The woolly mammoth (*Mammuthus primigenius*) remains from the Upper Palaeolithic site Kraków Spadzista Street (B)

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SUMMARY: Nearly all (99%) of the 9000 remains from the Kraków Spadzista Street (B) site belong to woolly mammoth. All skeletal parts are represented in the bone assemblage and come from one mammoth population. The age profile from the site is typical of a stable mammoth population. New excavations and analyses of materials indicate that 71 mammoths may have been killed at the site or died there naturally, probably not all at one time.

The Kraków Spadzista (B) site is one of many famous Mid Upper Palaeolithic (Gravettian) sites in Europe. It was discovered accidentally in the late autumn of 1967 and the excavations continue today. The Aurignacian and Gravettian sites from the Kraków Spadzista complex are located on a rocky prominence, which is isolated from the main part of Saint Bronislawa hill by a rocky cliff from the north and by a large Pleistocene depression from the east and west. After 11 years of excavations, approximately 140 sq. m of the site have been examined. At the site nearly 9000 bones and teeth of seven different species of Pleistocene mammals (Kubiak & Zakrzewska 1974; Lipecki & Wojtal 1996) and several hundred stone artefacts (Kozlowski & Sachse-Kozlowska 1974; Sobczyk 1995) were found. At Kraków Spadzista Street (B), only isolated bones or teeth (NISP= 15; MNI=7) from mammal species other than mammoth were found (Tab. 1).

Tab.1 - Number of identified specimens (NISP) and minimal number of individuals (MNI) found at the site Kraków Spadzista Street (B).

SPECIES	NISP	MNI
Canis lupus	4	1
Alopex lagopus	3	2
Ursus sp.	2	1
Equus caballus	1	1
Coelodonta antiquitatis	1	1
Mammuthus primigenius	5845	71
Rangifer tarandus	4	1
TOTAL	5860	78

Nearly all of identifiable bones belong to mammoth and all skeletal elements are represented (Tab. 2). The site yielded a large number of ribs (NISP = 2065, Minimum Number of Elements [MNE] = 715) and vertebrae (cervical, lumbar, caudal and sacrum bone; NISP = 1062, MNE = 767). Approximately 87% of all atlases (NISP = 92, MNE = 62) and 35 - 60% of expected limb bones were preserved. Numerous small bones such as sesamoids (NISP = 85) and phalanges (NISP = 172) were represented. A remarkable feature of the site is the presence of very small mammoth humeri (two) and femora (three), which could belong to mammoth foetuses. It is important to point out the presence of hyoid bones (NISP = 41; MNE = 36) and first milk teeth of woolly mammoth at Kraków Spadzista Street (B). In addition, one mammoth milk tusk was found during the excavation in 2000. It is the first record of this type of tooth in Poland. Unfortunately no large fragments of mammoth skull were represented in this mammoth bone assemblage. However, about 400 small parts (ca.10-20 cm in diameter) of skull were found. Of these fragments were 23 *basioccipitale* bones, undoubtedly belonging to 23 mammoth individuals.

Besides a large number of postcranial skeletal elements, numerous upper and lower cheek teeth (NISP = 338) of woolly mammoth are in this assemblage. Some teeth were still placed in the alveolus of maxillae and mandibles. Of 103 upper cheek teeth, seven were situated in the maxillary alveolus. Two pairs of upper teeth came from two individuals. A total of 198 lower cheek teeth were recovered at the site and of this total, 128 remained in the mandibles or refit to the alveolus or to associated teeth that were present in mandibles. Stage of tooth wear or damage to 37 teeth prohibits refitting to mandibles or maxillae and associated teeth. All of the mandibles from Kraków Spadzista Street (B) were missing the ramus portion and some of them were broken near the symphysis. The preservation of mammoth tusks was very poor. Very rarely were larger fragments of this tooth present. Only a few tusks with length from 50 - 100 cm were preserved and usually only small fragments (ca. 10-20 cm) were found.

As a result of excavations undertaken during the 1970s, a minimum number of individuals (MNI) for mammoth based on the mandibles and lower teeth was estimated at 60 (Kubiak and Zakrzewska 1974). During the 1990s, excavations at the site were continued and subsequently the estimated minimum number of individuals has been revised to 71 based on mandibles and lower cheek teeth. The eruption sequence and wear of the lower teeth were used to reconstruct the age distribution of the mammoths. The mammoth age profile from Kraków Spadzista Street (B) is characteristic for a sta-

