PRELIMINARY CHARACTERISTICS OF PATHOLOGIES FOUND IN THE SKELETONS OF MAMMOTHS AT THE KRAKÓW SPADZISTA STREET (B) SITE

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Summary. A locality of Kraków Spadzista Street (B) site, Poland is known for the presence of a substantial assemblage of mammoth bones accompanied by human artifacts from the Gravettian technocomplex. The age, according to radiocarbon dating, approximates at about 24 000 years BP, placing the site in the Last Glacial Maximum. It is assumed that this place was a mammoth butchering, and probably hunting, site. Woolly mammoth (*Mammuthus primigenius*) is represented by 99% of the faunal remains at this site (c. 7000 bones and teeth), which are attributed to at least 86 individuals. Other large mammals are known only from isolated bones and teeth.

The age profile of the mammoths is characteristic for a stable population with the largest number of young individuals (up to 12 years old), and other age categories represented in decreasing proportions. This age profile could represent time averaged, natural, but non-selective deaths or abrupt, non selective kills affecting whole herds.

The present study revealed that a proportion of mammoth bones bore pathological changes such as healed fractures, malformations of the different parts of the skeleton (vertebrae, carpals and teeth) and various pathological changes that occurred during the lifetime of these animals (furrows on the cement surface of teeth and holes in bones due to abscess).

The study of these pathologies is ongoing; however, my present purpose is to explore whether the number of pathological bones was characteristic of a natural population of mammoths, or should be rather ascribed to human selection of defective individuals.

Key words: Woolly mammoth, *Mammuthus primigenius,* bone pathologies, Poland.

MAMUTŲ GRIAUČIŲ, RASTŲ KROKUVOJE, SPADZISTA GATVĖS (B) SKLYPE, PRELIMINARI PATOLOGIJŲ CHARAKTERISTIKA

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Santrauka. Krokuvos Spadzista gatvės (B) pusė Lenkijoje žinoma kaip svarbi mamutų kaulų radimo vieta. Kartu rasti žmogaus darbo įrankiai, susiję su Graveto kultūra. Radiokarbono metodu kaulai datuoti Paskutiniojo apledėjimo išplitimo laikotarpiu (prieš 24 tūkst. metų). Spėjama, kad šioje vietoje mamutai buvo skerdžiami ir tikriausiai medžiojami. Jų (*Mammmuthus primigenius*) kaulai sudarė 99 proc. visų toje vietoje rastų kaulų (7 000 kaulų ir dantų), priskirtų 86 individams. Kiti stambūs žinduoliai buvo atpažinti tik iš pavienių kaulų ir dantų.

Pagal amžių mamutai sudaro stabilią populiaciją, kurioje vyrauja jauni individai (vyresni kaip 12 metų), o kitų amžiaus kategorijų proporcija mažėja. Amžius rodo natūralų laiko vidurkį, bet ne atrankinę (selektyvią) ar staigią mirtį. Šis darbas atskleidė, kad patologiniai pokyčiai – užgiję lūžiai, įvairių skeleto dalių (slankstelių, riešo ir dantų) išsigimimai ir kitos patologijos (cemento pakitimai dantų paviršiuje, skylės kauluose po absceso) – atsirado mamutams esant gyviems. Analizė padės išsiaiškinti, ar kaulų patologijų daugis būdingas natūraliai mamutų populiacijai, ar rastus pokyčius griaučiuose galima priskirti žmogaus selekcijos padariniams.

Raktažodžiai: mamutas, Mammuthus primigenius, Lenkija.

Introduction. A locality of Kraków Spadzista Street (B) site (south Poland) is known for its rich assemblage of mammoth bones accompanied by human artifacts. It was accidentally discovered in 1967. Regular excavations started the following year and have continued, with few intervals, until 2002 . The site is located on the Saint Bronisława hill. Kraków Spadzista Street (B) site is a part of a larger archaeological complex consisting of five Upper Palaeolithic localities in a very small area, less than 100 m diameter. The age, according to radiocarbon dating, approximates at 23-24 000 years (BP), placing the site in the Gravettian cultural complex (Kozłowski et al., 1974; Wojtal & Sobczyk, 2005).

Woolly mammoth (*Mammuthus primigenius*) is represented by 99% of the faunal remains at this site (c. 7000 remnants), which are attributed to at least 86 individuals. Other large Pleistocene mammals are known only from isolated bones and teeth. All parts of the mammoth skeleton are represented, including fragments of skull, tusks, teeth, axial parts of the skeleton (vertebrae and ribs) and limb bones. Although there are parts of whole skeletons, the bones are not in anatomical order but are mixed due to the action of large carnivores, Gravettian hunters and solifluction (Wojtal, 2001; Wojtal & Sobczyk, 2005; Wojtal, 2007; Kalicki et al., 2007).

