4
Rib											38	
Sternum											1	
Scapula											2	
Humerus											2	
Radius											2	
Ulna											2	
Magnum											2	
Triquetrum											2	
Scaphoid											2	
Lunatum											2	
Pisiform											2	
Trapezium											2	
Cuneiform											2	
Trapezoid											2	
Total carpals											16	
Metacarpal I											2	
Metacarpal II											2	
Metacarpal III											2	
Metacarpal IV											2	
Metacarpal V											2	
Metacarpal und.											10	
Total metacarpals											10	
Pelvis	3			3	1			1	1	1	2	50
Femur											2	
Patella											2	
Tibia											2	
Fibula											2	
Astragalus											2	
Calcaneum											2	
Naviculare											2	
Int. Cuneiform											2	
Ext. Cuneiform											2	
Cuboid											2	
Total tarsals											12	

Metatarsal I										2
Metatarsal II										2
Metatarsal III										2
Metatarsal IV										2
Metatarsal V										2
Metatarsal undef.										10
Total metatarsals										10
Phalanx I										20
Phalanx II										20
Phalanx III										20
Total phalanxes										60
Sesamoids										20
Metapodials										40
Phalanxes										60
Total	3		88	91	1		3	4	1	1

Skeletal part	NISP				MNE				MNIf	MNIc	IS	%OE
	R	L	A	Total	R	L	A	Total				
Cranium											1	
Upper teeth			5933	5933			2	2	1	2	6	11.1
Total upper jaw			5933	5933			2	2	1	2	7	9.5
Lower teeth											4	
Mandible											1	
Total lower jaw											5	
Teeth undef.											1	
Hyoid											3	
Atlas											1	
Axis											1	
Other cervical vert.											5	
Thoracic vert.											19	
Lumbar vert.											5	
Sacrum											1	
Caudal vert.											18	
Vertebra undef.												
Total vertebrae												
Ribs			18	18			6	6	1	1	38	5.3
Sternum											1	
Scapula		1		1		1		1	1	1	2	16.7
Humerus	2			2	2			2	2	2	2	33.3
Radius											2	
Ulna											2	
Magnum	1			1	1			1	1	1	2	16.7
Triquetrum											2	
Scaphoid											2	
Lunatum	1			1	1			1	1	1	2	16.7
Pisiform											2	
Trapezium											2	
Cuneiform											2	
Trapezoid											2	
Total carpals	2			2	2			2			16	4.2
Metacarpal I											2	
Metacarpal II											2	
Metacarpal III											2	
Metacarpal IV											2	
Metacarpal V											2	
Metacarpal undef.												
Total metacarpals											10	
Pelvis			1	1			1	1	1	1	2	16.7
Femur											2	
Patella											2	
Tibia	4			4	3			3	3	3	2	50
Fibula											2	
Astragalus											2	
Calcaneum											2	
Naviculare											2	
Int. Cuneiform											2	
Ext. Cuneiform											2	
Cuboid											2	
Total tarsals											12	

Metatarsal I												2
Metatarsal II												2
Metatarsal III												2
Metatarsal IV												2
Metatarsal V												2
Metatarsal undef.												
Total metatarsals												10
Phalanx I												20
Phalanx II												20
Phalanx III												20
Total phalanges												60
Sesamoids												20
Metapodials												40
Phalanges												60
Total	8	1	5952	5961	7	1	9	17	3	3		

