

## The number of mammoths *Mammuthus primigenius* (BLUMENBACH, 1799) at the Cracow Spadzista Street B site, estimated on the basis of their postcranial skeletal bones

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**Abstract.** In 1967 the Upper Palaeolithic site Cracow Spadzista Street B- was discovered. In the course of excavations carried out in 1968-1971 remains of 2-3 human dwellings built of mammoth bones were detected. On the basis of the mandibles and lower molars found at the site the number of the mammoths was estimated at 60 individuals (KUBIAK & ZAKRZEWSKA 1974). The present study of limb bones reveals a big difference between the number of individuals established on the basis of the mandibles and lower molars and that obtained from an analysis of the postcranial bones. The limb bones found at this site indicate merely 9-22 mammoth individuals. The limb bones may have come from killed animals, whose legs were cut off and brought to this site. The mammoth population from Spadzista Street was declining or subject to selective killing.

**Key words:** *Mammuthus primigenius*, Cracow Spadzista Street B, Upper Palaeolithic, Pleistocene, Poland.

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### I. INTRODUCTION

In 1967 a big accumulation of bones was accidentally discovered in Spadzista Street in Cracow. This locality is situated on the slope of St. Bronisława Hill, which rises above the valley of the River Rudawa. Excavations carried out in 1968-1971 suggested the Upper Palaeolithic age of the locality, which represents the Kostylenkov-Avdeyev Culture and has been designated as Cracow Spadzista Street B. The age of the find determined by radiocarbon method is 20 600 years B.P. (KOZŁOWSKI et al. 1974).

The bone material from this site consists almost exclusively of remains of the mammoth *Mammuthus primigenius* (BLUMENBACH, 1799). Some single bones and teeth of woolly rhinoceros *Coelodonta antiquitatis*, wolf *Canis lupus*, horse *Equus sp.* reindeer *Rangifer tarandus*, bear *Ursus sp.* and Arctic fox *Alopex lagopus* were also found here (KUBIAK & ZAKRZEWSKA 1974).

An analysis of the position of the mammoth bones shows that they constitute relics of three huts constricted of bones. Each of the buildings was overground structure about 2 m in diameter. A circle of 20 mammoth mandibles formed the foundation, which was reinforced with long limb bones stuck vertically in the substratum. Pelves and scapulae were used as structural components of the walls (KOZŁOWSKI & SACHSE-KOZŁOWSKA 1974). Tusks joined together by means of ribs formed the domed roof construction. The dome was probably covered with skins.

Nearly 200 molars, 120 lower and 70 upper teeth, have been taken into consideration in the studies conducted so far. On the basis of the mandibles and lower molars found at this site the number of individuals represented by the remains was estimated at 60 (KUBIAK & ZAKRZEWSKA 1974). Apart from the mandibles and molars, the site abounded in long bones of the fore- and hind-limbs, and massive bones of the carpus and tarsus. In earlier works (KOZŁOWSKI et al. 1971; KOZŁOWSKI & KUBIAK 1972; KUBIAK & ZAKRZEWSKA 1974) these bones were not taken into account in estimates of the number of individuals. The present work is an attempt to determine the number of mammoth individuals occurring in the study locality on the basis of bone remains of the postcranial skeleton in relation to the number established from the numbers of teeth. Moreover, it also aims at determining the physical fitness of the population from the Cracow Spadzista Street B site.

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## II. MATERIAL AND RESULTS

The bone material of the mammoth postcranial skeleton consists of a total of 370 long bones of limbs and carpal and tarsal bones. They were divided into right and left bones of the fore- and hind-limbs and their position in the mammoth skeleton was fixed. Their greatest length and smallest circumference of the diaphysis were measured.

### Humerus

The distal parts of most of the humeri were broken off. In all of them the proximal ends were missing.

Two bones are noteworthy for their very small dimensions: their total length is about 16 cm. They were univocally identified as belonging to a mammoth foetus. (Fig. 1, 2)

All together 34 humeri, 16 right and 18 left, were found at this site.

