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IRENA GLUZA

NEOLITHIC CEREALS AND WEEDS FROM THE LOCALITY OF THE LENGYEL CULTURE AT NOWA HUTA—MOGIŁA NEAR CRACOW

Neolityczne zboża i chwasty ze stanowiska kultury lendzielskiej w Nowej Hucie—Mogile koło Krakowa

ABSTRACT. Charred plant material and impressions of cereals were studied from the Neolithic locality Nowa Huta—Mogiła 62 in Cracow. Macrofossils were connected with the middle phase of the Lengyel Culture and were dated by C—14 to 3480 BC. Cereals were represented by large number of spike fragments, spikelets and grains of *Triticum dicoccum, T. monococcum* and *Hordeum vulgare* var. *nudum*. Grains of *Bromus arvensis* and *B. racemosus* occurred in great quantity, diaspores of 32 other species were less abundant.

Biology of cereal species and ecological requirements of weeds were discussed with the aim to indicate the type of soils taken into cultivation. The predominance of weeds growing today in root-crops and in summer cereals gives the reasons for conclusion that cereals were sown mainly as summer crop. Seeds and fruits of weeds belong to species which attain different hight. This fact suggests that either the cereals (at least some of them) were cut at relatively low level, that is at the lower half of the stem, or one of cereal species was of low hight, much lower than today. Large number of fruits and seeds of wild plants indicates that food supply included also wild plant (first of all brome-grasses, *Bromus arvensis* and *B. racemosus* and hazel).

The results were compared with data obtained from other middle European localities belonging to the same phase of the Neolithic.

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INTRODUCTION

The Nowa Huta Section of the Archaeological Museum of Cracow has been carrying out excavations in the Nowa Huta District of the city of Cracow for thirty years (Fig. 1). In 1969, at the time of field studies conducted by Dr. M. Godłowska and Dr. M. Kaczanowska on the left-bank terrace of the Vistula, abundant carbonized plant materials were found in pit 416, are 134, site Nowa Huta—Mogiła 62. On the basis of the pottery material found in the pit Dr. M. Godłowska determined the age of the find, referring it to the late stage of the middle phase of the Lengyel Culture (Modlnica group).

Pit 416 was dug in a loess bed in a slope that sinks mildly towards the north. Its study was an emergency action after the upper layers had been destroyed by building operations. The pit appeared at a depth of 130 cm and it had the shape of an oval, 180 and 120 cm in diameter, in the horizontal view (Fig. 2). In the central part of the outline there was a fairly intense darkening, not shown in the profile of the pit. The transverse section of the pit showed its trough-like shape. Its fill was dark earth with loosely scattered clods of daub and fragments of pottery. Traces of burning of the loess were observed at the edge of the pit at a depth of 160—170 cm in its southern part. Carbonized plant remains formed a layer at the bottom of the pit at a depth of 170—180 cm in the southern part and 180—190 cm in the northern.

In the proximity of the pit described above three other pits, without any visible plant remains and marked in the substratum only by a slight darkening of the loess, a grave with a human skeleton in a crouched position and a pottery fragment have been found. There were no traces of houses, but the settlement representing the Lengyel Culture probably persisted here for a long time, for a system of ditches surrounding it has been uncovered.

Detailed results of the archaeological studies carried out at this locality were given by Godłowska (1976).

Cracow occupies an area of 230 km², its configuration being very complex and rich (Fig. 3). The left bank of the Vistula, where pit 416 was discovered, is covered chiefly with brown soils formed on loess, rich in nutritive components and sometimes also in calcium carbonate. Humus slope washes of the nature of chernozem are accumulated at the foot of the slopes and the low-lying damp and wet areas are covered by a thick layer of black earth. Clayey muds lie in the valleys of the Rivers Vistula and Dłubnia (Komornicki 1974). A map

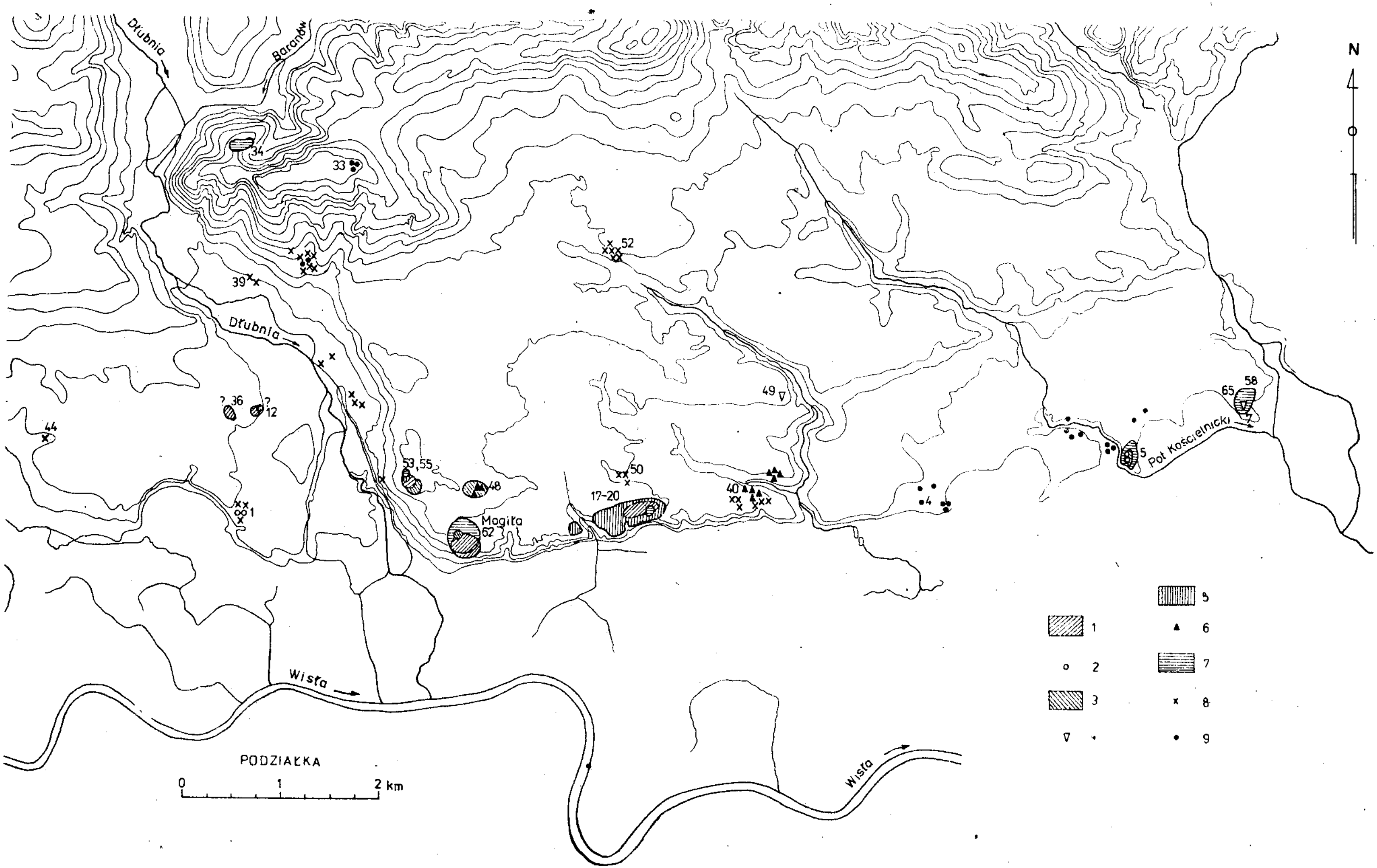

Fig. 1. Distribution of the Lengyel Culture sites on the territory of Nowa Huta in Cracow, acc. to Godłowska (1976). 1 — settlements of the Lengyel Culture (early phase); 2 — scattered findings; 3 — settlements of the Malice group of the Tisza Culture; 4 — scattered findings; 5 — settlements of the Lengyel Culture (middle phase, older stage); 6 — scattered findings; 7 — settlements of the Lengyel Culture (middle phase, younger stage): 8 — undefined findings of the Lengyel Culture; 9 — undefined Neolithic

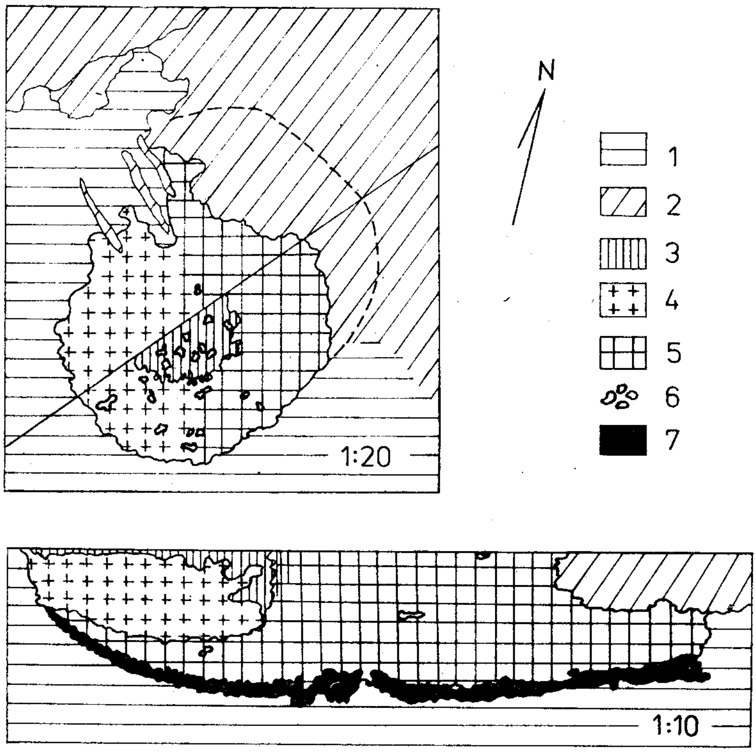

Fig. 2. Cracow—Nowa Huta, site Mogiła 62. Horizontal projection and profile of the pit 416. 1 — loess bed; 2 — disturbed area; 3 — dark earth; 4 — dark earth mixed with loess; 5 — dark filling; 6 — daub; 7 — charred plant remains

showing the potential natural vegetation of the Cracow area (Kornaś & Medwecka-Kornaś 1974) suggests that two complexes of forest communities were possible in the surroundings of the locality under study. The Pleszów terrace was overgrown with forests composed of many species of deciduous trees numbered in the complex of oak-hornbeam forest (resembling *Tilio-Carpinetum* but without the hornbeam or with a very small proportion of it). Various types of woods of the complex of river-side forest, similar to *Salici-Populetum*, *Alno-Padion* and *Carici elongatae-Alnetum*, developed in the valleys of the Vistula and Dłubnia. Woods spread everywhere but on the freshly exposed river deposits and bogs. There were probably no large natural treeless areas in the closest neighbourhood.

The area of Nowa Huta—Mogiła and adjacent Pleszów had already been colonized since the early Neolithic, first by people of the Linear Pottery Culture and next by settlers of early phases of the Lengyel Culture (Samborzec and Pleszów groups; Godłowska 1976; Kulczycka-Leciejowiczowa 1969). Even primitive husbandry of these groups of colonists must have had an effect on the primeval plant cover. The full reconstruction of the changes demands more extensive palynological studies, whereas the material discussed in this