Skeletal part	NISP				MNE				MNIf	MNIc	IS	%OE
	R	L	A	Total	R	L	A	Total				
Cranium											1	
Upper teeth			2	2			2	2	1	1	6	16.7
Total upper jaw			2	2			2	2	1		7	14.3
Lower teeth	1			1	1			1	1	1	4	12.5
Mandible											1	
Total lower jaw	1			1	1			1			5	10
Teeth undef.											3	
Hyoid											3	
Atlas											1	
Axis											1	
Other cervical vert.											5	
Thoracic vert.			2	2			2	2	1	1	19	5.3
Lumbar vert.											5	
Sacrum											1	
Caudal vert.											18	
Vertebra undef.			1	1			1	1	1	1	48	1
Total vertebrae			3	3			3	3			50	3
Ribs	3		22	25	3		10	9	1	1	38	11.8
Sternum											1	
Scapula	2	1		3	1	1		2	1	1	2	50
Humerus	3	2		5	2	1		3	2	2	2	75
Radius		1		1		1		1	1	1	2	25
Ulna		1	4	5		1	1	2	1	1	2	50
Magnum											2	
Triquetrum											2	
Scaphoid											2	
Lunatum											2	
Pisiform											2	
Trapezium	1			1	1			1	1	1	2	25
Cuneiform											2	
Trapezoid	1			1	1			1	1	1	2	25
Total carpals	2			2	2			2			16	6.3
Metacarpal I											2	
Metacarpal II											2	
Metacarpal III											2	
Metacarpal IV											2	
Metacarpal V											2	
Metacarpal undef.											10	
Total metacarpals											10	
Pelvis	1		1	2	1		1	1	1	1	2	25
Femur	1	1		2	1	1		2	1	1	2	50
Patella											2	
Tibia	1	1		2	1	1		2	1	1	2	50
Fibula	1			1	1			1	1	1	2	25
Astragalus											2	
Calcaneum											2	
Naviculare											2	
Int. Cuneiform											2	
Ext. Cuneiform											2	
Cuboid											2	
Total tarsals											12	

Metatarsal I												2
Metatarsal II												2
Metatarsal III												2
Metatarsal IV												2
Metatarsal V												2
Metatarsal un.												10
Total metatarsals												10
Phalanx I												20
Phalanx II												20
Phalanx III												20
Total phalanges												60
Sesamoids												20
Metapodials												40
Phalanges												60
Total	15	7	32	54	13	6	17	31	2	2		

Skeletal part	NISP				MNE				MNIF	MNIc	IS	%OE
	R	L	A	Total	R	L	A	Total				
Cranium	7	10	1675	1695	5	5		5	3	7	1	27.8
Upper teeth	26	29	975	1030	18	20	1	39	16	32	6	36.1
Total upper jaw	33	39	2650	2725	23	25	1	49	7		7	38.9
Lower teeth	6	8	3	17	4	4		8	3	3	4	11.1
Mandible	3	4	280	287	3	4	3	10	3	4	1	55.6
Total lower jaw	9	12	283	304	7	8	3	18	9	11	5	20
Teeth undef.			1855	1855			5	5	1	2	10	2.8
Hyoid			10	10			8	8	3	3	3	14.8
Atlas			11	11			8	8	8	8	1	44.4
Axis			9	9			5	5	5	6	1	27.8
Other cervical vert.			30	30			17	17	4	6	5	18.9
Thoracic vert.			331	331			117	117	9	9	19	34.2
Lumbar vert.			25	25			15	15	4	5	4	20.8
Sacrum			3	3			2	2	2	2	1	11.1
Caudal vert.			36	36			26	26	2	4	18	8
Vertebra undef.			300	300			10	10			48	1.2
Total vertebrae			745	745			200	200			50	22.2
Ribs	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	1	12	9	9	2	33.3
Lunatum	9	9		18	9	9		18	9	10	2	50
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
Trapezoid	7	4		11	7	4		11	7	7	2	30.6
Carpal undef.			1	1			1	1	1	1	16	0.3
Total carpals	37	48	2	87	37	47	1	84	9	10	16	29.2
Metacarpal I	6	3	1	10	6	4	1	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
Metacarpal undef.	2	1		3	2	1		3	2	2	10	1.7
Total metacarpals	24	22	1	47	24	23	1	47	8	8	10	26.1
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
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
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
Int. Cuneiform	6	4		10	6	4		10	6	6	2	27.8
Ext. Cuneiform	3	5		8	3	5		8	5	4	2	22.2
Cuboid	5	5		10	5	5		10	5	5	2	27.8
Total tarsals	39	29	2	70	33	29	2	62	9	9	12	28.7