Since the mammoth bones are accompanied by stone artifacts and that cut marks were found on the bones it has been suggested that this site was probably used for mammoth butchering, and probably hunting too (Wojtal & Sobczyk, 2005; Wojtal, 2007). The site area of approximately 150 m^2, along with the rest of the sites of this Upper Palaeolithic archaeological complex, is delimited by a rocky cliff from the north and by a large Pleistocene depression from the east and west. The site is thus isolated from three sides and is connected with the main height of Saint Bronisława hill only from the south. The nature of this location suggests that it might have been used by hunters as a natural trap for mammoths.

The age profile of the mammoths is characteristic for a stable population with the largest number of individuals in the 0-12 year age class, and other age categories represented in decreasing proportions (Lipecki & Wojtal, 1996; Wojtal & Sobczyk, 2005). This age profile could represent time averaged, natural, but non-selective deaths or also abrupt, non selective kills affecting whole herds (Haynes, 1991).

The present study reveals that some of the mammoth bones bear pathological changes. While the analysis of these pathologies is continuing, the purpose of this paper is to explore whether their frequency was characteristic of a natural population of mammoth, or should be rather ascribed to human selection of defective (impaired) individuals.

Material and Methods. While most of the material from Kraków Spadzista Street (B) site has been examined, there is still some part waiting for determination. Therefore the present study should be considered as preliminary and it is expected that the number as well as the mode of classification of pathologies may vary in course of further research.

The thoracic and lumbar vertebrae (total 506) included in this analysis were only those containing both the neural arch and the spinous process. This choice was caused by the great fragmentation of bone material.

The X-ray photographs of some bones had been taken to examine how deep the pathological changes penetrate the bones, which was not always visible from the outside (Fig. 6a-b, 7a-b).

Results. The most characteristic pathological changes observed were: healed bone fractures; malformations of the different parts of the skeleton; and various pathological changes occurred during lifetime.

Vertebrae. Various pathological changes were found on vertebrae. Most common are the holes and hollows in spinous processes. Twelve thoracic and one lumbar vertebrae (out of total 506) bear additional holes in spinous process which go straight through the bone tissue. Five holes have a smooth edge (Fig. 1) and three appear as if the bone tissue had started to remodel and close the hole but the closure was not completed (Fig. 2). Such remodelling occurred on vertebrae within the first section of the thoracic spine – i.e., the nape of adult animals. The vertebrae of this section differ from the remaining thoracic ones being bigger, much thicker and of slightly different shape. These vertebrae gave support to the massive muscles and therefore had to be much stronger than subsequent ones. This might explain why the holes in these vertebrae started to close.

Fig 1. **Spinous process of vertebra with additional hole penetrating throughout the bone tissue. Bar: 1 cm each section, applies to all Figures**

Fig 2. **Spinous process of vertebra with additional hole penetrating throughout the bone tissue. The bone tissue had started leaking to close the hole but the closure was not completed**

Among the remaining 494 thoracic and lumbar vertebrae a considerable share also bear pathological changes - usually hollows in spinous processes (Fig. 3). These hollows are similar to the holes described above but they do not penetrate through the bone. Like the penetrating holes, however, they appear mostly on thoracic vertebrae. It is too early to determine whether these two lesions are the same type of pathology. Other vertebrae did not bear any holes.

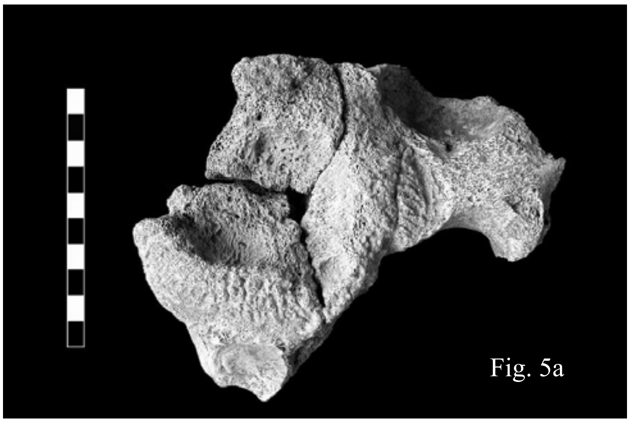
Fig 3. **Spinous process of vertebra with additional hollow**

In one individual spondylosis of two adjacent vertebrae was stated (Fig. 4). The intervertebral disk must have been damaged and osteophytes appeared making a perfect match between both contacting surfaces.

One vertebra has a hollow in the vertebral body (Fig. 5a, b). Here also, the intervertebral disk must have been damaged or infected. This change may be the result of an abscess or osteoblastoma.