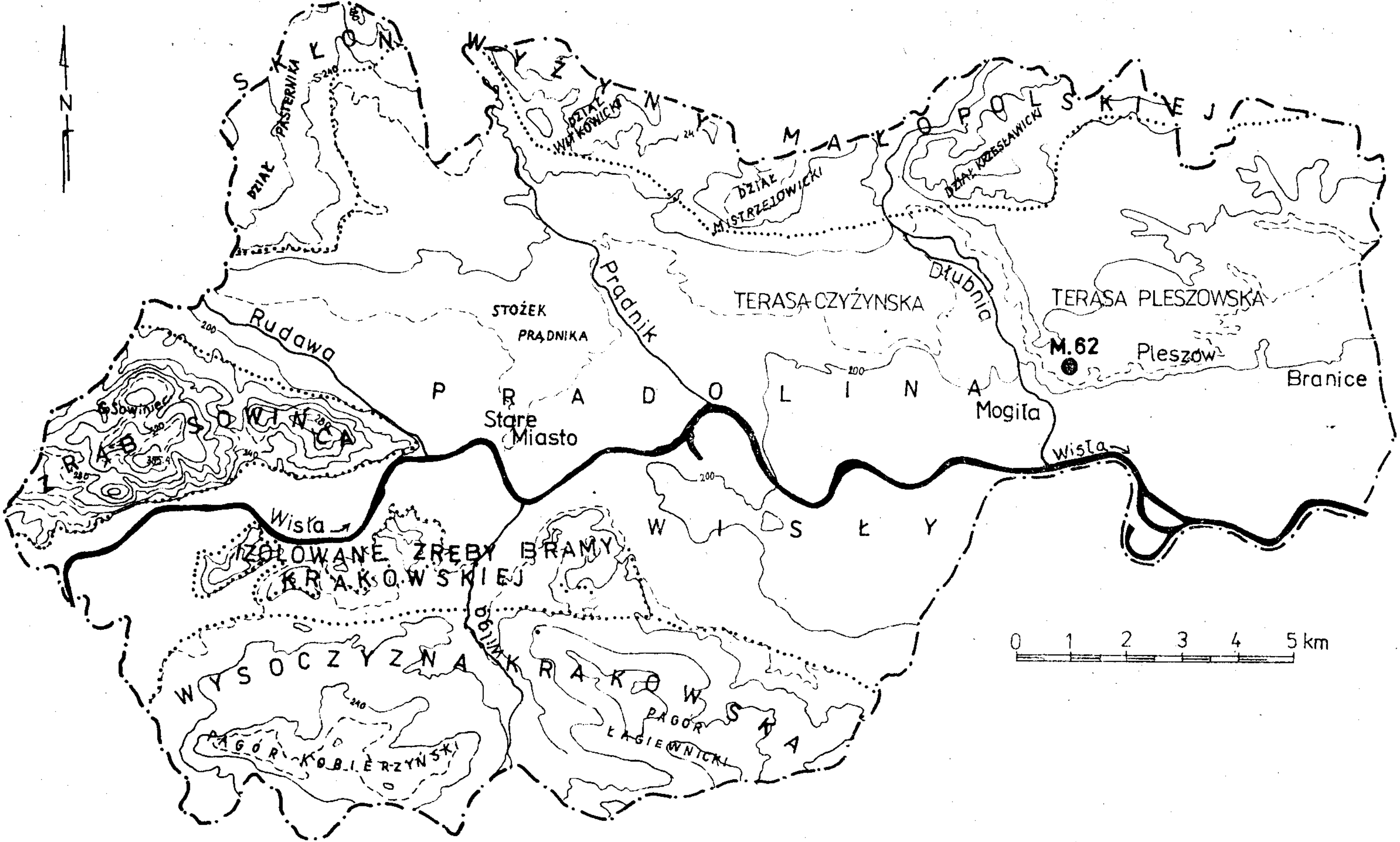

Fig. 3. Main geomorphologic units on the territory of Cracow acc. to Tyczyńska (1967), M. 62 — the locality Mogiła 62

paper gives a picture of the synanthropic flora which developed locally as early as the time of settlement of the Modlnica group of the Lengyel Culture.

Concluding these introductory remarks, I wish to express my grateful thanks to all that helped me with this work and so, above all, to Doc. Dr. K. Wasylikowa for her very kind assistance in the identification of remains and elaboration of the results. I am greatly indebted to Dr. M. Godłowska, who provided me with the material for study and archaeological data concerning the locality and to Dr. E. Rook for much archaeological information. I thank Doc. Dr. H. Trzcińska-Tacik for her help in the ecological-floristic analysis and Dr. M. Pazdur and Dr. A. E. Lanting for the radioactive-carbon dating of samples. My thank are also due to Doc. Dr. K. Radwański, Director of the Archaeological Museum in Cracow, for making it possible for me to carry out this work. I should besides mention Mr. L. Dziedzic and Mr. R. Łapanowski, who took photographs of macroscopic remains, for which I am grateful to them.

MATERIAL AND METHOD

The material used for palaeobotanical analysis consisted of daub with plant impressions obtained from four horizons of the pit and charred organic material from the bottom layer, gathered separately from the northern and the southern part of the pit. The carbonized organic remains were mixed with loess earth, yellow and grey-brown in colour, stuck partly together into not very compact clods. Small fragments of clay, resembling the daub in colour, were found in several clods.

All the charred material was closely examined under a magnifying glass before it was subjected to any further procedures and the corn spikes or their fragments were cleaned by removing the seeds and fruits of weeds, loose grains of corn and earth covering them with the help of a needle and a small brush. Although the examination was carried out with much care, no spikes were found with the glumes completely preserved. Only the thick lower parts of the glumes and the rachis internodes occurred with the wheat grains. In the fragmentary barley spikes there were nearly exclusively naked grains and only remains of the glumes between the grains. In the lumps with charred remains many spikes have persisted lying more or less horizontally but scattered in a disorderly manner on the surface, often overlapping each other (Pls. I, IV). Not all the remains could be exposed in them and consequently only fairly large fragments of spikes were cleaned, fixed in epoxide resin and left partly stuck in the lump of earth. On the bottom of the pit the corn species were not separated spatially, as the fragments of spikes of the three species identified occurred side by side in the clods of material derived from all over the pit floor.

In order to examine the quantitative relations between the remains of cereals and weeds and to get to know the composition of the material from the southern and the northern part of the pit, one two-kilogram sample from either part of the pit was soaked and washed through a sieve. Clods of material in which no fairly large fragments of spikes were observed and the earth removed in the course of the cleaning of spikes were used for this purpose. By washing these two samples, we obtained detached grains of wheats, their numerous spikelet forks and glume bases as well as grains and a rachis internode of barley. No straw was found in the whole of this material and only a few small nodes of grass stems. The seeds and fruits of weeds formed nearly a half of the carbonized vegetable matter obtained by washing, shrubs being represented by fragmentary hazel nutshells and charcoal found in the sample from the northern part of the pit.

In the lumps of daub examined under a binocular microscope the same cereal species have been identified as in the material obtained by washing. They occurred as impressions of naked grains, whole spikelets, their forks, and detached glume bases. There were also some impressions of barley rachis internodes and several fine caryopsides of grasses.

In the case of certain negative impressions, to make their identification easier, their positive casts were made by powdering the depressions with small amounts to talc and next coating them with a mixture of silicone rubber (Dow Corning 9161 — RTV + catalyst Dow Corning N—9162) and black dye (Indian ink). Having dried up, this mixture retained elasticity and could be easily separated from the daub or pottery.

The dimensions of charred seeds and fruits and those of casts were measured, using an ocular-micrometer, to an accuracy of 0.05 mm. In descriptions the commonly used order of measurements is: length × width × thickness.

In order to find the morphological differences between the cereal grains from the southern and the northern part of the pit, 100 grains of either wheat species and barley from either sample subjected to washing were measured. The grains badly deformed by burning were not measured. The indices, i. e. the length: width and thickness : width ratios were calculated and the results obtained are presented in the form of graphs and tables.

A sample of charred material was analysed at the C—14 Laboratory, Silesian Polytechnic University in Gliwice. The charred cereal grains and weed fruits used came from the northern, deeper part of the pit bottom. The age of sample Gd—164 was 5150±180 B. P., i. e. 3200±180 B. C. (Mościcki & Zastawny 1976). Several years later another sample of charred material, also from the northern, deeper part of the pit bottom, was dated in the C—14 Laboratory at Groningen. The result of dating of sample GrN—9239, obtained due to the courtesy of Dr. A. E. Lanting, is 4120±35 B. P. (2170±35 B. C.), and so the age of the archaeological find and charred plant remains would be considerably younger. A revision of the archaeological materials found together with the charred plant remains in the pit carried out by Dr. M. Godłowska, confirmed the correctness of the first determination concerning the cultural content of pit 416. To elucidate the differences between the results of these

Table 1

List of plant macrofossils from the locality Kraków, Nowa Huta—Mogiła 62, pit 416

Taxa*	Charred plant remains				Impressions in daub			
	S part depth: 170—180 cm		N part depth: 180—190 cm		S part	S part	S+N parts	N part
	washed fraction	unwashed fraction	washed fraction	unwashed fraction	depth: 130–140 cm	depth: 140–150 cm	depth: 150–160 cm	depth: 170–180 cm
1	2	3	4	5	6	7	8	9
I. Cereals								
Triticum monococcum L.								
grains	165+5 fr (3.5 cm³)		280 (7 cm³)			1		
spikelets		4		2	1	4+7?	5+2?	
spike fragments		8+2?		12				
Triticum dicoccum Schübl.								
grains	370+60 fr (14 cm³)		1240 (34 cm³)		1	4		
spikelets		11+2 fr		16+10 fr	5+2?	6+1 zw	8	5
spike fragments		15+3?		28+1?				
spikelet bases						2	1	2
Triticum monococcum/T. dicoccum								
grains	112+72 fr (6 cm³)		320+35 fr		1	1		
spikelets		2		2		14+2 zw	8	
spikelet bases	386		427		3+1 zw	45+8 zw	40+6 zw	5
glume bases	604		786		25	22+5 zw	36	3
glume fragments	20		18					
spike fragments		4		4+3				
lemma/palea fragments						+		

Triticum sp.								
grain fragments grains	14 cm³		9 cm³		1		1	
Hordeum vulgare L. em. Lam. var. *nudum*								
grains	232+252 fr (9 cm³)		390+320 fr (12 cm³)			1		
spike rachis fragment	1				1	2	2	
spike fragments		7+6?		9+7?				
Cerealia indet.								
stem fragments			8					
embryos			2?					
II. Wild herbaceous plants								
Polygonum aviculare L.	2							
Polygonum convolvulus L.	1285 (8 cm³)		1190 (7 cm³)					
Polygonum cf. *minus* Huds.	3							
Polygonum nodosum Pers.	28+4 fr		16+4 fr					
Polygonum persicaria L.	5		2					
Polygonum sp.	21+11 fr		14 fr					
Chenopodium album L.	271		174+23 fr					
Chenopodium polyspermum L.	80+14 fr		31+6 fr					
Chenopodium urbicum L.	7		2					
Chenopodium sp.	63+78 fr		25+38 fr					
Melandrium album (Mill.) Garcke	28		10					
Melandrium rubrum (Weig.) Garcke	4		2					
Melandrium sp.	18		13					
Silene inflata (Salisb.) Sm.			2					
Viola tricolor L./*V. arvensis* Murr.			2					
Potentilla reptans L.			7					
Lotus cf. *corniculatus* L.			1					
Trifolium hybridum L./*T. elegans* Savi.			2					
Trifolium cf. *montanum* L.	27		34+12 fr					
Trifolium cf. *repens* L.	3							

1	2	3	4	5	6	7	8	9
Trifolium sp.?	3		3					
Vicia sp./*Lathyrus* sp.					1			
Solanum nigrum L.	25+1 fr							
Euphrasia sp./*Odontites* sp.	1?		1					
Linaria cf. *vulgaris* (L.) Mill.	1 p							
Scrophularia sp.	6 n+11 t		32 n+3 t					
Verbascum sp.	6		13					
Ajuga genevensis L./*A. reptans* L.	1+1 fr							
Veronica sp.			1					
Plantago media L.	1							
Galium cf. *boreale* L.	9		24					
Galium verum L./*G. mollugo* L.	13		7					
Galium sp.	26		38					
Sambucus ebulus L.			3+6 fr					
Campanula sp.	2 n+1 spr		2					
Centaurea jacea L.	1+1 fr							
Centaurea scabiosa L.			2					
Bromus arvensis L. / *Bromus racemosus* L.	50 cm³		45 cm³					
Bromus sterilis L.	14+47 fr		12+28 fr					
Digitaria ischaemum (Schreb.) Muehlenb.	1							
Digitaria cf. *sanguinalis* (L.) Scop.	1		3					
Digitaria sp.	3 fr		2 fr					
Echinochloa crus-galli (L.) P. B.	8		4					
Setaria viridis (L.) P. B./*S. verticillata* (L.) P. B.	5		4+1 fr					
Panicoideae			1					
Caryophyllaceae	68		66					
Papilionaceae	1+4 fr		41					

Umbelliferae	2							
Compositae			3					
Gramineae	5		1					
undeterminated	6 n+1 t		5 n					
III. Trees and shrubs								
Corylus avellana L.	3 fr o		14 w 4 fr o					

fr — fragment, zw — charred, n — seed, t — capsule, p — flower bud, spr — hygroscopic spring, w — charcoal, o — nut two datings, another sample of material has been sent to the C—14 Laboratory in Gliwice. The age of this sample is Gd—893 5520±100 B. P. In the opinion of Dr. M. Pazdur both dates from Gliwice are consistent and the difference between them is due to the accidental fluctuation of measuring equipment. Average age of the sample is 5430±90 B. P. (3480 B. C.) and agrees well with the archaeological interpretation.

DESCRIPTION OF PLANT REMAINS

A list of all the plants identified is given in Table 1. The number of plant impressions in the daub is presented in the last four columns. The first four columns contain the numbers of charred seeds and fruits found in both the washed and nonwashed fractions of the material from the southern or the northern part of the pit. The nomenclature of cereals has been adopted after Schiemann (1948), that of the remaining plants after Rośliny polskie (Szafer et al. 1967), and the names from the Flora Europaea (1964—1976) are placed in brackets.

Cereals

Triticum dicoccum Schübl. — Emmer

Most cereal remains examined belonged to *Triticum dicoccum*. They were fragments of spikes, spikelets, grains and detached spikelet forks and glume bases (Table 1).

A specimen was classified as a fragmentary spike when it consisted at least of two neighbouring spikelets. In the clods I managed to find 43 distinct fragments of spikes and 4 uncertain ones, i. e. concentrations of grains which may have belonged to a single or to different spikes. In the best-preserved specimens all or most spikelets had two grains, with their ventral sides turned towards each other, and with the glume bases. Rarely, the neighbouring spikelets were still joined by fragmentarily preserved rachis internodes (Pls. I—III, V). Most specimens were however very badly damaged and nothing but grains remained of successive spikelets (Pl. IV). In many fragments one grain was as a rule found of each particular spikelet (Pl. IV, 2).

