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# LATE-PLEISTOCENE FLORA AND MAMMOTH SKELETON FROM RZOCHÓW NEAR MIELEC (S. POLAND)

**Abstract**

The composition of the flora identified on the basis of palynological studies and macroscopic remains of plants obtained from the deposits at Rzochów (S. Poland), in which the skeleton of a mammoth described as *Mammuthus trogontherii* was found (BORSUK-BIAŁYNICKA and WYSOCZAŃSKI-MINKOWICZ, 1969; LASKOWSKA-WYSOCZAŃSKA and NIKLEWSKI, 1969), represents a swamp-forest community resembling the *Carici elongatae-Alnetum* association. The results of geomorphological and palaeobotanic studies and those of the dating of bones by the apatite-collagen method (50,000—56,000 years) refer the peat from Rzochów to the Brørup interstadial of the last glaciation. The paper includes the opinion that the skeleton, in all probability, did not belong to a steppe elephant (*M. trogontherii*) but to a woolly mammoth (*M. primigenius*).

## INTRODUCTION

The find of the skeleton of a steppe elephant (*Mammuthus trogontherii*) in the channel of the river Wisłoka was quite a scientific event, which aroused great interest, still enhanced by the results of studies made by BORSUK-BIAŁYNICKA and WYSOCZAŃSKI-MINKOWICZ (1969) and LASKOWSKA-WYSOCZAŃSKA and NIKLEWSKI (1969). The authors of these studies wrote that the skeleton, referred to *M. trogontherii*, had been found in its primary deposition (BORSUK-BIAŁYNICKA), in a layer of peat at the bottom of the middle terrace of last glaciation age (LASKOWSKA-WYSOCZAŃSKA). The apatite-collagen dating of the bones points to an age of 50,000—56,000 years (WYSOCZAŃSKI-MINKOWICZ), corresponding to the decline of the early glacial of the last glaciation (ZAGWIJN & PAEPE, 1968). A similar opinion was put forward by NIKLEWSKI on the basis of palynological studies. According to him, the deposits making up the profile from Rzochów date from either the end of the Eemian interglacial or the Brørup interstadial.

The investigation taken up by the author of this paper was confined to the determination of the macroscopic remains of plants collected from a small sample of the deposit. It aimed at the enrichment of the picture of vegetation obtained by NIKLEWSKI on the basis of his palynological studies.

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## PALAEOBOTANIC ANALYSIS OF THE SAMPLE OF DEPOSIT FROM RZOCHÓW

A sample of deposit derived from the layer with mammoth bones and delivered by Wiktor JADERNA from Mielec in August 1967 is stored at the Palaeobotanic Museum, Institute of Botany, Polish Academy of Sciences, in Kraków.

### SITUATION OF SAMPLE IN PROFILE

The paper by LASKOWSKA-WYSOCZAŃSKA & NIKLEWSKI (*l. c.*) gives an analysis of particular layers of the profile carried out by NIKLEWSKI according to TROELS-SMITH's method. Employing the results of this analysis, one can easily localize the sample in question in the upper part of the layer underlying the peat and defined as dark-grey sandy loam (*cf.* Fig. 1). A fairly high proportion of sand in the deposit, a great share of macroscopic remains of plants, and the results of palynological studies (see Table I), especially relatively small numbers of sporomorphs of the *Cyperaceae* and *Polypodiaceae* point at this localization.

### MACROSCOPIC AND MICROSCOPIC REMAINS OF PLANTS

The whole of plant material studies comes from the above-mentioned sample of deposit, 200 cu.cm in volume. Numerous fruits and seeds, fragments of leaves, bark and wood (up to 1 cm in diameter), small charcoals, buds, various fragments of shoots and only sporadic mosses were obtained from it. No traces of transport were observed.