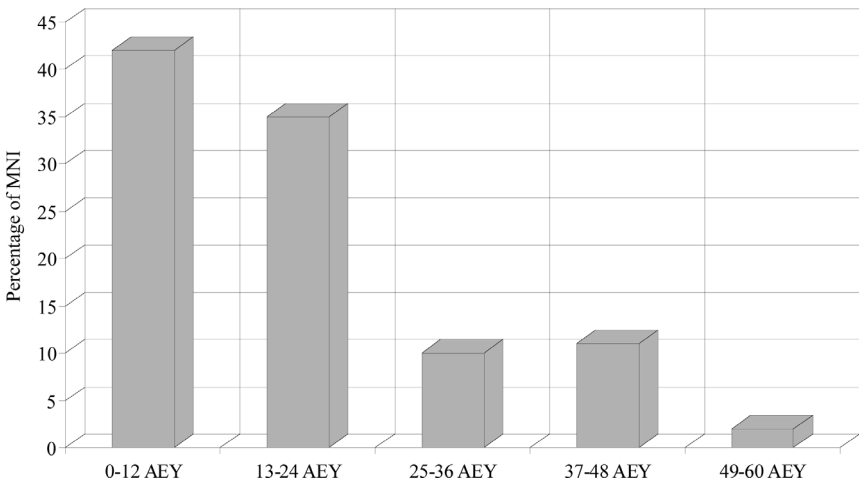

Fig.1 - Age profile of Kraków Spadzista Street (B) mammoth population. (AEY = African Elephant Years. MNI = 71).

ble population. The largest number of individuals is represented in the 0-12 years age class (30 individuals, 42 % of total MNI) and other age categories are represented in decreasing proportions (Fig. 1).

This age profile could represent time-averaged, natural (but non-selective) deaths or also abrupt, non-selective kills affecting whole herds (Haynes 1991, Soffer 1993).

In the woolly mammoth skeleton, different limb bone epiphyses fuse in a predictable order and rate through life (Lister 1999). During excavations at Kraków Spadzista Street (B), numerous diaphyses of long bones and unfused epiphyses were found. They come from animals that were still growing at the time of death. It is possible to divide the long bones into two age categories: the first one before fusing of epiphyses and a second one after epiphyses have completely fused. It is possible to describe the age of mammoth individuals based on epiphyseal fusion for 43 humeri, 51 femora, and 43 tibiae. Most humeri (n = 35, 81 %) belong to animals below 12 years old and only one humerus (3%) comes from an animal above 43 years in age. Approximately 86% of femora (n = 44) were under 34 years old and 76% of tibiae (n = 33) were under 26 years of age.

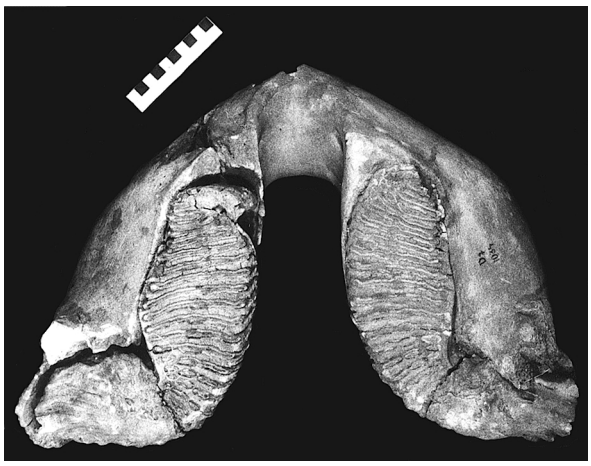

Fig.2 - Mammoth mandible with two abnormally twisted M_3.

Fig.3 - Neural spinosus of mammoth vertebrae with additional hole.

Fig.4 - Mammoth upper cheek tooth with furrows on the cement surface.

Few pathological bones and teeth were found at Kraków Spadzista Street (B). These included two carpals (*hamatum* and *capitatum*) that are fused together and four ribs that were broken and then healed during life. One mandible that belongs an individual around 40 years of age has two abnormally twisted M_3s (the last cheek teeth) (Fig. 2). The proximal ends of these teeth are twisted in the direction of the curve of the tooth.

Seven neural spinosus have additional holes (Fig. 3) and two neural spinosus of thoracic vertebrae are fused.

Especially noteworthy are three mammoth fibulae, which were broken and healed. A low number of abnormalities found on mammoth bones from Spadzista could suggest that this population was in good health. However 111 (about 30%) of lower and upper cheek teeth show visible furrows and small holes on the cement surface, which might be reflect a tooth defect such as hypoplasia (Fig. 4). If these furrows are hypoplasia, they might be an indication of periods of nutritional stress in this mammoth population.

Six percent of the mammoth bones show numerous carnivore gnawing marks, most of which are located on long bone diaphyses and epiphyses; however, other elements show these marks of carnivore activity also. Approximately one percent of identifiable elements show marks that may be the result of trampling, indicating that the bone deposit was visited several times by mammoths before final burial.

Amongst the huge number of mammoth bones, stone artifacts belonging to the Kostenki-Avdeevo (Gravettian) culture were found. Although many shouldered points, backed bladelets, and other tools were ascertained, cut marks on the bones are very rare.