In addition to these fragmentary spikes there were also detached charred spikelets, of which 27 were whole, 12 fragmentary ones and 29 impressions. They comprised glume bases, sometimes with a rachis internode, and one or two grains each (Pl. VIII).

The charred emmer glumes and their impressions showed a distinct keel — slightly divergent — on the ventral side, and a less distinct one on the dorsal side. The surface between the keels was smooth. These features were well seen on the cast of a spikelet impression in the daub (Pl. VI). The greatest width of this spikelet was 5.4 mm.

Table 2

Dimensions and indices for *Triticum dicoccum* grains from the Neolithic site Nowa Huta—Mogiła 62. L — length, B — breadth, T — thickness, S — southern part of the pit, N — northern part of the pit

	L	B	T	$\frac{100 \cdot L}{B}$	$\frac{100 \cdot T}{B}$
S					
n = 100 min.	4.20	1.65	1.55	170	67
aver.	5.28	2.65	2.31	203	87
max.	6.50	3.30	2.95	306	104
N					
n = 100 min.	4.65	1.75	1.60	163	70
aver.	5.39	2.73	2.32	199	85
max.	6.60	3.55	2.90	303	107

The emmer grains washed out from the two samples, 1610 complete and 60 fragmentary specimens altogether, had their ventral side flattened, with a shallow depression half-way along (Pl. VII). Their dorsal side was strongly convex, with a distinct though gentle asymmetrical ridge. The glume venation was imprinted on the lateral sides of many grains. Most grains had both ends narrowed and their greatest width in the middle (Pl. VIII, 1). The grains of some spikelets had their upper parts broadened and somewhat truncated (Pl. VIII, 6). Van Zeist (1968) described grains similar in shape and believed that this was a deformation caused by carbonization. The thick glume bases are resistant to the action of high temperatures and prevent the lower parts of grains from excessive swelling, whereas the upper portions of the glumes are easily destroyed and so make it possible for the upper halves of the grains to expand. The measurements of detached grains and the indices are given in Table 2 and Figs 4—5. Table 3 contains the measurements of the grains, spikelet forks and glumes preserved in detached spikelets and fragmentary spikes.

The emmer grains derived from one-seeded spikelets (not only from the top ones, as indicated by the scar left after the tearing off of the next spikelet) differed from the grains of two-seeded spikelets. Some of them resembled einkorn grains, for they had their ventral and dorsal sides more convex (Pl. VIII, 7). Their furrow was tightly compressed in the lower part and more widely opened in the upper part than it was in the einkorn grains. Others were similar to the typical emmer grains but somewhat narrower (Pl. VIII, 8). The thickness: width ratio for the grains from one-seeded spikelets comes close to the maximum values obtained from emmer grains and the minimum ones from einkorn grains. This likeness in the shape of some grains of these two wheat species makes them incapable of being discriminated and so they are all placed together under the caption *Triticum dicoccum* or *T. monococcum* (22 cm³) in the table.

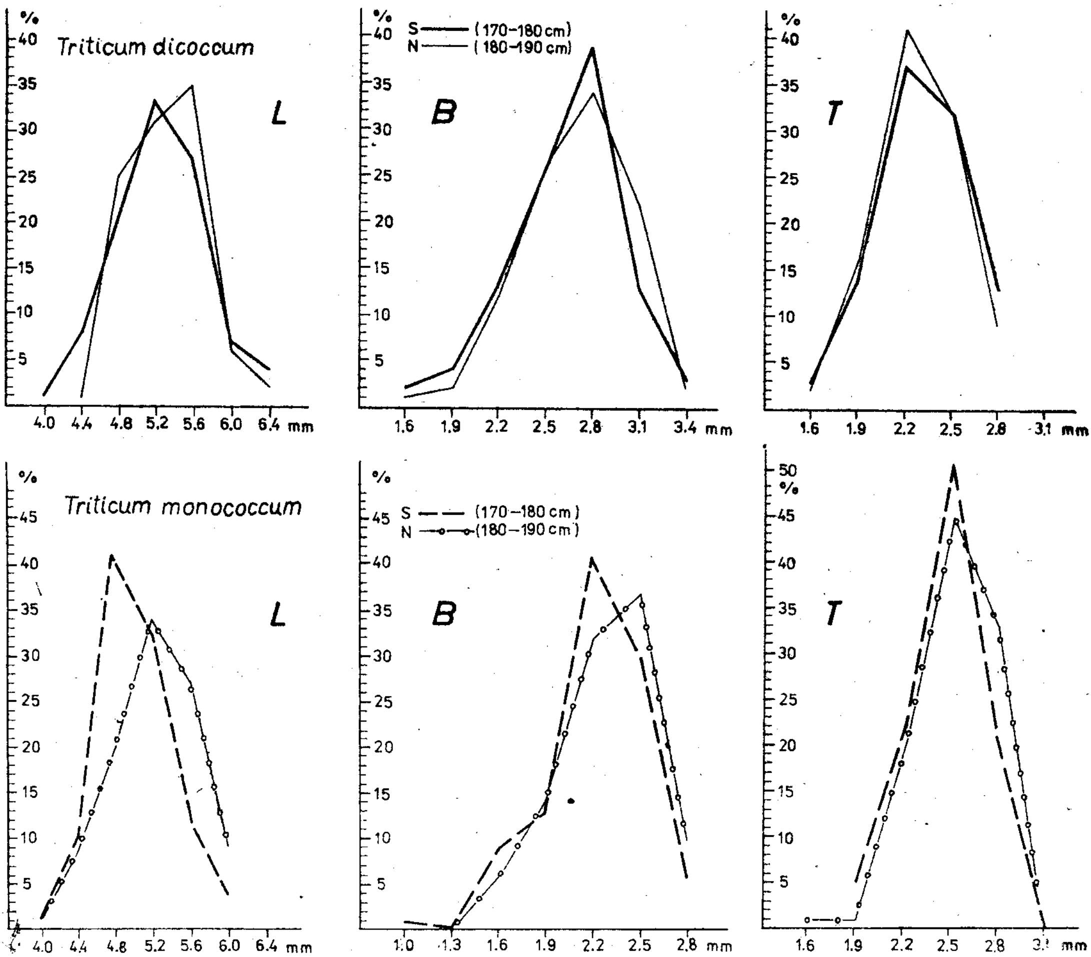

Fig. 4. Dimensions of grains of *Triticum dicoccum* and *T. monococcum* from the pit **416.** L — length; B — breadth; T — thickness; S — grains from the southern part of the pit; N — grains from the northern part of the pit; n = 100 for each dimension

Triticum monococcum L. — Einkorn wheat

The number of remains belonging to *Triticum monococcum* was considerably smaller. They were fragments of spikes, detached spikelets, grains, spikelet forks and glume bases (Table 1).

The spike fragments (20+2?) contained 3 to 10 spikelets. The grains of these fragments were strongly compressed. Some of them were seen from the ventral side, others from the dorsal side. In many specimens the glume basis and cracked rachis internodes stuck between the grains. Most spike fragments had well-developed grains (Pls. IX, X, XI); only in a few fragments the grains were markedly narrower and more damaged (Pl. XI). These may have been spikes with unripe grains. In some spike fragments particular grains differed

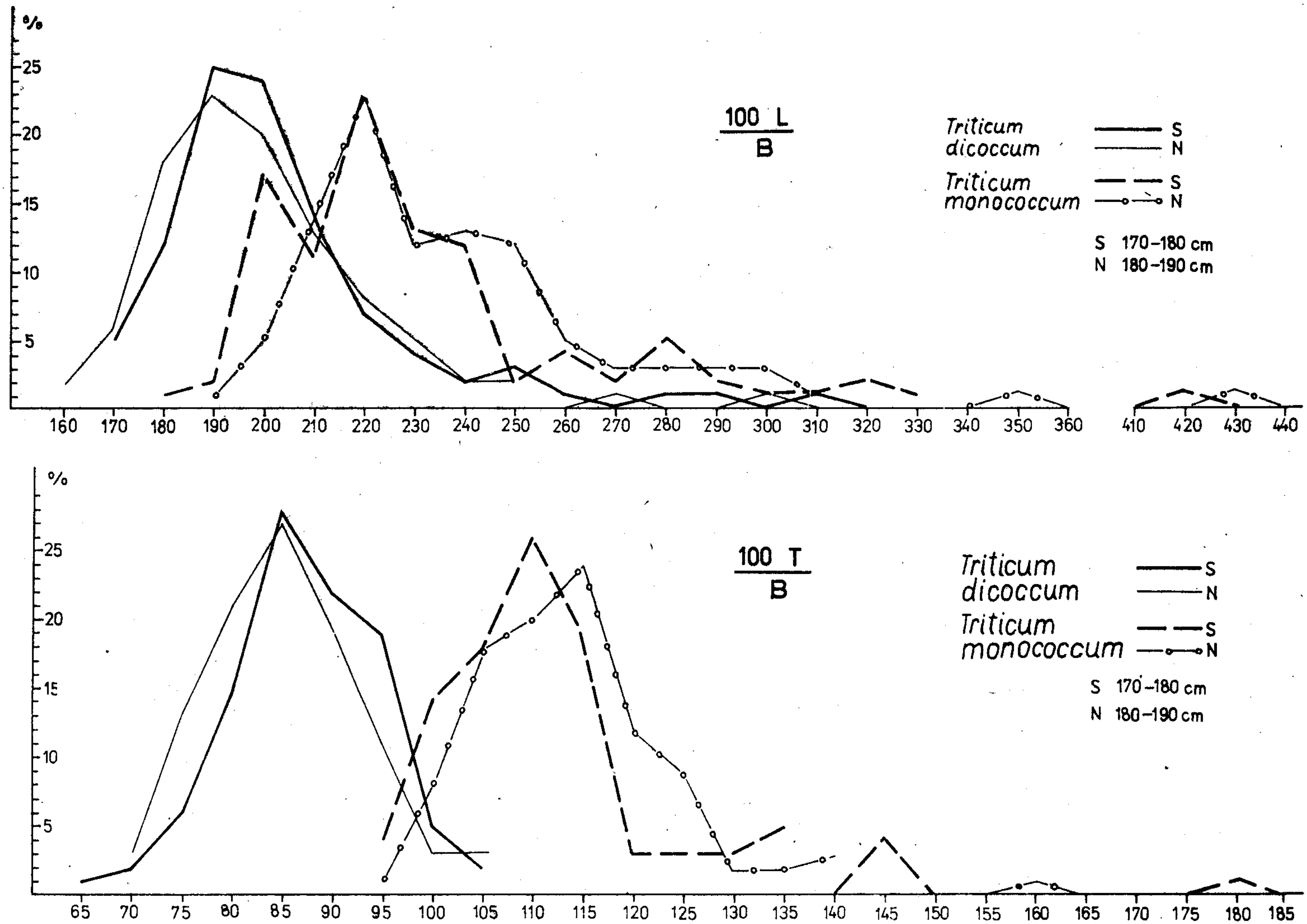

Fig. 5. The ratios of length(L) to breadth (B) and thickness(T) to breadth for grains of *Triticum dicoccum* and *T. monococcum* from the pit 416. N — grains from the northern part of the pit S; — grains from the southern part of the pit

Table 3

Dimensions of grains and spikelets of *Triticum dicoccum* from the site Nowa Huta-Mogiła 62

I. Breadth of spike rachis internodes (lower end)
0.9 0.7 0.6 1.1 0.9 0.7 mm

II. Detached 2-grained spikelets [1]

"A"	2.2	1.7	1.5				1.7	1.6	2.2		2.0
"B"										0.7 0.8	
L	6.0	5.8 5.1	5.0 5.1	5.2 4.8	5.2 5.6	5.2 5.0	4.5 4.6	5.0			
B							2.0 2.0				
T	2.5 2.2	1.7 2.3	2.0 2.3	2.1 2.3	1.8 2.3	2.0 1.7		2.0	2.6 2.4		

III. Detached 1-grained spikelets [1]

breadth of spikelet base	"A"	1.6	1.7		
breadth of glume base	"B"	0.7			
length of grain	L	5.0	4.5	5.4	5.7
breadth of grain	B	2.7		2.5	2.4
thickness of grain	T	2.5	2.2	2.5	2.4

IV. Spike fragments [1]

"A"	not possible to measure				
"B"					
L	5.2 4.8 4.8 4.5 4.6 4.8	5.7 5.0 5.2	5.3 5.0 5.2 5.0 4.8	5.2 5.0 5.3 5.0 5.7	5.0 5.1 4.8 5.5
B	2.6 2.6 2.3 2.7 2.7	2.1 2.3 2.5	3.0 2.3 2.8 2.5 2.2	2.2 2.6 2.2 2.7	2.5 2.5 2.8 2.4
T	2.2			2.5	

[1] Groups of measurements concern specimens from one fragment of spike or spikelet

in width and in the degree of opening of the furrow. Fragments of detached spikelets (6 charred and 10+9? imprints) had spikelet base and one grain. A nearly complete spikelet was preserved as an impression in the daub (Pl.VI).