The picture of vegetation based on the macroflora has been completed with the results of a palynological analysis carried out by Dr. MAMAKOWA. This analysis not only facilitated the localization of the sample in the profile but also added a few new taxa to the list of plants given by NIKLEWSKI. These are: *Lemma* sp., *Mentha* type, *Nuphar t. luteum*, *Phragmites* sp., *Pteridium* sp., *Ranunculus t. acer*, *Sambucus* cf. *nigra*, *Stratiotes aloides* and *Viola t. palustris.*

I had also at my disposal the numerical table of sporomorphs determined by NIKLEWSKI from the profile at Rzochów, made available to me by Dr. ZIEMBIŃSKA-TWORZYDŁO from Warsaw. The table gives the following taxa as sporadic, and so omitted in the pollen diagram published by NIKLEWSKI (Fig. 1): *Anemone* type, *Anthemis* type, *Caltha* type, *Cerastium* type, *Dianthus* type, *Helianthus* type and *Lychnis* type.

The cumulated results of macro- and microscopic studies on the sample from Rzochów are given in Table I. No descriptions of the identified remains are added, since in most cases they are well known fruits and seeds, the taxonomic status of which is unquestionable.

The fossil remains of the genus *Betula*, which at my request Dr. BIAŁOBRZESKA and Dr. TRUCHANOWICZÓWNA worked out using JENTYS-SZAFER's graphic method, make an exception in this respect.