### Ulna, femur and tibia

A large number of other limb bones were found here, including: 48 ulnae (25 right, 23 left), 40 femurs (21 right, 19 left), tibiae 36 (13 right, 23 left). Their measurements allowed a distinction of three groups of bones: Group I (small bones), Group II (medium-sized bones), Group III (large bones) (Table I).

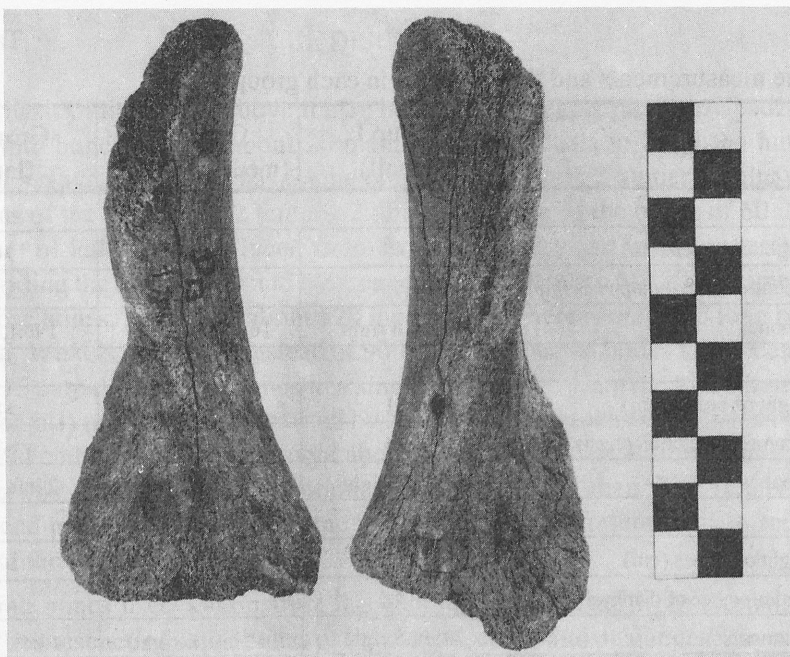


Fig. 1. Two humeri (right and left) of mammoth foetus. The scale is 10 cm.

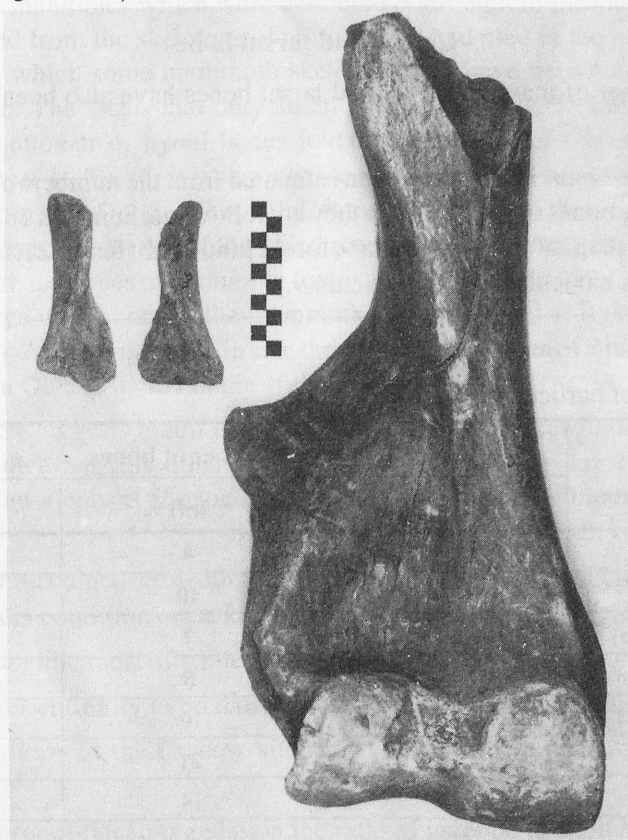


Fig. 2. Comparison of two foetus humeri and one adult mammoth humerus. The scale is 10 cm.