The charred einkorn glume bases and their impressions showed a distinct keel on the ventral side, more salient than in emmer glumes and shifted further towards the ventral side. It formed a pronounced ridge, visible on the spikelet base as low as the level of the ventral scar (Pl. VI). This feature makes it possible to discriminate the spikelet forks of the two wheat species (Knörzer 1971). Another keel, less prominent, was on the dorsal side of the glume. No distinct venation was seen between both keels. Some spikelet forks were found with the rachis internodes preserved.

Table 4

Dimensions and indices for *Triticum monococcum* grains from the Neolithic site Nowa Huta—Mogiła 62. L — length, B — breadth, T — thickness, S — southern part of the pit, N — northern part of the pit

		L	B	T	$\frac{100 \cdot L}{B}$	$\frac{100 \cdot T}{B}$
S						
n = 100	min.	4.20	1.10	1.95	179	93
	aver.	5.09	2.24	2.49	231	113
	max.	6.25	2.85	3.00	330	145
N						
n = 100	min.	4.15	1.10	1.75	195	96
	aver.	5.30	2.28	2.56	239	114
	max.	6.25	2.90	3.05	332	159

The grains of this species obtained from the two samples, 445 entire grains and 5 fragments altogether, had their ventral and dorsal side very convex and both ends narrowed (Pl. VII). On the dorsal sides they had a pronounced ridge running more or less symmetrically. Most grains were characterized by their small width and narrow furrow (Pl. XI, 1). Some of the grains were broader, their furrows being more widely opened and with rounded edges (Pl. XI, 2). The great convexity of the ventral and dorsal sides was a character common to both types of grains, finding its reflection in their thickness and the thickness: width ratio. The value of this index clearly differs einkorn and emmer grains from each other, which has already been emphasized by Klichowska (1970, 1976). The measurements of the grains and of some of the spikelets are given in Tables 4 and 5 and in Figs 4—5.

Triticum dicoccum Schübl. and *T. monococcum* L.

The two samples of material contained 813 detached spikelet forks and 1390 glume bases not identified to specific level. Fifty spikelet forks were

Dimensions of grains and spikelets of *Triticum monococcum* from the site Nowa Huta—Mogiła 62

I. Spike rachis internodes
length mm 1.5 1.2 1.2
breadth mm 1.1 1.0 1.0 1.1 1.1 1.0 0.9

II. Detached spikelets[1]

breadth of spikelet base	"A"	1.7	1.6	1.5		1.8
breadth of glume bases	"B"	0.6			0.5	
length of grain	L					
breadth of grain	B					2.0
thickness of grain	T					

III. Spike fragments[1]

"A"													1.3			
"B"	0.4	0.5				0.5			0.5							
L	4.6	4.5	5.1	4.7	4.6	5.2	4.6	5.0		4.8	4.4			3.9	4.8	4.2
B			2.2		2.3		1.9	2.1		2.0	2.1	2.0				1.8
T	2.0					2.5									2.3	

"A"	not possible to measure												
"B"													
L	5.0	5.0	4.9	4.5	4.8		4.8	4.2	4.7	5.0	4.8	4.0	4.0
B	2.2	2.2		2.2	2.3	2.3	2.5	1.2		1.3		1.2	1.4
T			2.6		2.5		1.6		1.8				

[1] Groups of measurements concern specimens from one fragment of spike or spikelet

chosen at random from either sample and their width (A) and the width of the base of both glumes (B) were measured (Table 6; Fig. 6).

The spikelet fork width curve has two peaks (Fig. 6), which indicates the presence of two species. The fork widths of several einkorn and emmer spikelets derived from fragmentary spikes (Tables 3, 5) evidence that there is a wide range of variation of this dimension for both wheat species and single specimens cannot be identified on this basis alone.

Table 6

Breadth of spikelet bases (A) and glume bases (B) from unsegregated samples of *Triticum dicoccum* and *T. monococcum* from the site Nowa Huta—Mogiła 62. S — southern part of the pit, N — northern part of the pit

	A	B right side	B left side
S			
n = 50 min.	1.00	0.45	0.42
aver.	1.66	0.66	0.65
max.	2.35	0.95	0.95
N			
n = 50 min.	1.20	0.45	0.42
aver.	1.69	0.66	0.66
max.	2.35	0.90	0.95

The glume base width curve has also two peaks (Fig. 6). This trait discriminates the einkorn and emmer remains examined. A comparison of the graph with the width of the glume bases preserved in spikes (Tables 3, 5) allows the assumption that the specimens less than 0.6 mm wide belong to *T. monococcum* and those above 0.6 mm to *T. dicoccum*.

Hordeum vulgare L. em. Lam var. *nudum* — Naked common barley

The barley remains included fragmentary spikes, parts of spike rachides impressed in daub, a fragment of a charred rachis and numerous detached grains.

The fragmentary spikes, 16+13? in number, consisted nearly exclusively of grains only, which were arranged in triplets. Fine crumbled parts of the rachis preserved among the grains were found only in few specimens, but there were no well-seen remains of lemma or palea. In some spike fragments the grains were thick, broad and divergent to the sides. The lateral grains in triplets differed little both in shape and in size from the middle grain (Pl. V, 5; Pl. XIII). In most fragments the grains were more closely pressed against each other in a triplet and the middle grain was larger and broader than the lateral ones (Pl. V, 6—8. Pl. XII). No traces of destroyed lemmas or paleas were

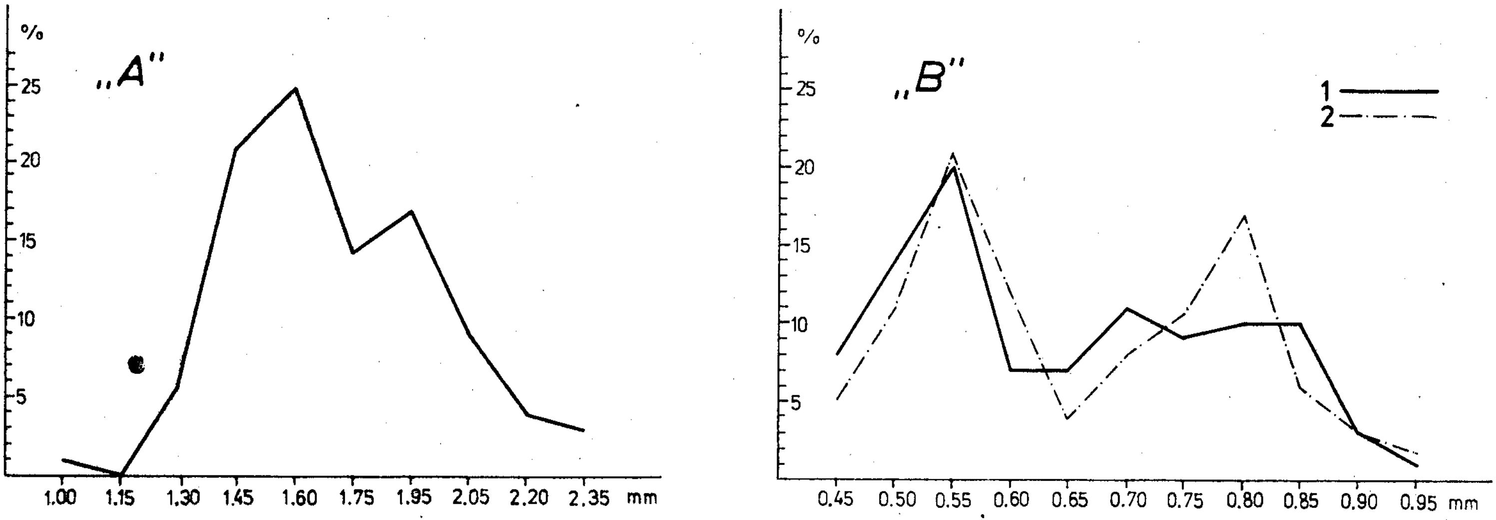

Fig. 6. ***Triticum dicoccum*** **and** ***T. monococcum*** **from the pit 416. A — breadth of spikelet base; B — breadth of glume base; 1 — left glume; 2 — right glume from the same spikelet; n — 100 for each dimension**

observed on the surface of the grains. There were however delicate transverse wrinkles of the epidermis visible in the well preserved specimens. These features are characteristic of the grains of the naked barley (van Zeist 1968).

A small amount of daub from the upper layers of the pit also contained some traces of barley, namely, an impression of a half of a naked grain and five impressions of spike rachis fragments. One fragment represented the top part of a stem with the three lowermost rachis internodes (Pl. XIV). The remains of three spikelets of a triplet could be seen on at least one internode in the casts of these impressions. They consisted of the lower half of the palea, and a narrow strip of the lemma base or a scar left after the breaking-off of the lemma (Pl. VI). In the middle portion of the palea there was a longitudinal fold which was a trace of the grain furrow.

The preservation of all these elements on the rachis, apart from the characters of caryopsides, indicates that this was naked barley, in which naked grains fall out of the ear, while the glumes, lemmas, paleas, rachillae and lodicules remain on the spike rachis. In the hulled varieties lemma and palea coalesce with the grain and fall off together with it and only glumes remain on the spike rachis (Schiemann 1948). The lower portions of the bristle like glumes were visible in one impression (Pl. VI, 4) and on the only charred specimen preserved (Pl. V, 11). The edges of the rachis and the lower portions of the glumes of these specimens were hairy.

The shape of rachis internodes, as shown in their impressions, was rather differentiated. Some of them were short and broad, others more elongated (Pl. VI). Only some of them were fit for being measured. The length of two separate longer internodes was 3.5 and 3.6 mm and their upper and lower widths were 2.6 and 1.3 mm in the first specimen and 2.6 and 1.4 mm in the second. The total length of rachis fragment composed of three internodes

Table 7

Dimensions and indices for the grains of *Hordeum vulgare* var. *nudum* from the Neolithic site Nowa Huta—Mogiła 62. L — length, B — breadth, T — thickness, S — southern part of the pit, N — northern part of the pit

		L	B	T	$\frac{100 \cdot L}{B}$	$\frac{100 \cdot T}{B}$
S						
n = 100	min.	3.60	1.60	1.07	154	60
	aver.	4.89	2.55	1.93	194	75
	max.	6.20	3.35	2.85	253	88
N						
n = 100	min.	3.75	1.65	1.05	158	62
	aver.	4.87	2.52	1.89	195	74
	max.	6.15	3.40	2.75	242	83

was 4.4 mm. Their upper widths were 2.7 and 2.3 mm and the lower width of the lowermost internode was 1.8 mm.

A total of 622 entire grains, 572 halves and 1 damaged fragment of spike rachis were obtained from the two washed samples. The grains were spindle--shaped (Pl. XIV), oval in cross-section, and their furrows narrow and shallow, with rounded edges. There were no traces of lemma and palea, but transverse epidermal wrinkles were seen. Two types of caryopsides were distinguished: larger dumpy, mostly symmetrical grains and smaller narrower ones, with the furrow bent in the lower half of the grain (Pl. V, 10). Out of a hundred grains picked out at random, 43 had the furrow bent in the lower half. The differentiation of the grains in shape is shown by the two-peak curve representing the grain length: width ratio, but is not reflected in their size and in the thickness: width ratio (Figs 7 and 8; Table 7).

Hordeum vulgare has a six-row variety, called also dense-eared (var. *hexastichon* L.) and a four-row, otherwise lax-eared, variety (var. *tetrastichon* Korn.). The criteria for the distinction of these forms are differences in the length of the rachis internodes and in the arrangement of spikelets in the spike (Schiemann 1948; Szczegółowa uprawa roślin, 1976; Gierat 1973).

The six-row barley has a relatively short and compact spike. The rachis internodes are short and, in consequence, the spikelets of neighbouring triplets press against each other and, pushing each other aside, are arranged in 6 symmetrical rows. All the grains in a triplet are the same size. The four-row barley has longer rachis internodes and a looser ear. The lateral spikelets of neighbouring triplets imbricate each other and thus only four rows of spikelets can be seen distinctly in the cross-section of a spike. In this variety the lateral grains are asymmetrical, somewhat twisted in relation to their axes and apparently smaller than the middle grains. Most of the now grown many-rowed barleys belong to this variety.

According to Schiemann (1948), the lower length limit of the rachis internode of four-row barley is 2.5 mm. In more recent agricultural literature the values 2.8—4.0 mm are given for the length of the rachis internodes of this variety and 1.7—2.1 mm for the length of the internodes of the six-row barley (Szczegółowa uprawa roślin, 1976).

However, a number of reservations have been made in palaeobotanic works as regards the possibility of the discrimination of these two forms in subfossil materials exclusively on the basis of the length of rachis internodes. Their absolute length need not differ between the two varieties and two or three basal internodes of the lax-eared form are so short and broad that they can be easily confused with the internodes of the dense-eared form (van Zeist 1968). On the other hand, in the top portion of the spike of the dense-eared form there are sometimes fairly elongate internodes, similar to those of the lax--eared form. Having come across single internodes of the spike rachis in fossil materials, one finds it hard to tell from which part of the spike they come and, consequently, these fragments cannot be identified precisely.