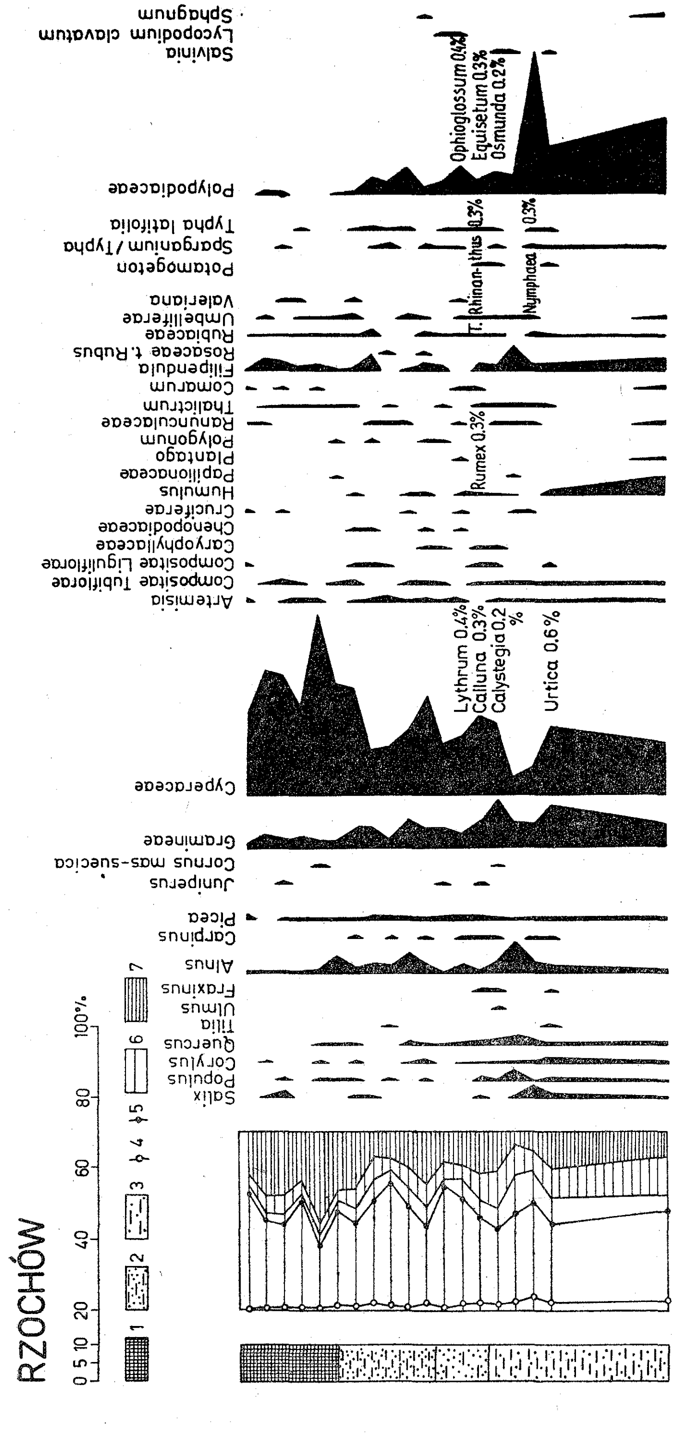



Fig. 1. Pollen diagram from Rzochów (after LASKOWSKA-WYSOCZAŃSKA and NIKLEWSKI, 1969, fig. 5)

1. peat; 2. sandy loam; 3. loamy sand; **4. *Betula*; 5. *Pinus*;** 6. NAP; 7. *Cyperaceae*

Table I

List of micro- and macrofossil plant remains

Abbreviations: c.sc — catkin scale, fr — fruit, l — leaf, m.cat — male catkin, msp — microspore, mspr — microsporangium, Msp — macrospore, oos — oospore, s — seed, sh.sh. — short shoot, stb — statoblast, sto — stomate, w — wood

| Plant names | Absolute numbers of sporomorphs (Anal. K. Mamakowa) | Macroscopic plant remains |
|---|---|---|
| **Trees and shrubs** | | |
| *Acer* sp. | 1 | |
| *Alnus* sp. | 7 | w (14) |
| *A. glutinosa* | — | fr (4), m.cat (+) |
| *Betula t. alba* | 67 | |
| *B.t. humilis* | — | fr (180) |
| *B.t.verrucosa* | — | c.sc (27) |
| *Carpinus betulus* | 1 | |
| *Corylus avellana* | 6 | |
| *Fraxinus* sp. | 1 | |
| *Juniperus* sp. | 2 | |
| *Picea abies* | 20 | |
| *Pinus silvestris* | 483 | l (94), m.cat (1), s (9), sh.sh (21), sto (13), w (5) |
| *Quercus* sp. | 10 | |
| *Rubus* cf. *idaeus* | — | s (1) |
| *R. saxatilis* | — | s (1) |
| *Salix* sp. | — | w (2) |
| *Salix t. glauca* | 2 | |
| *Sambucus* cf. *nigra* | 2 | |
| *Tilia cordata* | 1 | |
| *Ulmus* sp. | 2 | |
| **Herbaceous plants** | | |
| *Alisma plantago-aquatica* | — | s (6) |
| *Anthemis* type | 1 | |
| *Artemisia* sp. | 5 | |
| *Calla palustris* | — | s (5) |
| *Callitriche* cf. *polymorpha* | — | fr (1) |
| *Calluna vulgaris* | 1 | |
| *Caltha* type | 1 | |
| *Carex acutiformis* | — | fr (12) |
| *C. leporina* | — | fr (6) |
| *C.panicea* | — | fr (1047) |
| *C.paniculata* | — | fr (7) |
| *C.paradoxa* | — | fr (18) |
| *C.pseudocyperus* | — | fr (19) |
| *C.pulicaris* | — | fr (3) |
| *C.* sp. *div.* | — | fr (110) |
| *Chenopodiaceae* | 2 | |
| *Comarum palustre* | 1 | fr (56) |
| *Compositae Ligulif.* | 3 | |