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
Metatarsal undef.			1	1			1	1	1	1	10	0.6
Total metatarsals	25	24	1	50	25	24	1	50	9	9	10	27.8
Phalanx I	1	4	42	47	1	4	41	46	3	3	20	12.8
Phalanx II			24	24			24	24	2	2	20	6.7
Phalanx III			7	7			7	7	1	1	20	1.9
Total phalanxes	1	4	73	78			77	77	3	3	60	7.1
Sesamoids			35	35			35	35	2	2	20	9.7
Metapodials			29	29			12	12	1	1	40	1.7
Phalanxes			10	10			7	7	1	1	60	0.6
Total	407	451	7384	8246	323	321	419	1054	18	32		

Skeletal part	NISP				MNE				MNif	MNIc	IS	%OE
	R	L	A	Total	R	L	A	Total				
Cranium			1	1			1	1	1	1	1	25
Upper teeth	2	1	1650	1653	2	1	2	4	1	2	6	16.7
Total upper jaw	2	1	1651	1654	2	1	3	5	1	2	7	17.9
Lower teeth											4	
Mandible	2		1		1		1	1	1	1	1	25
Total lower jaw	2		1		1		1	1	1	1	5	5
Teeth undef.			156	156			2	2	1	1	10	5
Hyoid											3	
Atlas			1	1			1	1	1	1	1	25
Axis											1	
Other cervical vert.			6	6			2	2	1	1	5	10
Thoracic vert.			26	26			9	9	1	2	19	11.8
Lumbar vert.			20	20			7	7	1	1	5	35
Sacrum			2	2			1	1	1	2	1	25
Caudal vert.											18	
Vertebra undef.			26	26			4	4	1	1	48	2.1
Total vertebrae			81	81			24	24	1	1	50	12
Ribs	16	15	124	155	8	7	33	48	2	2	38	31.6
Sternum											1	
Scapula	3	1		4	3	1		4	3	3	2	50
Humerus	3	2		5	2	2		4	2	3	2	50
Radius	2		1	3	2		1	3	2	2	2	37.5
Ulna	2	5		7	1	3		4	3	3	2	50
Magnum	1	1		2	1	1		2	1	1	2	25
Triquetrum	3	1		4	3	1		4	3	4	2	50
Scaphoid		1		1		1		1	1	1	2	12.5
Lunatum	3			3	3			3	3	3	2	37.5
Pisiform											2	
Trapezium											2	
Cuneiform	3	2		5	3	2		5	3	3	2	62.5
Trapezoid		1		1		1		1	1	1	2	12.5
Total carpals	10	6		16	10	6		16			16	25
Metacarpal I		1		1		1		1	1	1	2	12.5
Metacarpal II	1			1	1			1	1	1	2	12.5
Metacarpal III	1	1		2	1	1		2	1	1	2	25
Metacarpal IV	1	1		2	1	1		2	1	1	2	25
Metacarpal V											2	
Metacarpal undef.											10	
Total metacarpals	3	3		6	3	3		6	1	2	10	15.0
Pelvis	4	2	2	8	1	1	1	2	1	3	2	25
Femur	7	5	2	14	4	2	1	6	4	4	2	75
Patella		1	1	2		1	1	2	1	1	2	25
Tibia	2	3		5	1	1		2	1	3	2	25
Fibula	3	2		5	2	2		4	2	3	2	50
Astragalus	1	1		2	1	1		2	1	1	2	25
Calcaneum	1			1	1			1	1	1	2	12.5
Naviculare											2	
Int. Cuneiform		1		1		1		1	1	1	2	12.5
Ext. Cuneiform											2	
Cuboid											2	
Total tarsals	2	2		4	2	2		4	1	1	12	8.3

Metatarsal I												2	
Metatarsal II	1	1		2	1	1		2	1	2		2	25
Metatarsal III	1			1	1			1	1	1		2	12.5
Metatarsal IV												2	
Metatarsal V												2	
Metatarsal undef.												10	
Total metatarsals	2	1		3	2	1		3				10	7.5
Phalanx I												20	
Phalanx II			2	2			2	2	1	1		20	2.5
Phalanx III												20	
Total phalanxes			2	2			2	2	1	1		60	0.8
Sesamoids				1				1	1	1		20	1.3
Metapodials			7	7			5	5	1	1		40	3.1
Phalanxes			2	2			2	2	1	1		60	0.8
Total	63	49	2030	2140	44	33	74	150	4	4			