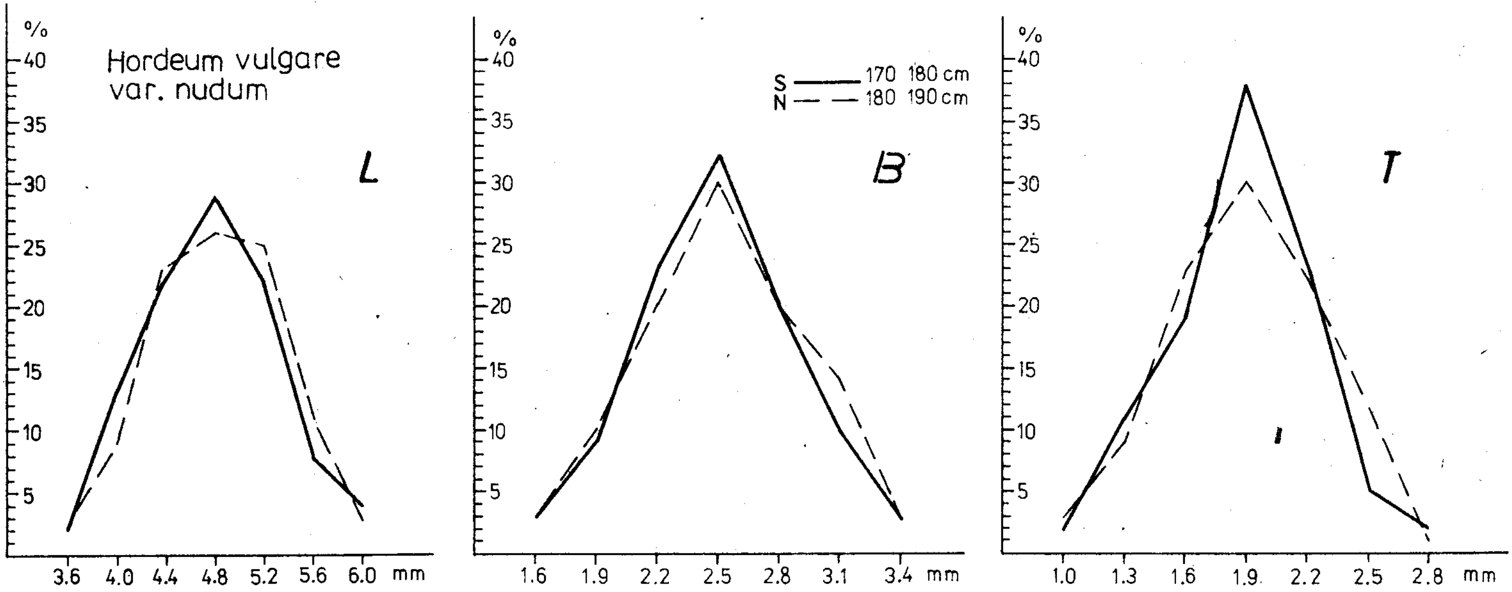

Fig. 7. Dimensions of grains of *Hordeum vulgare* var. *nudum* from the pit 416. L — length; B — breadth; T — thickness; S — grains from the southern part of the pit; N — grains from the northern part of the pit; n = 100 for each dimension

The length of the two longest Neolithic internodes from Mogiła lies clearly above the lower limit of the internode length in the lax-eared form and corresponds to the length of the several longest rachis internodes included by van Zeist (1968) in the lax-eared form. The measurements of the remaining impressions of internodes permit only the supposition that they may come from the lower part of a spike of the lax-eared form or that they are remains of the dense-eared form. Taking into account all the characters observed in our fossil material and so the length of the rachis internodes and the occurrence

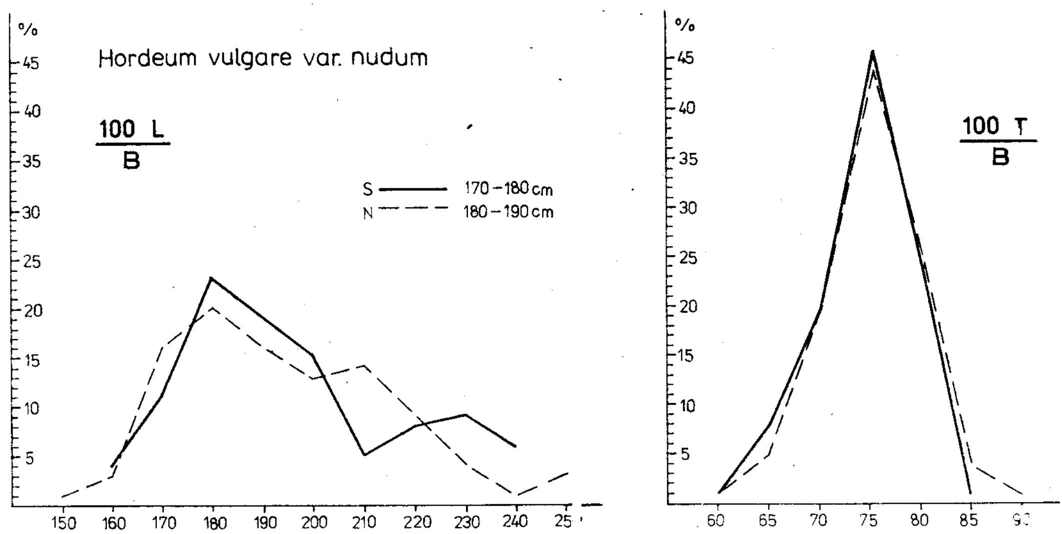

Fig. 8. The ratios of length (L) to breadth (B) and thickness (T) to breadth (B) for grains of *Hordeum vulgare* var. *nudum* from the pit 416. S — grains from the southern part of the pit; N — grains from the northern part of the pit

of two types of grains, we may assume that in the settlement examined naked four- and six-row barley was cultivated. Most of the spike fragments belonged to the four-row variety of barley.

Wild plants

Betulaceae

Corylus avellana L.

Seven fragmentary nutshells and 14 tiny charcoals have been obtained from the two samples. A cracked half of a nutshell was also preserved in a clod of charred material. Internal canals runinng along the long axis of the nut were observed in the transverse surface. The charcoals from the northern part of the pit were first erroneously identified as hornbeam (*Carpinus betulus* L. — Gluza 1971). Their derivation from hazel is based on the presence of scalariform perforation in the vessels.

Campanulaceae
Campanula sp.

Four seeds, ovate-elliptic in outline, slightly bent and flattened, with delicate longitudinal striation (Pl. XIX). Measurements: 0.60 × 0.50 × 0.25; 0.65 × 0.55 × 0.15; 0.65 × 0.55 × 0.25; 0.75 × 0.55 × 0.15 mm.

Campanulaceae indet.

A sclerenchymatic hygroscopic spring has been found in a sample of washed material (Pl. XIX). Such springs occur in the septa of capsules of *Campanulaceae.* They facilitate the bursting of capsules and the dispersal of seeds (Tacik 1971).

Caprifoliaceae
Sambucus ebulus L.

Three entire and 6 fragmentary seeds (Pl. XVIII), broadly ovate in outline, with the dorsal side gently convex and the ventral side slightly roof-shaped. Measurements of three seeds: 2.3 × 1.6 × 0.9, 2.5 × 1.7 × 0.95, 2.6 × 1.8 × × 0.95 mm.

Caryophyllaceae
Melandrium album (Mill.) Garcke (*Silene alba* (Mill.) E. H. L. Krause)

Thirty-eight seeds numbered in this species (Pl. XVI). Measurements of 28 seeds: length — 1.04 (0.85—1.20), width — 0.83 (0.75—0.95), thickness 0.67 (0.55—0.75) mm.

Melandrium rubrum (Weig.) Garcke (*Silene dioica* (L.) Clairv.)

Six seeds, similar in shape to those of *M. album*, but with considerably thinner and longer papillae arranged irregularly (Pl. XVI). Measurements of 4 seeds: 1.25 × 1.05 × 0.75, 1.10 × 0.85 × 0.60, 1.20 × 1.05 × 0.85, 1.20 × × 1.10 × 0.80 mm.

Melandrium sp.

Thirty-one seeds of this genus had their papillae poorly developed, which did not allow their identification to specific level.

Silene inflata (Salisb.) Sm. (*S. vulgaris* (Moench.) Garcke)

Species represented by 2 seeds (Pl. XVI). Dorsal side flattened in one specimen, rounded in other. Hilum surrounded by characteristic papillae (Wasylikowa 1978). 5—6 rows of pointed high papillae on lateral sides, and blunt ones on flattened surfaces. Measurements of seeds: 1.10 × 0.95 × × 0.65, 1.20 × 1.00 × 0.75 mm.

Caryophyllaceae indet.

Entire and fragmentary seeds, 134 in number; most of them heavily deformed, with poorly developed papillae.

Chenopodiaceae

Chenopodium album L.

445 complete and 23 fragmentary seeds, circular, somewhat elongated towards the radicle tip, which projects distinctly beyond the circumference of the seed (Pl. XVI). Lower side of seed (with trough) domed, upper side flattended, with a small dimple in the middle. The edge is well marked in most seeds. A revision of the morphological characters of the specimens described in a previous paper (Gluza 1971) as *Ch. opulifolium* showed that they belonged to *Ch. album* or its hybrids (Wieserowa 1979). Measurements of 20 seeds: diameter — 1.14 (1.05—1.20) mm, thickness — 0.56 (0.40—0.70) mm.

Chenopodium polyspermum L.

101 complete and 20 fragmentary seeds (Pl. XVI). Measurements of 20 seeds: diameter — 0.78 (0.70—0.90) mm, thickness — 0.44 (0.40—0.50) mm.

Chenopodium urbicum L.

Nine seeds with a shallow trough, covered by an irregular reticulum on the surface (Pl. XVI). Measurements of 5 seeds: (diameter × thickness) 0.90 × × 0.40, 0.90 × 0.35, 1.00 × 0.30 and 0.85 × 0.50 mm.

Chenopodium sp.

88 complete and 116 fragmentary seeds, their coats partly wanting. (Pl. XVI). Some of them may have belonged to *Atriplex*.

Compositae

Centaurea jacea L.

A complete achene and a fragment; both specimens lacking in pericarp. (Pl. XVIII). Measurements of whole achene: 3.1 × 1.3 × 1.0 mm.

Centaurea scabiosa L.

Two achenes, ovate-elongate in shape, with pericarp destroyed (Pl. XVIII). Upper end of achenes convex, lower end narrowed and bent, with a lateral indent, ±1.2 mm long. Measurements: 3.8 × 1.3 × 1.4 and 3.7 × 1.1 × 1.0 mm.

Compositae indet.

In the sample from the northern part of the pit there were three seeds, varying in shape, partly damaged (Pl. XIX).

Gramineae

Bromus arvensis L., *B. racemosus* L., *B. sterilis* L.

The caryopsides of *Bromus* (Pl. XV) were, beside cereals, the most abundant (95 cm^3) of the plant remains from both horizons of the pit. Most of them, about three-quarters of the whole volume, belong to *Bromus arvensis* L. Fewer, about a quarter of the volume, have been identified as *B. racemosus* L., whereas 26 whole grains and 75 halves are referred to *B. sterilis* L.

A special study on caryopsides of this genus was carried out in connection with the abundance of material, its great morphological differentiation and difficulties in identifying fossil specimens.

It covered 5 species which occur in the Cracow region nowadays and have grains resembling the fossil specimens in shape. This study permitted the identification of *B. arvensis* and *B. racemosus* in the Neolithic material from Mogiła. Its detailed results were presented in a separate paper (Gluza 1977).

Digitaria ischaemum (Schreb.) Muehlenb.

A naked caryopsis, ovate in outline (Pl. XVIII). Measurements: 1.10 × × 0.7 × 0.50 mm.

Digitaria cf. *sanguinalis* (L.) Scop.

Four naked caryopsides, elliptical in outline (Pl. XVIII). Measurements: 1.05 × 0.65 × 0.35, 0.95 × 0.65 × 0.35, 0.85 × 0.60 × 0.35 and 1.00 × 0.60 × × 0.30 mm.

Digitaria sp.

Five badly damaged naked caryopsides.

Echinochloa cruss-galli (L.) B. P.

Twelve naked caryopsides (Pl. XVIII) with ventral side flattened and dorsal side strongly convex. Embryo, rounded at top, extending over three-quarters of caryopsis length. Measurements of eight grains: 1.13 (0.90—1.30) × ×0.92 (0.85—1.10) × 0.53 (0.45—0.70) mm.

Setaria viridis (L.) P. B. or *S. verticillata* (L.) P. B.

Nine complete and one fragmentary caryopsides, ovate-elliptic in outline with flattened ventral side and convex dorsal side. The elongated radicle extends over three-quarters of the caryopsis length (Pl. XVIII). Fragments of the lemma, with papillae arranged in transverse rows, preserved on two caryopsides. Measurements of 5 caryopsides: 1.10 × 0.75 × 0.55, 1.05 × × 0.70 × 0.35, 1.15 × 0.70 × 0.40, 1.05 × 0.70 × 0.35 and 1.10 × 0.75 × × 0.5 mm.

Panicoideae indet.

A distorted caryopsis.

Gramineae indet.

Seven small caryopsides, further identification impossible (Pl. XIX).

Guttiferae

Hypericum sp.

A revision of the material has shown that the previous determination of this genus, published in preliminary report, is incorrect (Gluza 1971).

Labiatae

Ajuga genevensis L. or *A. reptans* L.