| | | |
|---|---|---|
| *Compositae Tubifl.* | 2 | |
| *Cyperaceae* | 164 | |
| *Filipendula* sp. | 32 | |
| *F.ulmaria* | — | fr (54) |
| *Gramineae* | 144 | |
| *Heleocharis palustris* | — | fr (8) |
| *Hottonia palustris* | — | fr (1) |
| *Humulus lupulus* | 2 | |
| *Lemna* sp. | 1 | |
| *Lycopus europaeus* | — | fr (75) |
| *Lythrum* sp. | 2 | |
| *L.salicaria* | — | s (8) |
| *Mentha* type | 1 | |
| *M.aquatica* | — | fr (3) |
| *Nuphar* cf. *luteum* | 1 | |
| *Phragmites communis* | 12 | fr (3) |
| *Poa trivialis* | — | fr (1) |
| *Polygonum hydropiper* | — | fr (1) |
| *P.t. persicaria* | 1 | |
| *Polypodiaceae* | 164 | |
| *Potamogeton* sp. | 1 | fr (1) |
| *Potentilla* sp. | — | fr (2) |
| *Pteridium* sp. | 38 | |
| *Ranunculus t.acer* | 1 | |
| *R.sceleratus* | — | fr (1) |
| *Rorippa* cf. *silvestris* | — | s (1) |
| *Rubiaceae* | 4 | |
| *Sagittaria sagittifolia* | — | s (1) |
| *Salvinia natans* | 1 | Msp (3), mspr (12) |
| *Schoenoplectus tabernaemontani* | — | fr (1) |
| *Solanum* cf. *dulcamara* | — | s (1) |
| *Sparganium* sp. | 5 | |
| *S.ramosum* | — | fr (21) |
| *Stellaria* cf. *media* | — | s (1) |
| *Stratiotes aloides* | 1 | |
| *Thalictrum* sp. | 1 | |
| *T.* cf. *flavum* | — | fr (2) |
| *Typha* sp. | — | fr (17) |
| *T.latifolia* | 2 | |
| *Urtica dioica* | — | fr (41) |
| *Valeriana* cf. *officinalis* | — | fr (1) |
| *Veronica serpyllifolia* | — | s (1) |
| *Viola* sp. | — | s (2) |
| *V.t.palustris* | 1 | |
| **Mosses, algae and bryozoa** | | |
| *Drepanocladus exannulatus for.proceus* | — | l (+), det. K. KARCZMARZ |
| *Nitella* sp. | — | l (oos) |
| *Lophopus cristallinus* (*Pallas*) | — | stb (17), det. J. S. MIKULSKI |

Twenty-seven scales of *Betula* were obtained from the deposit and 11 of them were fit for detailed studies. In Dr. TRUCHANOWICZÓWNA's opinion, the scales from Rzochów bear characters of *B. verrucosa.* They are marked by a large angle of inclination of the lateral lobes and considerably shortened middle lobes. Such deviations most frequently happen in small samples in which we come upon extreme values of some characters.

Out of the total of 180 nuts of *Betula*, Dr. BIAŁOBRZESKA examined a sample consisting of 100 specimens and came to the conclusion that they belonged to the *B. humilis* type. This is a population with fairly long and narrow nuts compared with those of the general sample. They resemble the local samples of *B. humilis* described in the paper from 1960 (p. 33) only that they are narrower than these last. The values of the angles of the base in the nuts from Rzochów lie, according to Dr. BIAŁOBRZESKA, within the range of individual variation of *B. humilis.*

Only the presence of *Betula t. alba* has been demonstrated in the pollen spectrum of the sample examined (*cf.* Table I).

The result of the studies on the *Betula* nuts and scales from Rzochów is rather unexpected and not easy to explain. I assume the occurrence of both species, i.e. *B. humilis* and *B. verrucosa*, for their presence, especially the presence of *B. verrucosa*, is not only possible but also very probable in the plant communities under description.