Conclusion

Mammoth remains from the Kraków Spadzista Street (B) site come from one population, which lived during the Last Glacial Maximum about 20,000 years ago. Few abnormalities of bones and teeth in addition to the age profile support the argument that the mammoths were probably in good health.

It is possible that this huge mammoth bone assemblage was deposited in the same location where the mammoths died. Soffer (1993) proposed that such deposits - containing large numbers of mammoth bones representing all skeletal elements and age classes, as well as a scarcity of cut marks and a relatively extensive record of scavenger gnaw marks - are non-cultural accumulations.

Tab.2 - Mammoth bones representation at Krakow Spadzista Strret (B).

Bone	NISP	MNE dex	MNE sin	MNI
ATLAS	**92**	-[a]	-[a]	**62**
AXIS	**51**	-[a]	-[a]	**30**
STERNUM	**8**	-[a]	-[a]	**7**
SCAPULA	**103**	23	22	**23**
HUMERUS	**84**	26	24	**26**
ULNA	**106**	28	42	**42**
RADIUS	**119**	40	45	**45**
PISIFORME	**17**	8	9	**9**
LUNATUM	**40**	25	15	**25**
TRAPEZIUM	**21**	12	9	**12**
TRIQUETRUM	**41**	23	18	**23**
SCAPHOIDEUM	**24**	13	9	**13**
TRAPEZOIDEUM	**28**	13	15	**15**
HAMATUM	**38**	21	16	**21**
CAPITATUM	**25**	11	14	**14**
I METACARPALE	**8**	3	5	**5**
II METACARPALE	**30**	13	17	**17**
III METACARPALE	**29**	16	13	**16**
IV METACARPALE	**32**	11	17	**17**
V METACARPALE	**16**	13	3	**13**
PELVIS	**135**	16	26	**26**
FEMUR	**125**	27	31	**31**
TIBIA	**101**	22	27	**27**
FIBULA	**80**	22	33	**33**
CALCANEUS	**37**	17	20	**20**
ASTRAGALUS	**59**	30	29	**30**
NAVICULARE	**52**	23	26	**26**
CUBOIDEUM	**24**	11	13	**13**
CUNEIFORME LATERALE	**32**	19	13	**19**
CUNEIFORME INTERMEDIUM	**23**	12	11	**12**
CUNEIFORME MEDIALE	**13**	7	6	**7**
II METATARSALE	**22**	9	13	**13**
III METATARSALE	**28**	14	14	**14**
IV METATARSALE	**24**	17	7	**17**
V METATARSALE	**10**	6	4	**6**

-[a] MNE was not counted

Such a large skeletal accumulation from 71 mammoths at Kraków Spadzista Street (B) on a relatively small surface suggests a place where a prolonged process of bone accumulation occurred, and not a location where a single event took place. This hypothesis is confirmed by the presence of trampling marks and different weathering stages visible on the mammoth bone surfaces. It is impossible to know if Spadzista reflects human hunting of mammoth herds or of individual animals, or if the bones resulted from natural mortality of mammoths and the carcasses were subsequently utilized by Paleolithic people. It is possible that Kraków Spadzista Street (B) represents a combination of these different events.

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REFERENCES

Haynes, G. 1991. *Mammoths, Mastodonts and Elephants: Biology, Behavior, and the Fossil Record.* Cambridge.

Kozłowski, J.K. & Sachse-Kozłowska, E. 1974. Archeological finds. In Upper paleolithic site with dwellings of mammoth bones - Cracow, Spadzista street B. *Folia Quaternaria*, 44: 23-77.

Kubiak, H. & Zakrzewska, G. 1974. Fossil mammals. In Upper paleolithic site with dwelling of mammoth bones- Cracow Spadzista Street (B). *Folia Quaternaria*, 44: 77-95. Kraków.

Lister, A.M. 1999. Epiphyseal fusion and post-cranial age determination in the woolly mammoth Mammuthus primigenius. In G. Haynes, J. Klimowicz and J.W.F. Reumer (eds.), Mammoths and the mammoth fauna: studies of an extinct ecosystem. *Deinsea* 6: 79.

Lipecki, G. & Wojtal, P. 1996. Mammoth population from Cracow Spadzista Street (B) site. *Acta zool. cracov.*, 39 (1): 289-292.

Sobczyk, K. 1995. Osadnictwo wschodniograweckie w dolinie Wisły pod Krakowem. *Rozprawy habilitacyjne* UJ, 303. Kraków. (In Polish).

Soffer, O. 1993. Upper Paleolithic adaptations in central and Eastern Europe and man/mammoth interactions. In Soffer, O. & Praslov N.D. (ed.), *From Kostenki to Clovis, Upper Paleolithic - Paleo-Indian Adaptations.* 31-49.