A complete and a fragmentary fruit with sculpture in the form of an irregular network and a large hilum on the ventral side (Pl. XVII). Measurements of entire fruit: 1.85 × 1.00 × 0.85 mm.

Papilionaceae

Lotus cf. *corniculatus* L.

One seed, circular in outline, slightly narrowed in lower portion (Pl. XVII). Radicle extending half-way along cotyledon, seed coat partly destroyed. Measurements: 1.30 × 1.20 × 1.05 mm.

Trifolium hybridum L. or *T. elegans* Savi.

Two seeds, ovate in outline, with slightly flattened sides (Pl. XVII). Radicle extending over three-quarters of cotyledon, marked by poorly seen groove on the surface. Measurements: 1.40 × 1.25 × 1.00 and 1.45 × 1.20 × 1.00 mm.

Trifolium cf. *montanum* L.

Sixty-one entire and 12 fragmentary seeds, elongate-ovate in shape and circular in cross-section (Pl. XVII). Radicle tip bent, reaching half-way along the seed, hilum situated in a depression by the end of the radicle. The measurements of Neolithic seeds resemble those of the present-day seeds of *T. campestre* Schreb. (*T. procumbens* L. pro p.) and *T. strepens* Cr. (*T. aureum* Poll., *T. agrarium* L. pro p.), but the seeds of these two species differ from those of *T. montanum* in the position of the hilum. Measurements of 20 seeds: 2.16 (1.90—2.50) × 1.30 (1.10—1.60) × 1.08 (0.80—1.20) mm.

Trifolium cf. *repens* L.

Three thick-ovate seeds, with coat cracked and smooth (Pl. XVII). Lower part tapering, upper part broadened and rounded. Radicle extending more than half-way along cotyledon, hilum close to the end of the radicle. Measurements: 1.20 × 1.10 × 0.85, 1.30 × 1.20 × 0.90 and 1.25 × 1.00 × × 0.85 mm.

Trifolium sp.

Six seeds have their seed coats fragmentarily preserved, their radicles reaching to the middle or one-third of the cotyledon length.

Vicia — type

A negative impression of one seed, circular in outline, with a diameter of 5.4 mm and an indistinct hilum, was found in a lump of daub from a depth of 130—140 cm. The seed may have belonged to the genus *Vicia*, *Lathyrus* or *Pisum*.

Papilionaceae indet.

Ten complete and 36 fragmentary small seeds with their radicles damaged have also been included in this family.

Plantaginaceae

Plantago maior (L.)?

A re-examination of the material has shown the incorrectness of this determination (Gluza 1971).

Plantago media L.

One seed, elliptic in outline, with edges slightly upturned around the ventral side (Pl. XVII). The dorsal side slightly domed, the ventral side has a longitudinal thickening in the middle. Measurements: 1.55 × 0.65 × 0.25 mm.

Polygonaceae

Polygonum aviculare L.

Two nutlets (Pl. XVI), measuring 1.75 × 1.00 × 0.95 and 2.00 × 1.10 × × 1.00 mm.

Polygonum convolvulus L. (*Fallopia convolvulus* (L.) A. Löve)

A total of 2475 (15 cm^3) nutlets of this species have been found. Their surface is covered with characteristic warts. About 766 fruits have the pericarp destroyed in varying measure and in some seeds it is lacking entirely. These seeds show the embryo clinging to one margin of the endosperm (Kulpa 1974) or only a depression left after the destroyed embryo (Pl. XVI). Measurements of 100 nutlets from both samples: 2.37 (2.0—2.70) × 1.69 (1.40—2.20) mm.

Polygonum cf. *minus* Huds.

Three nutlets measuring: 1.75 × 1.35 × 0.80, 1.65 × 1.25 × 0.90 and 1.60 × 1.20 × 0.70 mm (Pl. XVI).

Polygonum nodosum Pers.

Forty-four entire and eight fragmentary nutlets have been obtained from both samples (Pl. XVI). After a preliminary examination (Gluza 1971) some of these fruits were included in *P. tomentosum*. The small size of the fruits indicates that all specimens belong to *P. nodosum*. Measurements of 10 fruits: 1.66 (1.45—1.90) × 1.36 (1.20—1.50) × 0.58 (0.40—0.65) mm.

Polygonum persicaria L.

Seven nutlets. Measurements of 5 of them: 3.7 × 2.8 × 1.7, 3.4 × 2.8 × × 1.4, 3.9 × 2.8 × 1.7, 3.1 × 2.8 × 1.4 and 4.1 × 2.9 × 1.5 mm (Pl. XVI).

Polygonum sp.

Twenty-one complete and 14 fragmentary nutlets. Most specimens without pericarps.

Rosaceae
Potentilla reptans L.

Seven fruits, elliptic-pyriform in outline; dorsal side semicircularly curved and ventral side straight (Pl. XVI). Lateral side with papillae. Measurements of 7 fruits: 0.82 (0.72—0.95) × 0.57 (0.50—0.65) × 0.35 (0.10—0.40) mm.

Rubiaceae
Galium cf. *boreale* L.

Thirty-one schizocarps, with their pericarps damaged, elliptic-ovate outline in dorsal view and reniform in lateral view (Pl. XVIII). On the ventral side shallow longitudinal depression with a distinct protuberance in some specimens. The lateral and dorsal sides of the schizocarps are longitudinally grooved. Measurements of 10 schizocarps: 0.79 (0.65—0.95) × 0.49 (0.35—0.55) ×0.48 (0.45—0.60) mm.

Galium verum L. or *G. mollugo* L.

Twenty schizocarps, circular or broadly elliptical in outline. Dorsal side grooved shallowly, with a network of transversely elongated cells. Shallow rectangular depression on ventral side (Pl. XVIII). Measurements of 10 schizocarps: 0.84 (0.70—1.00) × 0.67 (0.50—0.75) × 0.61 (0.55—0.70) mm.

Galium sp.

Sixty-four small schizocarps, circular or ovate in outline, with a longitudinal or transverse depression on the ventral side.

Scrophulariaceae
Euphrasia sp. or *Odontites* sp.

Two seeds, elongate-ovate, with one end pointed and the other truncated obliquely, with longitudinal ribs and one side flattened.

Linaria cf. *vulgaris* (L.) Mill.

A charred flower, not quite developed, much resembling the flower buds of this species. Its turned-out upper lip of the corolla, with a straight short spur, and calyx base with a segment of the pedicel are preserved (Pl. XVII).

Scrophularia sp.

This genus is represented by 38 seeds and 14 fragments of capsules. Seeds, elliptical or cylindrical, with truncated ends (Pl. XVII). Surface covered with 5—8 strongly protruding longitudinal wavy ribs, triangular in cross-section. Between them numerous double thin transverse ridges separate hollows, which are shallower than those in the seeds included in the genus *Verbascum* L. Measurements from 24 seeds: length 0.63 (0.55—0.80), width and thickness 0.39 (0.35—0.45) mm.

Verbascum sp.

Nineteen seeds, circular or conical in shape (Pl. XVII). Wavy blunt ribs, 7—9 in number, arranged longitudinally, with fairly deep hollows between them divided by transverse protuberances. Measurements from 10 seeds: length 0.70 (0.55—0.80), width and thickness 0.45 (0.35—0.55) mm.

Veronica sp.

One seed. Its dorsal side is convex and the ventral side flattened. The elliptical protruding hilum is situated in the middle of the ventral side and wrinkles run radially from it towards the circumference (Pl. XVII). Measurements: 0.85 × 0.50 × 0.25 mm.

Solanaceae

Solanum nigrum L.

Twenty-five entire and one fragmentary seeds. Fine network on the surface of seed coat (Pl. XVIII). Measurements from 15 seeds: 3.06 (2.80—3.20) × × 2.40 (2.20—2.70) × 0.76 (0.30—1.40) mm.

Umbelliferae indet.

Two schizocarps, differing in shape and with pericarps destroyed (Pl. XIX).

Violaceae

Viola tricolor L. or *V. arvensis* Murr.

Two seeds obovate in shape, with a poorly seen seed suture connecting the hilum with the shield-like torus. In the lower part of the seeds there is a depression left after the detachment of the elaiosome (Pl. XVII). Measurements of seeds: 1.30 × 0.80 × 0.75 and 1.45 × 0.75 × 0.80 mm.

Remaining materials

In the material washed through a sieve there were also 11 undetermined seeds, several cylindrical remains resembling a plant germ and one fructification of *Claviceps purpurea* (Fries) Tulasne. Some animal remains were also found, namely, 7 insect coprolites, 1 small vertebra, 1 tooth and 3 small fragments of bones.

ECOLOGICAL AND PHYTOSOCIOLOGICAL ANALYSIS OF MATERIAL

General remarks

Compared with the Neolithic finds described so far from Poland the plant material under study is of special interest. For the first time so many carbonized cereal spikes together with a large number of seeds and fruits of wild herbs, which form a half of the charred vegetable matter, occurred in a Neolithic locality in the territory of Poland. This material is abundant not only in respect of its volume but also as regards the number of species. Thirty-three herbaceous species have been determined altogether from both samples, five forms have been identified to generic level only and some of the heavily damaged remains are unidentifiable.

The caryopsides of *Bromus arvensis* and *B. racemosus* occurred in quantities so far never reported from other Neolithic localities. Their volume exceeded the total volume of the detached cereal grains. Only 20% of the total volume of wild plant remains was formed of seeds and fruits of the other herbs. The fruits of *Polygonum convolvulus* (2475 — 10 cm^3) and seeds of *Chenopodium album* (about 120) were the most numerous of them. *Polygonum nodosum*, *Trifolium* cf. *montanum*, *Bromus sterilis* and, unidentified to specific level, *Chenopodium* sp., *Scrophularia* sp., *Galium* sp., *Caryophyllaceae* and *Papilionaceae* occurred in numbers exceeding 40 specimens. Other taxa were represented by single specimens.

The origin of the remains and their appropriation have not been determined unequivocally. The uniform state of preservation of the material in the pit — burnt diaspores of wild plants mixed with burnt corn — allows the supposition that the wild and cultivated species grew side by side and had been deposited in the pit at the same time. Analysis of this material may therefore provide interesting data to determine the nature of the field communities and permit us to put forward some suppositions about the farming of the population representing the Lengyel Culture in the Nowa Huta—Mogiła area.

Biology and ecology of cereals

The emmer (*Triticum dicoccum*), which forms the greatest proportion of the material, has low requirements as regards soil conditions and, to a certain extent, also climatic conditions. It can grow both on humid and heavy fertile soils and on dry, stony unfertile mountain soils. The great resistance of emmer to drought is due to its well-developed root system, which is twice as long as that of other spring wheats (Januševič 1976). In his monograph of wheats Percival (1921) writes that emmer is adapted to a mild and dry climate and most of its varieties are little resistant to frost. On the other hand, however, it is known that the relict cultivation of emmer has so far persisted in some mountainous regions characterized by great thermal fluctuations (Schiemann 1948; Januševič 1976). Most of the varieties known at present are fast-growing spring forms; Percival mentions only one winter variety.

This species of wheat is particularly fit for sowing on new soils, because its straw is thick, tough and resistant to lodging. These properties are exceedingly advantageous, when high-productive soils on which many other cereals lodge are put under cultivation for the first time (Januševič 1976).

Stoletova's (after Januševič 1976) description of a cultivation carried on in the Volga-Kama region of the U. S. S. R. at the beginning of the present century provides interesting data for reconstructing the cultivation of emmer in prehistoric times. Emmer was sown on new soils tilled by means of a wooden plough, the seeds being put at a small depth. Unthrashed grain was used for sowing, which required the storage of a great quantity of spikelets as seeding material. In the opinion of the local population, a decrease in the cultivation of emmer at the beginning of the century was connected with the introduction of the iron plough and the application of other agrotechnical procedures, e. g. pre-winter ploughing and harrowing. They made it impossible to introduce emmer spikelets to an adequate depth, because, as a result of ploughing down, they first got too deep into the soil and next, at the time of harrowing, they caught the harrow tines and were pulled out on to the surface. In his description of the cultivation of emmer in a mountainous region in the north of Czechoslovakia in the 1930, Kühn (1970) too, reports the use of spikelets for sowing. There, it was sown by hand — sparse sowing was applied — as the last of the cereals, from mid April to mid May, and the ripe grain was harvested in August. Thrashed and mechanically sown grain has a lesser germinating power, because the germ is frequently damaged.

Emmer grain is characterized by its high protein content. In the modern times it has been used to produce groats and white flour for baking. Unthrashed grain was used — instead of oats and barley — as fodder for horses and other domestic animals, and its stiff straw was sometimes utilized for thatching roofs (Januševič 1976; Percival 1921).

The einkorn (*Triticum monococcum*) gives small crops of grain, worse in quality than that of emmer. Not unlike emmer it has small soil requirements, but differs from it in being still more resistant to frost. Einkorn can grow even on unfertilized sandy and rocky mountain soils, where other wheats fail. This quality is responsible for the survival of its cultivation till now in some mountainous regions of Central and Southern Europe (Percival 1921). Spring and winter varieties of this species are known, but the spring forms are cultivated more frequently (Schiemann 1948). In Europe the winter forms are sown in September and the spring ones in March; they are gathered in August and in the first half in September (Percival 1921). The great fragility of einkorn spikes is sometimes the cause of its spontaneous seeding of fields and, as a result, its growing among other cereals as a weed (Percival 1921). In spite of its slower development, einkorn can fruit in a field sown with emmer. Cases of emmer fields heavily infested with einkorn are described in literature (Vavilov 1926).