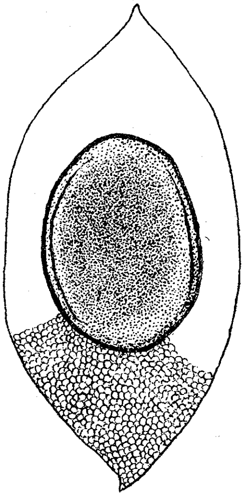
### STATOBLASTS OF *BRYOZOA*

In addition to fairly numerous remains of insects, 17 statoblasts (flotoblasts) of *Lophopus cristallinus* (Pallas) were also found in the deposit discussed. The statoblasts have been identified and commented on by Prof. MIKULSKI of the Institute of Biology, Copernicus University in Toruń (Fig. 2). *L. cristallinus* is a holarctic species, rare at present, although known from many localities. No detailed data from Poland are available. It occurs in stagnant waters and slowly flowing streams, grown over by plants. This species well tolerates low temperatures, its vegetative colonies were found even under ice, and in the Pyrenees (Lac d'Oredon) it reaches to an altitude of 1869 m.

### RECONSTRUCTION OF THE PICTURE OF VEGETATION

NIKLEWSKI's pollen diagram and list of plants identified on the basis of their macroscopic remains preserved in the deposit permit the distinction of two forest communities. The wet valley floor was occupied by a marsh alderwood with *Alnus glutinosa, Pinus silvestris, Picea abies* and *Betula t. alba* and also with the hop (*Hummulus lupulus*), characteristic of this community, shrubs (*Sambucus* cf. *nigra, Rubus idaeus*) and numerous species of aquatic plants and swamp associations (*cf.* Table I). In composition, the alderwood from Rzochów resembles the modern *Carici elongatae—Alnetum* association.

The other community was a widespread pine forest, which was not very close



and occupied the higher-lying areas of differentiated relief. Single trees of greater climatic requirements (*Quercus*, *Corylus*, *Carpinus*, *Tilia*) or their only small groups grew in this forest in favourable habitats as regards the quality of soil and other ecological factors. Then the share of the oak, which was the commonest of these trees, did not exceed 2.6% (NIKLEWSKI). The undergrowth most likely of this forest may have provided single sporomorphs noted in the course of the palynological studies, such as *Anemone* type, *Anthemis* type, *Artemisia* sp., *Calluna* sp., *Cerastium* type, *Dianthus* type, *Juniperus* sp., *Lycopodium clavatum*, *Pteridium* sp,. *Ranunculus t. acer*, *Rhinantus* type and *Vicia* type.

Fig. 2. Statoblast of *Lophopus cristallinus* (Pallas) from Rzochów (drawn by M. ŁAŃCUCKA-ŚRODONIOWA) magnified 83

## AGE OF DEPOSITS

It has already been mentioned among the main results of studies at Rzochów given in the Introduction that the deposits discussed come from the profile of the middle terrace, now almost unanimously referred to the last glaciation. Their differentiation and succession, with a thick layer of sandy gravels at the bottom, are typical of this terrace, and the dating of the mammoth bones is also consistent with this determination.

NIKLEWSKI, the author of the palynological study, assumed a somewhat different attitude towards this question (*cf.* Fig. 1). Having at his disposal a pollen diagram which neither at the bottom nor at the top shows any clearcut changes in the picture of vegetation and thus reflects no changes in the climate, he thinks that this diagram may represent either the end of the Eemian interglacial or the younger part of the Brørup interstadial. In view of the contents of the palynological picture NIKLEWSKI's circumspection is quite understandable. The results of geomorphological studies and the dating of the mammoth bones are however conclusive in this case. The same is also suggested by the results of geomorphological and palaeobotanic studies of the deposits of the middle terrace at Brzeźnica, situated about 15 km south of Rzochów, in the valley of the same river (ŚRODOŃ, 1965; MAMAKOWA and STARKEL, 1974). The profile of Brzeźnica contains a palynologically worked-out layer of peat representing the Paudorf interstadial *sensu lato* (Hv 4899 — 35,965$\pm$1000 B. P.); it has an overlying position in relation to the peat occurring at the bottom of the terrace of the same age at Rzochów.