Skeletal part	NISP				MNE				MNif	MNic	IS	%OE
	R	L	A	Total	R	L	A	Total				
Cranium			1	1			1	1	1	1	1	50
Upper teeth											6	
Total upper jaw			1	1			1	1			7	
Lower teeth		2		2		1		1	1	1	4	12.5
Mandible	1	3	124	127	1	1	1	2	2	2	1	100
Total lower jaw	1	5	124	129	1	2	1	3			5	30
Teeth undef.											10	
Hyoid											3	
Atlas											1	
Axis			1	1			1	1	1	1	1	50
Other cervical vert.											5	
Thoracic vert.			4	4			2	2	1	1	19	5.3
Lumbar vert.											5	
Sacrum											1	
Caudal vert.											18	
Vertebra undef.			23	23			1	1	1	1	48	1
Total vertebrae			28	28			4	4	1	1	50	4
Ribs	8	5	202	215	6	4	4	14	1	1	38	18.4
Sternum											1	
Scapula	2		11	13	2			2	2	2	2	50
Humerus											2	
Radius			1	1			1	1	1	1	2	25
Ulna											2	
Magnum											2	
Triquetrum											2	
Scaphoid											2	
Lunatum											2	
Pisiform	1			1	1			1	1	1	2	25
Trapezium											2	
Cuneiform											2	
Trapezoid											2	
Total carpals	1			1	1			1	1	1	16	3.1
Metacarpal I											2	
Metacarpal II											2	
Metacarpal III	1			1	1			1	1	1	2	25
Metacarpal IV		1		1		1		1	1	1	2	25
Metacarpal V											2	
Metacarpal undef.											10	
Total metacarpals	1	1		2	1	1		2	1	1	10	10
Pelvis											2	
Femur		1		1		1		1	1	1	2	25
Patella	1			1	1			1	1	1	2	25
Tibia	1			1	1			1	1	1	2	25
Fibula	1			1	1			1	1	1	2	25
Astragalus		1		1		1		1	1	1	2	25
Calcaneum											2	
Naviculare											2	
Int. Cuneiform											2	
Ext. Cuneiform											2	
Cuboid											2	
Total tarsals		1		1		1		1			12	4.2

Metatarsal I												2	
Metatarsal II												2	
Metatarsal III												2	
Metatarsal IV												2	
Metatarsal V												2	
Metatarsal undef.												10	
Total metatarsals												10	
Phalanx I			1	1			1	1	1	1	1	20	2.5
Phalanx II												20	
Phalanx III												20	
Total phalanxes			1	1			1	1	1	1	1	60	0.8
Sesamoids												20	
Metapodials			1	1			1	1	1	1	1	40	1.3
Phalanxes												60	
Total	16	13	369	397	14	9	13	35	2	2			

Skeletal part	NISP				MNE				MNIf	MNIc	IS	%OE
	R	L	A	Total	R	L	A	Total				
Cranium											1	
Upper teeth											6	
Total upper jaw											7	
Lower teeth											4	
Mandible											1	
Total lower jaw											5	
Teeth undef.											10	
Hyoid											3	
Atlas											1	
Axis											1	
Other cervical vert.											5	
Thoracic vert.											19	
Lumbar vert.											5	
Sacrum											1	
Caudal vert.											18	
Vertebra undef.											48	
Total vertebrae											50	
Ribs			39	39			5	5	1	1	38	13.2
Sternum											1	
Scapula											2	
Humerus	3	2	1	6	1	1		2	1	1	2	100
Radius											2	
Ulna		1	1	2		1		1	1	1	2	50
Magnum											2	
Triquetrum											2	
Scaphoid											2	
Lunatum											2	
Pisiform											2	
Trapezium											2	
Cuneiform											2	
Trapezoid											2	
Total carpals											16	
Metacarpal I											2	
Metacarpal II											2	
Metacarpal III											2	
Metacarpal IV											2	
Metacarpal V											2	
Metacarpal undef.											10	
Total metacarpals											10	
Pelvis											2	
Femur		1		1		1		1	1	1	2	50
Patella											2	
Tibia	1			1	1			1	1	1	2	50
Fibula		1		1		1		1	1	1	2	50
Astragalus		1		1		1		1	1	1	2	50
Calcaneum		14		14		1		1	1	1	2	50
Naviculare											2	
Int. Cuneiform											2	
Ext. Cuneiform											2	
Cuboid											2	
Total tarsals		15		15		2		2	1	1	12	17