Husked einkorn grain can be used as fodder for horses and cattle and thrashed grain to produce groats and, more rarely, bread flour, beer and vinegar (Percival 1921). The fine and flexible straw of einkorn is used as straw-rope for binding, e. g. in the cultivation of grape-vine (Schiemann 1948).

Most of the varieties of the common barley (*Hordeum vulgare*) cultivated

Ecological requirements and life forms of wild species

Phytosociological units	Species	Number of specimens	Ecological figures						Life form [5]
			F	R	N	L	T	K	
Potentillo-Polygonetalia	*Polygonum aviculare*	2	x	x	x	7	x	x	sa, wa
	Potentilla reptans	7	6	7	5	6	6	3	p
Bidentetalia tripartitae	*Polygonum nodosum* [1]	48	7	x	8	6	6	4	sa
	Bromus sterilis	63	4	x	5	7	7	4	wa, (sa)
Onopordetalia acanthii	*Chenopodium urbicum* [2]	9	—	—	—	—	—	—	sa
	Linaria cf. *vulgaris*	1	3	7	3	8	5	5	p
	Chenopodium polyspermum	121	6	x	8	6	5	4	sa
	Digitaria ischaemum	1	5	2	3	7	6	4	sa
	D. cf. *sanguinalis*	4	3	5	4	7	7	3	sa
Polygono-Chenopodietalia	*Echinochloa crus-galli*	12	5	x	8	6	7	5	sa
	Polygonum cf. *minus*	3	8	4	8	7	6	3	sa
	Setaria viridis/S. verticillata [3]	10	4/4	x/x	7/8	7/7	6/8	x/4	sa
	Solanum nigrum	26	5	7	8	7	6	3	sa
Secali-Violetalia arvensis	*Polygonum convolvulus*	2475	x	x	x	7	x	x	sa
	Viola tricolor/V. arvensis	2	x	x	x	5	5	3	sa, wa, (p)
Atropetalia	*Sambucus ebulus*	6	5	8	7	8	6	3	p
	Bromus arvensis	68 cm³	4	8	?	6	x	4	sa, wa
Rudero-Secalietea	*Chenopodium album*	457	4	x	7	x	x	x	sa
	Melandrium album	38	4	x	7	8	x	x	sa, wa, (p)
	Polygonum persicaria	7	3	x	7	6	5	3	sa
	Bromus racemosus	27 cm³	8	5	5	6	6	2	wa
	Centaurea jacea	1	x	x	x	7	x	5	p
Molinio-Arrhenatheretea	*Galium* cf. *boreale*	31	x ~	8	2	6	x	7	p
	Lotus cf. *corniculatus*	1	4	7	2	7	x	3	p
	Trifolium hybridum/T. elegans [4]	2	6	7	5	7	5	5	p
	Trifolium repens	3	x	x	7	8	x	x	p

Festuco-Brometea	*Ajuga genevensis/A. reptans* [3]	2	4/6	7/x	2/6	8/6	x	x/2	p
	Centaurea scabiosa	2	3	8	3	7	x	3	p
	Plantago media	1	4	8	3	7	x	7	p
	Silene inflata	2	4 ~	7	2	8	x	x	p
	Trifolium cf. *montanum*	67	3 ~	8	2	7	x	4	p
Alno-Padion	*Melandrium rubrum*	6	6	7	8	x	x	4	sa, wa, (p)

x — indifferent species
~ — resistant to moisture changes
1 Ellenberg's numbers for *P. lapathifolium* were accepted
2 Species not considered by Ellenberg
3 First figure concerns the first species, second one the second species
4 *T. elegans* not considered by Ellenberg
5 After: Korsmo 1930; Mowszowicz 1953; Szafer et al. 1967; Petersen 1972. Trawy uprawne i dziko rosnące, 1974
sa — summer annual, wa — winter annual, p — perennial, F — moisture, R — soil reaction, N — nitrogen content, L — light, T — temperature, K — continentality

in Europe are lax-eared forms. The dense-eared varieties, with short and rigid straw, are rarely grown nowadays because of their low fertility (Rośliny użytkowe 1966). The common barley occurs in spring, winter and variable (i. e. fit to germ in spring and in autumn) forms (Schiemann 1948; Gierat 1973). Both the spring and the winter forms have lower water requirements than other cereals and this is why the exceedingly humid or periodically wet soils are unsuitable for them (Górski et al. 1973; Nowiński 1970).

Ecological requirements of wild species

The Ellenberg method (1974) used, among others, to classify soils designed for arable fields and grassland, was applied for determining the habitats from which the species found may have come. Ellenberg characterized the ecological requirements of the species on the basis of their occurrence in definite plant communities and provided them with numerical marks from 1 to 9 (or 12). He took into account such main environmental factors as soil moisture (F), pH (R) and nitrogen compound content (N), and also the thermal (T) and light (L) requirements of plants and their adaptation to oceanic and continental climates (K). The higher the index value in Ellenberg's classification, the greater are the requirements of the species with respect to a given factor.

Ellenberg's indices are based on observations made in the western part of Central Europe and their wider application in Polish conditions would need introducing certain changes as regards some species. None the less, some successful attempts have been made in this country to characterize present-day fields on their basis (Borowiec 1972). The Ellenberg method has also been used to reconstruct the environmental conditions of development of the vegetation of the early medieval Cracow and several West German localities (Wasylikowa 1978 and Willerding 1978, respectively).

Ellenberg's table made it possible to give index values for 31 herb species from the Mogiła 62 locality (Tables 8 and 9). In two cases, which the identification was approximate and two species could be involved, the index values of both species were given in Table 8. On the other hand, the index values used to calculate the means in Table 9 were those of the species whose presence was considered to have been more probable, i. e. *Setaria viridis* and *Ajuga genevensis*.

As regards the index for soil moisture (F), nearly all species are concentrated within classes 3 to 6 (Table 9), chiefly in classes 3 to 5 (18 out of the 25 species), which indicates that they grew on dry to fresh soils, having an inclination rather to dryer habitats. Only *Polygonum minus*, *P. nodosum* and *Bromus racemosus*, with their F index equal to 7 and 8, most often grow on moist or wet soils. These results do not confirm the opinion expressed by Kruk (1980) that the species of wet habitats dominate among the weeds found in Mogiła 62. Another conclusion of this author, namely that the cereals were harvested in a particularly

Table 9

Ecological figures (Ellenberg 1974) for the species from Nowa Huta—Mogiła 62

Figure values	2	3	4	5	6	7	8	Number of species	Average	x
F moisture	—	5	9	4	4	1	2	25	4.7	6
R reaction	1	—	1	2	—	8	6	18	6.6	11
N nitrogen	5	4	1	4	—	6	6	26	5.2	5
L light	—	—	—	1	8	14	6	29	6.8	2
T temperature	—	—	—	5	8	3	—	16	5.8	15
K continentality	1	9	7	4	—	2	—	23	3.9	8

wet year, is also incorrect. It is based on mistakenly accepted presence of *Bromus secalinus* and *Lolium temulentum*, two species occurring abundantly in the fields in unusually wet seasons. Detailed study of the present-day and fossil *Bromus* grains (Gluza 1977) has proved that these species were absent in the material from Mogiła 62.

As far as the pH of soil (R) is concerned, most species (14 in 18) have index values of 7 and 8, which point to soils with weakly acid to basic reaction. Only two species — *Digitaria ischaemum* (R 2) and *Polygonum minus* (R 4) — are encountered on acid soils and other two — *Digitaria sanguinalis* and *Bromus racemosus* (R 5) — on moderately acid ones (Table 9).

Two distinct groups of species (Table 9) are observed with the index of nitrogen content (N). The index values 2 and 3 characterize the plants growing in nitrogen-poor soils. There are 9 such species, representing chiefly the communities of grassland. Twelve species, occurring on nitrogen-rich soils, chiefly in segetal communities, have the index values 7 and 8.

Most of the plants identified are characterized by fairly great light requirements: 20 species occur most frequently in lighted places, although they tolerate some shading (index values L 7 and 8) and 9 species require half--shaded places (index 5 and 6). The thermal requirements (T) of the plants, are characterized by the index values 5—7, which indicate the moderately warm to warm habitats. As regards adaptation to the fluctuation of temperature expressed by the index K, 20 species have values 3—5, which cover the conditions from those intermediate between oceanic and suboceanic to the weakly subcontinental ones. According to this classification, only one species (*Bromus racemosus* — K 2) is eu-oceanic and two (*Plantago media* and *Galium* cf. *boreale* — K 7) are of a more continental nature.

Generally speaking, in the material under study there were no groups of species of wild plants that would indicate their origin from extreme habitats. Only two types of habitats differing in nitrogen content have been distinguished fairly sharply on the basis of Ellenberg's classification. Having assumed that most of the species grew together at least for some time, we may state that their habitats were moderately moist, weakly basic or weakly acid, and with a moderate nitrogen content.

Biological types of wild plants

The material from Mogiła contained diaspores of 16 species of therophytes (annuals), spring and winter ones, the spring species, 12 in number, being prevalent, 13 hemicryptophytes (perennials) and 3 species having both annual and perennial forms (Table 8). Most of the therophytes identified germinate in spring, only a few in summer. The group of therophytes which bear fruit in the second vegetational season includes *Bromus racemosus* and some varieties of *Polygonum aviculare*, *Bromus arvensis*, *B. sterilis*, *Melandrium album*, *M. rubrum* and *Viola arvensis*.

The large proportion of spring therophytes in the assemblage of weeds from Mogiła differs it clearly from the composition of weeds which contaminate the stock of the same wheat species discovered in a Neolithic pit, representing the Early Danubian Culture, at Burgliebenau (Natho 1957). Only four out of the 13 species of weeds found in Burgliebenau have exclusively spring forms. Two species have annual and perennial varieties and the remaining ones are exclusively winter forms. Natho thinks that the predominance of the winter-annuals and the presence among them of the species considered to be characteristic of winter crops (*Bromus secalinus*, *Centaurea cyanus* and *Agrostemma githago*) suggest that the weeds came from a field sown with winter cereal varieties. According to her, this fact supports the generally accepted opinion that only winter cereal varieties were cultivated in the Neolithic. Giżbert (1964), who had been studying fossil plant remains from the region of Cracow for many years, held a similar opinion. According to that authoress, only millet, more sensitive to cold, was grown as a spring crop, whereas other cereals were sown in autumn. The material from Mogiła indicates that in the period when the settlement of the Modlnica group existed the spring varieties of cereals were also cultivated in this region.

Most of the perennial species found at Mogiła reproduce both generatively, by means of seeds and fruits, and vegetatively. The high proportion of these species may be explained by the fact that the method of land cultivation applied in the Neolithic did not destroy the underground parts of these plants and so they were able to survive in the fields for several years (Knörzer 1971). After all, nowadays the crumbling of the underground parts of some perennial species does not destroy them either, but, what is more, contributes to an increase in the infestation of fields with weeds. *Sambucus ebulus*, *Linaria vulgaris* and *Centaurea scabiosa* were probably such onerous perennial weeds (Tymrakiewicz 1959).

Classification of species according to their present-day phytosociological value

The syntaxonomic classification of species (Table 10) has been adopted after Szata roślinna Polski (Medwecka-Kornaś et al. 1972) and completed on the basis of the observations made by Trzcińska-Tacik (Trzcińska-Tacik & Wieserowa 1976).

Now, most of the species identified (20 in 33) belong to the associations of the class *Rudero-Secalietea*. They occur in segetal communities in cultivated fields and in ruderal communities in the nearest surroundings of human abodes on balks and at the roadsides. Some of them may also appear in natural nitrophilous associations developing at riversides (e. g. *Polygonum nodosum* and *Potentilla reptans*).

Nine species belong to field communities (*Secali-Violetalia arvensis*). Two of them (*Polygonum convolvulus* and *Viola arvensis*) are characteristic of the order and now occur equally often amidst cereals and root crops. The remaining species are characteristic of the suborder *Polygono-Chenopodietalia*, which includes weed communities now encountered chiefly in growths of root crops, vegetables and in gardens, more rarely in spring corn. There were no species characteristic of the contemporary communities of the suborder *Centauretalia cyani*, which develop in the crops of spring and winter cereals, but which in winter cereals produce the most typical forms.

The differentiation of the present segetal communities into two suborders — *Polygono-Chenopodietalia* and *Centauretalia cyani* — is connected with different methods of land cultivation for cereals and root crops and different vegetative periods of these two groups of crops (Kornaś 1972).

The growing season of root crops begins in the early or late spring. The cultivating procedures, such as hacking and weeding, cause that among root crops and vegetables only these annual weeds can develop which germinate late and flower and fruit towards the end of summer or in autumn. The weed species prevailing in cereal fields are those whose development is adapted to the vegetative cycle of cereals. The winter annual weeds which germinate in the autumn, simultaneously with the corn, develop best amidst the winter forms of cereals. Spring therophytes that germinate in the spring cannot find suitable conditions for development in winter cereals. Their competitive power is small compared with that of the corn and they do not usually flower and fruit by the end of its development. Sometimes, however, their developmental cycle can be completed, e. g. the plants growing at the edge of fields or in places where the corn has frozen may flower and fruit. This may also happen in a stubble field after the harvest, but the diaspores of these plants do not get mixed with the seed grain.