Table I

## Bone measurements and their number in each group

Bone	Group I (small)	Group II (medium- sized)	Group III (large)
<b>Ulna</b>			
greatest lenght of bones (cm)	<40	40-60	>60
smallest circumference of diaphysis (cm)	<17.8	19-29	>29
number of bones	6 left, 6 right	16 left, 16 right	1 left, 3 right
<b>Femur</b>			
greatest lenght of bones (cm)	<51	52-80	>80
smallest circumference of diaphysis (cm)	<24	24.5-33	>33
number of bones	6 left, 6 right	13 left, 11 right	2 left, 2 right
<b>Tibia</b>			
greatest lenght of bones (cm)	<32	33-46	>46
smallest circumference of diaphysis (cm)	<19.5	22-26	>26
number of bones	7 left, 5 right	12 left, 6 right	4 left, 2 right

## Carpal and tarsal bones

A great number of massive carpal and tarsal bones have also been found at the site (Table II)

The numbers of individuals have been estimated from the numbers of particular bones and for respective bones of the fore-limb they are follows as: humerus 18, ulna 25, lunatum 15, triquetrum 14, capitatum 7, hamatum 9; for the hind-limb: femur 21, tibia 22, calcaneus 10, astragalus 21, naviculare 15, cuboideum 9.

Table II

## Numbers of particular carpals and tarsals

Bones	Number of bones		
	right	left	total
lunatum	15	9	24
triquetrum	14	10	24
capitatum (magnum)	4	7	11
hamatum (uniciform)	9	8	17
calcaneus	9	10	19
astragalus	14	21	35
naviculare	15	14	29
cuboideum	4	9	13



### III. DISCUSSION

On the basis of the results above it may be assumed that people from Spadzista Street used the limb bones of only about 20 mammoth individuals to build the huts, for the skeleton of a single mammoth has 6 long bones of fore-limb: 2 humeri, 2 ulnae, 2 radius and 6 bones of the hind-limb: 2 femurs, 2 tibiae, 2 fibulae. If the bones of 60 individuals (the number of individuals deduced from those mandibles and lower molars) had been used to building the huts, we should have expected the presence of 120 specimens of each kind of those bones, altogether about 520 long bones, whereas only 158 long bones have been found. What is more, 172 instead of 900 carpal and tarsal bones have been collected (there are 15 carpal and tarsal bones in a single mammoth). Damage to the humeri (distal ends broken off) may have been caused by sedimentation processes, whereas the lack of the proximal ends was perhaps brought about by solifluction or sedimentation; however, it may well be that they were intentionally broken off by man. The removing of the proximal end made it easier to stick the bones into the substratum so as to reinforce the structure of the hut.

The limb bones used to construct the huts may have come from animals killed by hunters. The presence of small bones of the carpus, tarsus and phalanges may suggest that those men brought the legs cut off from the killed mammoths to the site. On the other hand, some of the mandibles which were deliberately brought to the site on the hill may have been obtained from the skeletons of animals that had died in the nearby areas. The river Rudawa, on which some mammoth skeletons may have been found, flows in the vicinity of the site. The thesis that only about 20 mammoths were killed by hunters is supported by the number of hyoid bones found at this site and representing 15 to 18 individuals (KUBIAK 1980), for it is improbable that these small bones were deliberately brought to the camp site. On the other hand, it may well be that they were brought here together with the tongues cut out of the killed mammoths. Two very small humeri found at the site were perhaps bones of mammoth foetus, which is indicated by their dimensions; in length they agree with bones of the mammoth foetuses found at Bereleche (BARYSHNIKOV et al. 1977). At the same time, in size they yield to the bones of a juvenile mammoth from the Magadan Oblast, it died in the 10th month of life (VERESCHAGIN 1980).

HAYNES (1989) suggests that it is greater vulnerability that accounts for the fact that the mammoth, rather than any other animals, provided food to palaeolithic man. In the case of the African elephant (*Loxodonta africana*) heightened vulnerability is characterized by:

1. Periodic or sustained crowding around limited resources, such as water holes, resulting in a loss in condition occasionally increased injury due to fighting.
2. Increased juvenile mortality rates.
3. Increased susceptibility to predation, disease and accidental death.

The poor condition at the Cracow site shows a very small recruitment rate - 1.7% (HAYNES 1988).