Osteoblastoma-like changes . A few bones with holes were found in the bone tissue which seemingly were the result of osteoblastoma. These included: two metapodia (Fig. 6a, b), an astragalus and one rib (Fig. 7a, b). There are also two first ribs of one individual with expanded tips (Fig. 8), most probably a result of cancer which must have also included the sternum.

Fig 4. **Spondylosis of two adjacent vertebrae of one individual**



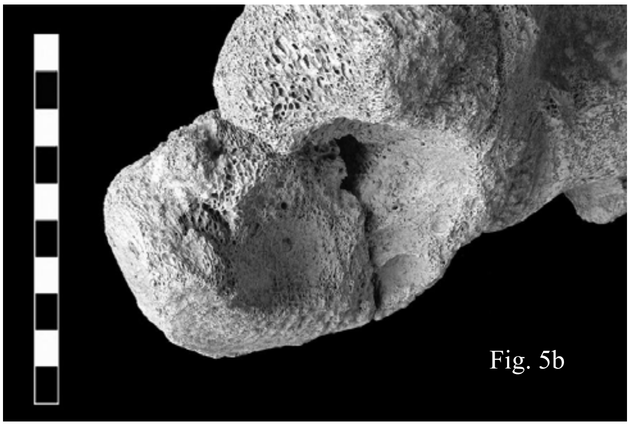


Fig 5. **Hollow in a vertebral body caused by an abscess or osteoblastoma** (a and b)

Fusions. There are a few fused bones: two fused carpals (capitatum and hamatum), and two fused thoracic vertebrae (Fig. 9).

Teeth. The molar assemblage from the Kraków Sapdzista Street (B) site consists of 338 specimens and 55 mandibles. Many of these mandibles contain two or more teeth in alveolar bone. Out of these, 259 upper and lower molars were examined for furrows in cement (Fig. 10), while the remainder either had no cement due to poor preservation, or were teeth fragments; both categories were excluded from analysis. Out of 259 molars, the furrows are visible in 130. The furrows were observed on teeth from the second milk molar to the third permanent molar (Niven & Wojtal 2002). They are present mostly on the lingual, and less often on buccal side of teeth. Notably, in some cases, they appear on both sides of the same molar. Six lower molars (M_1 and M_2) show furrows on their posterior ends. Several specimens, which just had begun to wear, also exhibit furrows. Generally, fewer upper molars contain cement furrows but this might be due to the smaller sample size of these cheek teeth. In conclusion, many molars with more than one furrow were found; single furrows predominate but as many as four have been documented. Taking into account the way of wearing molars by mammoths it seems that the development of furrows was seasonal. The explanation for this phenomenon may be seasonal change for harder or more acid food (see below).

There is one mandible with two twisted teeth (M3) and one twisted molar (Fig. 11).

Bone Fractures. Three fibulae are broken and healed (Fig. 12).

Discussion and Conclusions

As can be seen from this paper, mammoths from Kraków Spadzista Street (B) site had various pathologies, some of which were very conspicuous. Since these mammoths were killed by Gravettian hunters one question arises – did these people choose weaker animals? To answer this question it is necessary to compare the share of pathologies with those in other populations. The most known localities of this age and with similar human activity are Dolní Věstonice, Milovice and Pavlov (Czech Republic; Svoboda et al., 2005). Another problem to be solved is: can we state with confidence that the animal was weakened just from the observable changes on the bones? In some cases we can assume worse condition of animals. These are spondylosis, abscesses and osteoblastoma, all causing pain in humans. On the other hand, fused bones (carpus bones and vertebrae) probably did not affect animals in any way. The other pathologies are actually a big question mark. It is not possible to say, just from bone material, whether animals with twisted teeth had any problems with taking food or wearing new teeth.

Similarly, furrows in teeth cement may indicate some impairment but it is more likely that it is just a result of different diet. The mammoth dentition consisted of six sets of molars in their lifetime. New molars grew in and pushed worn ones out, with each successive molar becoming larger and in use for longer time period. Constructed of enamel plates held together by cement, mammoth molars were characterized by high crowns adapted to their abrasive diet. Cement was deposited around the crown in course of development and, as with other dental tissues, cement was layered in seasonal, monthly, or annual increments. The long lifetime of mammoths and the use of teeth by adult animals in particular provide a valuable insight of the individual's life history. The cement furrows presented herein seem not to be hypoplasious as was previously assumed (Niven & Wojtal, 2002) because they develop only on the cement surface and not on the enamel. They are rather abfractions, i.e. the losses of tooth structure appearing usually at the line of the gums caused by friction and pressure but not by dental caries. High acidity in the mouth contributes to occurrence of such loss. In humans, abfractions are not a result of sickness.