The relation of the fossil flora from Rzochów to the Brørup interstadial can, in addition, be grounded on the data concerning the profiles at Łążek Zaklikowski in the valley of the River Sanna (right-hand tributary of the Vistula), about 75 km north-east of Rzochów (BIELECKA, 1969). In the profiles at Łążek, referred by BIE-

LECKA to the last glaciation, there are two layers of peat with underlying layers sand and gravel. Palaeobotanic studies carried out by MAMAKOWA (1968), confirmed by radiocarbon dating, proved that the upper peat layer, 25 cm in thickness, derives from the Paudorf interstadial *sensu lato*. As regards the layer of older peat, 1.0—1.4 m thick, BIELECKA (1969) referred it with reservation to the end of the Eemian interglacial or the Brørup interstadial and so in accordance with NIKLEWSKI's determination of the age of the peat at Rzochów. It is therefore very probable that both these peat layers, occurring in terraces of the same age, arose in the Brørup interstadial. The lower peat layer at Łążek was examined by MAMAKOWA (*l.c.*) by the method of pollen analysis (only 3 samples). It should be emphasized that the spectra obtained from these samples do not differ essentially from the spectra from the upper peat, which is admittedly of Paudorf age.

The share of warmer elements in the composition of vegetation, such as *Salvinia natans* and *Humulus lupulus*, the importance of which to the estimation of the climate is stressed by NIKLEWSKI, in my opinion, does not deny the age determination of the peat at Rzochów. The presence of these and also several other plants (*cf.* Table I) proves that in the south of Poland the Brørup interstadial was a period whose climate allowed a fairly considerable differentiation of vegetation. The above-mentioned plants are elements of an edaphically conditioned association much resembling *Carici elongatae—Alnetum*, when the Boreal-type pine forest with the spruce and only sporadic share of trees which have greater climatic requirements was dominant in the surroundings.

The composition of the known forest communities of the Brørup interstadial suggests, and it is not the first time that this supposition has been put forward (ŚRODOŃ, 1965), that in southern Poland the climate of the period separating the Eemian interglacial from the Brørup interstadial was not severe enough to prevent a number of the forest trees common to the end of the former period and to the latter from persisting *in situ*.

It has already been mentioned many times that the valleys of the Carpathian rivers lack organic deposits of Eemian interglacial age. This is most probably connected with the intensive erosional activity of waters, which at the end of the interglacial and at the beginning of the last glaciation laid down thick gravelly-sandy deposits, occurring very regularly at the bottom of the middle terrace.

## FOSSIL ELEPHANT FROM RZOCHÓW

The authors of studies carried out at the locality of Rzochów generally agree that the deposits containing the bones of a fossil elephant, identified as *Mammuthus trogontherii*, represent the early period of the last glaciation. This is confirmed by an analysis of the palaeobotanic material presented in this paper. The discovery of steppe elephant bones in deposits of this age is an unusual event, for according to the specialists in these problems it belongs to the fauna of the early and middle

Pleistocene. "During the Riss glacial complex, *E. trogontherii* specialized further into a cold steppe or tundra form, the woolly mammoth" (Butzer, 1972, p. 261).

The picture of vegetation obtained on the basis of the deposits in which the mammoth bones were found at Rzochów represent neither a tundra nor a steppe but an extensive Boreal-type pine forest and an edaphically conditioned swamp community with *Alnus glutinosa*. This was a forest period recognized as interstadial.

It might be assumed that the determination of the mammoth bones from Rzochów is incorrect, that they did not belong to a steppe elephant but to a forest one (*Palaeoloxodon antiquus*), whose bony remains are known from the period the early Pleistocene to the last glaciation (Butzer, 1972). However, this is not the case. According to Dr. Kubiak, an expert at the problems concerning fossil elephants, the molars from Rzochów can by no means be referred to *P. antiquus* (oral communication).