In a growing proboscidean population the ratio of juvenile to adult is as 1:1. A stable population is characterized by the ratio juveniles to adults as 1:2, whereas in a healthy

population affected by stresses the ratio is higher than 1:2 (HAYNES 1985, 1988). The percentage of animals able to bear young in a declining population will include over 70%. In a healthy stable or growing population it will be about 30-50% of adult animals (HAYNES 1988). In the calculations above it has been assumed that the age structure and mortality relative to age are similar in both the mammoth and the African elephant. It has been noted that, as far as elephants are concerned, in periods when unfavorable factors prevail (drought, diseases) young animals (0-8th year of life) are most exposed to danger of life. A relatively high proportion of mature individuals (10-40 years of age) is characteristic of the population which is subject to the action of stress factors (HAYNES 1985).

On the basis of BARYSHNIKOV's (1977) study it may be assumed that the bones included in group I represented animals below 10 years of age, those in group II animals 10-20 years old, and in group III those more than 20 years old. The percentage of adults in the population of mammoths calculated from the numbers of bones and indicating the condition of the animals suggests that was a dying-out population. Judging from all the three sorts of bones (ulna, femur and tibia), the adult mammoths formed above 70%. Unfortunately, it is impossible to determine univocally which of the bones of group I come from calves under 2 years old of age. In consequence, we do not know the exact ratio of newborns to mature individuals. Even if we assume that the bones belonged to young animals (up to two-year-olds), the ratio will be lower than 1:2.

On the assumption that the types of behaviour in the mammoth population resembled those of the African elephant, the watering place (in the case of the Kraków site it was the Rudawa river) was an excellent hunting area. Not only healthy individuals gathered there, but also infirm and ill animals, which were an easy prey to the hunters from Spadzista Str. Remains of dead animals could also be found around the watering place, from where the palaeolithic hunters were in a position to bring mandibles and teeth needed to build the huts of to the site. The location of the huts on St. Bronisława Hill was very advantageous to the hunters. The huts were situated on a bluff rising above the bottom of the Rudawa valley on its southern side. The land configuration and the surface features of the underlying limestone rock determined by drillings show that the rocky spur on which the camp was located was a rocky outlier, in the past connected to St. Bronisława Hill with a distinct lowered tract. The top of the rock on which the huts were built was at most 40 to 60 m<sup>2</sup> in area. Owing to its situation the camp provided an excellent observation point over riverine plain grown over by steppe-tundra vegetation. At the same time it was a place relatively uneasy of access and so safe from assaults of big predators.

Huts resembling the Kraków ones in the type of construction and built of identical material, i.e. mammoth bones, have been discovered in the Ukraine. The huts at Mezin and Meziritchi are characterized by clear building design and give evidence of great skill of their builders in their craft. Unlike what we observe at the Spadzista Street site, whole mammoth skulls were used to build the huts at Ukraine sites. According to PIDOPLITCHKO (1969), in the hut at Mezin mammoth tusks specially selected in respect of length and curvature were fixed in the alveoli of incisors to form the roof framework. Two tusks, not touching each other, connected with a fragment of another tusk formed a frontal arch (PIDOPLITCHKO 1969). As regards the hut at Mezeritchi, the side walls were additionally

reinforced with mandibles, put one in another, five mandibles together. Besides a fence of long bones stood in front of entrance permanent dwelling cabins, inhabited all the year round, whereas the huts in Spadzista Street were probably utilized as the hunters' seat only for certain part of the year, which is confirmed by the number of flint tools used by hunters found at the site (KOZŁOWSKI et al. 1974).

#### IV. CONCLUSIONS

1. The estimated number of huts at the site has not been changed (at least two, probably three huts). Limb bones of only 20 mammoths were used to build them, although the construction of one hut took about 20 mandibles.

2. The animals that provided the limbs had most probably been killed by the hunters, which agrees with the numbers of individuals estimated on the basis of the hyoid bones.

3. Hunting for mammoths and not for other species may be accounted for by the poor physical condition of the populations living in the neighborhood of the hill where the hunters camped.

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