Fig 6. **Metapodium with a hole probably caused by osteoblastoma: a, general view; b, X ray camera picture**

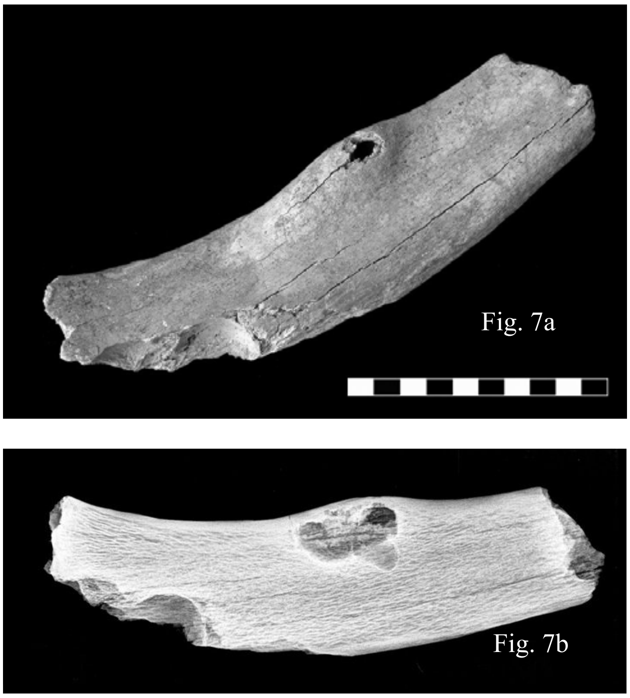


Fig 7. **Rib with a hole probably caused by osteoblastoma: a, general view; b, X ray camera picture**

Fig 8. **First rib with expanded tip, most probably a result of cancer which must have had included also the breastbone**

The holes and hollows in spinous process are even more questionable. This kind of pathology was also found in other mammoth populations: from Sevsk (Russia) and Siberia (Musil, 1983; personal information of Leshchinskiy), and also from Dolní Věstonice and Milovice (Czech Republic; and was never mentioned in other species. It is not clear if these are stages of the same type of change or if there are a few types of pathologies which look similar. They occur mostly on thoracic vertebrae and it seems likely that the holes were closing but only in adult animals as these vertebrae gave support to nape muscles. These pathologies may be ontological changes but may as well be a result of poor diet.

Mammoths were quite safe during their lifetime; they did not have any natural enemies except humans. Young animals were protected by the herd and the adults were too strong and big for predators. In such circumstances even weak individuals could survive and heal, which is evident from the healed fibula fractions and the great extent to which some of the pathologies developed.

Fig 9. **Two fused thoracic vertebrae** (lateral view)

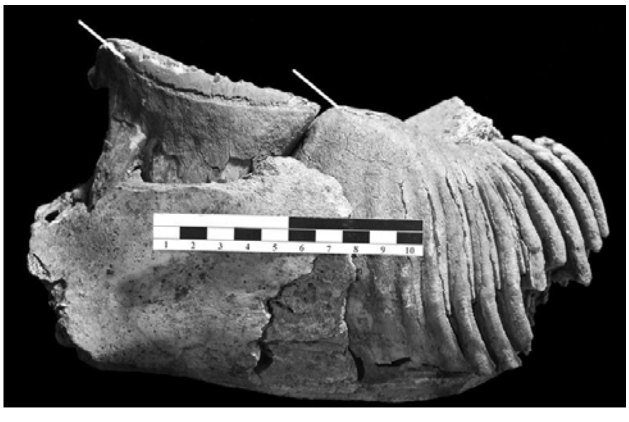


Fig 10. **Molars with furrows in cement: general view of mandible with two molars** (furrows are visible on both molars)

Fig 11. **Twisted molar**

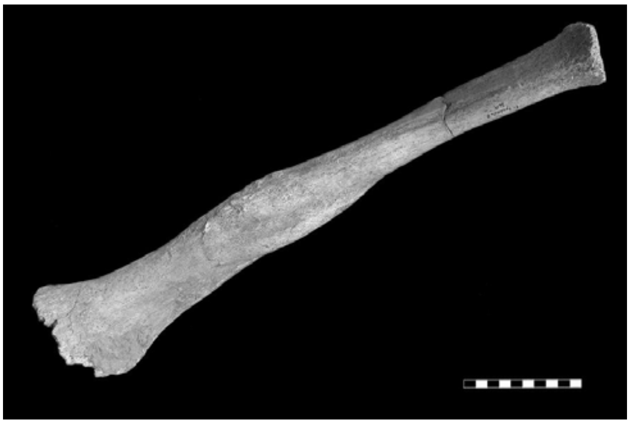


Fig 12. **Broken and healed fibula**

This study gives a first insight to the new and huge (really of mammoth size!) topic. The present study is a preliminary one and the research is ongoing. Comparisons with other mammoth populations are scheduled. However, some of these questions probably could be solved only by studying living elephants.

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