Metatarsal I												2
Metatarsal II												2
Metatarsal III												2
Metatarsal IV												2
Metatarsal V												2
Metatarsal undef.												10
Total metatarsals												10
Phalanx I												20
Phalanx II												20
Phalanx III												20
Total phalanges												60
Sesamoids												20
Metapodials												40
Phalanges												60
Total	4	20	41	65	2	6	5		13	1	2	

Skeletal part	NISP				MNE				MNIf	MNIc	IS	%OE
	R	L	A	Total	R	L	A	Total				
Cranium											1	
Upper teeth			844	844			2	2	1	1	6	16.7
Total upper jaw			844	844			2	2	1	1	7	14.3
Lower teeth											4	
Mandible											1	
Total lower jaw											5	
Teeth undef.			4	4			1	1	1	1	10	5
Hyoid											3	
Atlas											1	
Axis			4	4			1	1	1	1	1	50
Other cervical vert.											5	
Thoracic vert.			45	45			7	7	1	2	19	18.4
Lumbar vert.											5	
Sacrum											1	
Caudal vert.			1	1			1	1	1	1	18	2.8
Vertebra undef.			38	38			2	2	1	1	48	2.1
Total vertebrae			88	88			11	11	1	1	50	11
Ribs	6	3	90	99	6	3	9	18	2	2	38	23.7
Sternum											1	
Scapula	1	1	2	4	1	1		2	1	2	2	50
Humerus		3	7	10		2	1	2	2	2	2	50
Radius											2	
Ulna	3	3	2	8	2	1		3	2	2	2	75
Magnum											2	
Triquetrum											2	
Scaphoid											2	
Lunatum											2	
Pisiform											2	
Trapezium	1			1	1			1	1	1	2	25
Cuneiform		1		1		1		1	1	1	2	25
Trapezoid											2	
Total carpals	1	1		2	1	1		2	1	1	16	6.3
Metacarpal I											2	
Metacarpal II											2	
Metacarpal III	2	2		4	2	2		4	2	2	2	100
Metacarpal IV											2	
Metacarpal V											2	
Metacarpal undef.											10	
Total metacarpals	2	2		4	2	2		4	1	1	10	20
Pelvis		6	2	8		2		2	2	2	2	50
Femur											2	
Patella											2	
Tibia			1	1			1	1	1	1	2	25
Fibula	1			1	1			1	1	1	2	25
Astragalus											2	
Calcaneum	1			1	1			1	1	1	2	25
Naviculare		1		1		1		1	1	1	2	25
Int. Cuneiform											2	
Ext. Cuneiform	1	1		2	1	1		2	1	2	2	50
Cuboid		1		1		1		1	1	1	2	25
Total tarsals	2	3		5	2	3		5	1	1	12	20.8
Metatarsal I											2	
Metatarsal II											2	
Metatarsal III											2	
Metatarsal IV											2	
Metatarsal V											2	
Metatarsal undef.											10	
Total metatarsals											10	
Phalanx I			2	2			2	2	1	1	20	5
Phalanx II			1	1			1	1	1	1	20	2.5
Phalanx III							3	3	1	1	20	7.5
Total phalanxes			3	3			6	6			60	5
Sesamoids											20	
Metapodials			7	7			3	3	1	1	40	
Phalanxes											60	
Total	16	22	1048	1088	15	15	34	63	2	2		