It still remains to consider the possibility, which cannot be excluded either, that the bony remains from Rzochów belonged to a woolly mammoth (*M. primigenius*), a species common in the woodless periods of the last glaciation. I mention it because in his description of some localities of the woolly mammoth in Poland, Kubiak (1972) reckons also the locality at Rzochów, here discussed, among them. In his opinion, the distinction of the teeth of the steppe elephant from those of the woolly mammoth presents great difficulties. "It is particularly difficult in the transitional forms living at the turn of the Middle Pleistocene. The distinctive characters of these species are so much interrelated that the inclusion of teeth in one or the other species is often the matter of the author's approach to the problem. ...At the present state of knowledge the specific determination of some dental specimens representing one of these two forms is impossible" (Kubiak, 1965, pp. 15 and 16).

The opinions quoted above entitle us to attempt a somewhat different interpretation of the mammoth locality at Rzochów from that given in papers by the authors mentioned in the Introduction of the present study.

The surface of the peat layer uncovered at the time of a low water level is rather large, for it occupies three-quarters of the width of the bottom of a fairly large river. The peat is black and compact, with tree trunks and branches. The thickness of its layer has been reduced by the erosional action of the river by 40—50 cm, as indicated by the position of the top of the same peat layer in the profile of the middle terrace adjacent to the locality under study (Laskowska-Wysoczańska and Niklewski, 1969).

Kubiak (1965) enumerates six localities of the woolly mammoth in the valley of the River Wisłoka, including that at Rzochów, and one of the steppe elephant, situated in the upper part of the valley, about 50 km from Rzochów. The stratigraphic position of these bones is not well known, they were — if my information is reliable — most often found during the excavation of sand and gravel from the river bottom. The bony remains of the woolly mammoth most probably lay primarily in the deposits of gravel, clay and sand which made up the accumulative middle terrace and were heavily eroded by the river.

Bones of the steppe elephant, which is considered to be an ancestor of the woolly mammoth, are known from a small number of localities situated in the neighbouring valleys of the rivers Wisłoka, Wisłok and San (Kubiak, 1965). They may also be derived from the deposits of the middle terrace, where — unlike the bones of the woolly mammoth — they had been transported to and redeposited. They may have come from Pleistocene formations older than the last glaciation preserved in the Northern Carpathians and in their foreland.

In the light of the foregoing remarks and opinions the bones from Rzochów may be regarded — in accordance with Kubiak's conviction (1972) — as belonging to the woolly mammoth. Then they would come from the deposits making up the middle terrace, their age being naturally younger than the age of the wood peat in which they were found (Laskowska-Wysoczańska and Niklewski, 1969).

The finding of a woolly mammoth skeleton in interstadial alder wood peat needs an explanation. It is probable that this skeleton belonged to a specimen that lived in a cold woodless period neighbouring directly upon a forest interstadial. Under unknown circumstances this mammoth may have perished in the swamp reconstructed above, which at the time still possessed its hummock structure characteristic of the *Carici elongatae—Alnetum* association. In this geographical latitude this swamp may have thawed to a considerable depth in summer months and become a trap from which the heavy animal could not get out (*cf.* Vereshchagin, 1967). This explanation agrees with the absolute age obtained for the bones (50,000—56,000 years).

It may well be that the mammoth bones got into the peat layer at Rzochów in a different way. The undermining of the middle terrace by flooded waters of the Wisłoka may have caused — as often happens nowadays — a big lump of deposits, in our case containing teeth and a number of skeletal bones of a woolly mammoth, to break off and slide down on to the eroded surface of the peat. This may have taken place in the Holocene, not before the Wisłoka had cut through the thick layer of deposits of the last glaciation. Then, however, it must be assumed ohat the process of washing away of this lump of deposits occurred while the flow tf the Wisłoka was so quiet that it was unable to transport and remove the bones.

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*Translated by Jerzy Zawadzki*

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