The conditions in a field of spring corn somewhat resemble those predominating in the fields of root crops. Annual species of weeds germinating in the spring develop in the corn sown in the spring, their flowering and fruiting

Table 10

Classification of species from Nowa Huta—Mogiła 62 according to their present-day syntaxonomic value. A — archaeophyte, Ap — apophyte

Geographic-historical classification	Habitats	Species	Number of specimens	Phytosociological units
A	weeds and ruderal plants	*Bromus arvensis*	68 mm^3	*Rudero-Secalietea*
Ap		*Chenopodium album*	457	
Ap		*Melandrium album*	38	
Ap		*Polygonum persicaria*	7	
Ap	trodden or periodically inundated places	*Polygonum aviculare*	2	*Potentillo-Polygonetalia*
Ap		*Potentilla reptans*	7	
Ap	water shores	*Polygonum nodosum*	48	*Bidentetalia tripartitae*
A	roadsides, vicinity of houses	*Bromus sterilis*	68	*Onopordetalia acanthii*
A		*Chenopodium urbicum*	9	
Ap		*Linaria* cf. *vulgaris*	1	
Ap	weeds of root-crops, gardens and summer cereals	*Chenopodium polyspermum*	121	*Polygono-Chenopodietalia*
A		*Digitaria ischaemum*	1	
A		*D.* cf. *sanguinalis*	4	
A		*Echinochloa crus-galli*	12	
Ap		*Polygonum* cf. *minus*	3	
A/A		*Setaria viridis/S. verticillata*	10	
A		*Solanum nigrum*	26	
A	weeds of cereals and root-crops	*Polygonum convolvulus*	2475	*Secali-Violetalia arvensis*
Ap/A		*Viola tricolor/V. arvensis*	2	
Ap	forest clearings, roadsides, thickets	*Sambucus ebulus*	6	*Atropetalia*

Ap Ap Ap Ap Ap Ap/Ap Ap	moist and fresh meadows	*Bromus racemosus* *Centaurea jacea* *Galium* cf. *boreale* *Galium verum/G. mollugo* *Lotus* cf. *corniculatus* *Trifolium hybridum/T. elegans* *Trifolium repens*	27 cm^3 2 33 20 1 2 3	*Molinio-Arrhenatheretea*
Ap Ap Ap Ap Ap	xerothermic grassland	*Ajuga genevensis/A. reptans* *Centaurea scabiosa* *Plantago media* *Silene inflata* *Trifolium* cf. *montanum*	2 2 1 2 67	*Festuco-Brometea*
Ap Ap	forest and thickets	*Corylus avellana* *Melandrium rubrum*	6 17	*Querco-Fagetea*

proceeding simultaneously with or even ahead of the development of the corn. However, even at present the communities of weeds do not always develop typically and fields occur in which species of both the above-mentioned suborders grow together (Kornaś 1972).

The assemblage of wild species from Mogiła shows resemblances in composition to the communities of weeds from the present fields of root crops. This might be explained by the lower density of cereal crops in those times and the late time of ripening of both wheats, i. e. emmer and einkorn, similar to that of the root crops.

Kruk, in 1980, presented another interpretation of plant material from Mogiła. On the basis of species composition of wild plants he thought that the pit 416 contained weeds of an unknown root crop cultivation, in addition to cereal weeds. However, this conclusion may not be correct. Biological properties of emmer and einkorn indicate that plants of the *Polygono-Chenopodietalia* could have had better conditions for development in the fields of these two wheat species than in the fields of the present-day summer varieties of bread wheat, *Triticum aestivum*. Studies of more findings of large grain accumulations, heavily infested by weeds, are necessary to get better understanding of weed communities of the past.

Another large group of species found at Mogiła occurs now very often (or nearly exclusively) in ruderal habitats. They probably appeared in such habitats as early as the Neolithic, e. g. *Polygonum aviculare* in trodden places, *Bromus sterilis*, *Chenopodium urbicum* and *Potentilla reptans* on roadsides and fallows, *Sambucus ebulus* in balks and wood clearings and *Polygonum nodosum* by ditches. These species may also have grown in fields as weeds, as they do nowadays, although with frequencies varying from species to species, *Bromus sterilis* being the rarest; but Dobrochotov (1961) writes that this species, too, infests cereal fields. Four species characteristic of the class *Rudero-Secalietea* — *Bromus arvensis*, *Chenopodium album*, *Melandrium album* and *Polygonum persicaria* — may also have grown as weeds and ruderal plants.

The third group of herbs from Mogiła consists of perennial species which now occur chiefly in meadow associations of the class *Molinio-Arrhenatheretea* and in grassland associations of the class *Festuco-Brometea*. The diaspores of the species of periodically wet meadows (order *Molinietalia coeruleae*) namely *Bromus racemosus*, *Galium boreale* and *Trifolium hybridum* or *T. elegans*, are quantitatively dominant as regards meadow plants. Today such communities develop most frequently in places left after the felling of wet woods, on drying peatbogs or, more rarely, in abandoned, damp, cultivated fields (Medwecka-Kornaś et al., 1972). At the beginning of the Neolithic there existed no meadow communities of the form known now (Knörzer 1975) and the species of today's meadows may have found their natural habitats in forest clearings, at the edge of woods and in naturally woodless strips of terrain in river valleys. As farming expanded, they may have spread over cultivated fields and deforested areas used as pastures. The generally forest species *Melandium rubrum* may have invaded fields from similar habitats. The plants of present xerothermic grasslands may have grown on dry soils, rich in calcium carbonate, on the slopes of river valleys, especially those with the southern exposure, from where they spread on to cultivated fields (Medwecka-Kornaś 1972).

Regarding the material from Mogiła, it may be supposed that all the wild species occurred either permanently or temporarily as weeds of cereal fields and together with cereals were deposited in the pit. Only the brome-grasses, *Bromus arvensis* and *B. racemosus*, may have been gathered on purpose. The derivation of these species from cultivated fields is the more probable because today they appear with cereals and some of them, like *Polygonum convolvulus*, *Bromus sterilis* and *B. arvensis* were, in addition, often found in excavations of various archaeological periods. A weed association cannot however be characterized on the basis of one sample. To be sure, at the time represented by the material examined the agriculture in the Cracow area had already gone through a thousand-year-long period of development, none-the-less we do not know if then there already were weed associations of an established composition. We have no suitable materials from this area at our disposal and only the finding of other fossil localities of cereals with weeds may make the solution of this problem possible. It may be supposed only that in the case in question the weed association was characterized by a composition different from that of the typical present associations of weeds of winter corns. In its specific composition it resembled the communities encountered in the present root-crops and spring corn.

Historical-geographical spectrum

Among the herbs identified there are 24 native species — apophytes (Table 10). Most of them probably came into the cropland from their natural moist habitats, situated in the valleys of the Vistula and Dłubnia and a smaller number from the neighbouring thickets and dry grassland, occupying the higher portions of the slopes of these valleys. The remaining 6 (+3?) species are of alien origin — archaeophytes (Trzcińska-Tacik 1979; Zając 1979). In this country they do not occur in natural habitats and probably arrived in it with the first beginnings of agriculture. The above-cited authors disagree as to the inclusion of three species in the group of archaeophytes. *Digitaria ischaemum* regarded by Trzcińska-Tacik as an archaeophyte is considered by Zając to be an apophyte. Trzcińska-Tacik counts *Bromus arvensis* among the ephemerophytes and *B. sterilis* among the apophytes, whereas Zając places both these species among the archaeophytes. The difference concerning *B.arvensis* is apparent and due to the fact that Trzcińska-Tacik adopts a different definition for ephemerophytes. According to her, they are species appearing temporarily both in prehistoric times and nowadays. In consequence, in accordance with the more commonly used definition, *B. arvensis* is an archaeophyte and this is how it is treated in the present paper.

REMARKS ON THE CULTIVATION AND HARVESTING OF CEREALS

The cereals preserved in the pit at Mogiła belonged to three species most frequently cultivated in the Neolithic. The quantitative relations between their remains (Table 1) indicate that emmer predominated (48 cm^3), whereas einkorn (10.5 cm^3) and naked barley (21 cm^3) were less abundant.

It is hard to answer the question for certain whether these cereals were sown together or separately. It seems that the sowing of barley, with its tough spike rachis and grains easily separated on thrashing, mixed up with wheats, the spikes of which break up easily and the grains of which are enclosed firmly in glumes, would have been unpractical considering the technique of trashing and perhaps also that of harvesting itself. It is generally assumed that the wild two-row barley (*Hordeum spontaneum*), from which the cultivated forms of barley have been derived, was at first a weed (Helbaek 1966), but it has been sown separately ever since it became domesticated (Januševič 1976). The fact that in all the cultivated forms of barley the fragility of the spike rachis has been eliminated, which result has not been acquired in cultivated spelt wheats, is believed to be a physiological and morphological confirmation of these opinion. One of the proofs of the monocultural growing of naked barley (*Hordeum vulgare* var. *nudum*) in the Neolithic was the discovery of a pure assemblage of barley grains in the cultural layer of the Herpály group at Berettyóujfalu in Hungary. The neighbouring cultural layers of this locality contained large amounts of grain of emmer and einkorn without an admixture of barley (Hartyányi & Máthé 1979).

As regards the biology of the cereals found, both wheat forms could be sown as spring crops, such forms are most commonly cultivated now. It is noteworthy that in comparison with barley the ripening season of both these wheats comes later. Although einkorn should be sown earlier than emmer, if sown together they may ripen simultaneously at the break of August, as I have observed on experimental plots in the Botanical Garden in Cracow. In literature there is no exact information about the ripening season of the naked varieties of many-rowed barleys such as might be referred to the Neolithic without major reservations.

At present, winter varieties of hulled many-rowed barley are nearly exclusively grown in Poland (Gierat 1973). They are gathered at the end of June or in the first half of July (Górski et al. 1973). The spring varieties also ripen earlier than emmer and einkorn (Mandy 1970). If the Neolithic varieties had similar properties, the differences in ripening season between these three cereals may indicate the separate sowing of barley and wheats, no matter whether the barley grown then was a spring or a winter form.

The predomination of spring cereals in the settlement under study is evidenced by the presence of the weeds now rather attached to root-crops and spring cereals and the lack of species typical of winter cereals, namely, *Bromus secalinus*, *Centaurea cyanus* and *Agrostemma githago*. Only *Bromus arvensis*, found in a large number, now often occurs in fields of winter cereals (**Mowszowicz** 1975), but this species was probably gathered from a wild stand.

The large number of weeds may indicate a lasting use of the fields. Generally, in the first year new soils are little infested with weeds, which increase in number in the course of a few years owing to the accumulation of their diaspores in the soil (**Rasinš** 1959). The large proportion formed by perennial species and even the presence of fallow species, which avoid arable soils, like *Melandrium album*, *Silene inflata* and *Linaria vulgaris* (**Tymrakiewicz** 1959), might indicate a primitive method of tillage and the sowing of fallows, where some perennial species, hard to remove, may have grown (**Rasinš** 1959). The presence of several meadow plants, growing in both fairly dry and rather moist places, signals the existence of open habitats. The fields left to lie fallow may have been used as pastures, for animal breeding was beside plant cultivation the main source of livelihood for this cultural group, as indicated by the bones of sheep, goats, cattle and pigs found in the nearby area of Pleszów, at the sites of earlier and later phases of the Lengyel Culture (**Kulczycka-Leciejewiczowa** 1969).

An analysis of the ecological requirements of the plants might form the basis for considerations on the distribution of the cultivated fields from which the assemblage studied was derived and for a comparison of the conclusions made here with the opinions held by archaeologists. The results obtained in archaeological studies have permitted the determination of the regions inhabited and exploited by people of particular Neolithic cultures in the western part of the Małopolska Upland (**Kruk** 1973). In **Kruk**'s opinion, settlers representing the Lengyel Culture and the preceding Linear Pottery Culture colonized areas situated close to the rivers, on the lower parts of the slopes of the river valleys. For the cultivation of plants they designed the lowest-lying places, which owing to their high moisture content and fertility favoured garden-type plant production. During the Lengyel Culture habitation in this region the area of exploited land was enlarged by the inclusion of the marginal zone of the upland, which may have been connected with an increasingly important role played by the slash and burn methods and the cultivation of cereals (**Kruk** 1973). The population of both these Early Neolithic cultures led relatively settled life and set up permanent large settlements and smaller camps inhabited periodically. Archaeological data show that at Pleszów, situated near Mogiła, dryer parts of the ground bordering upon the settlement were put under cultivation in the period of habitation associated with the Lengyel Culture (**Godłowska** 1976).

The question of field location cannot be solved on the basis of the biology of cereals found at Mogiła, for the species identified show great tolerance of soil moisture only that very moist soils do not favour barley. The ecological requirements of wild plants better illustrate the nature of habitats. Most of them grew on dry or fresh, basic or slightly acid soils. Only a few of them came from moister places. The dominance of the species of dry and fresh soils indicates that the fields were situated in higher parts of the terrain, or if they

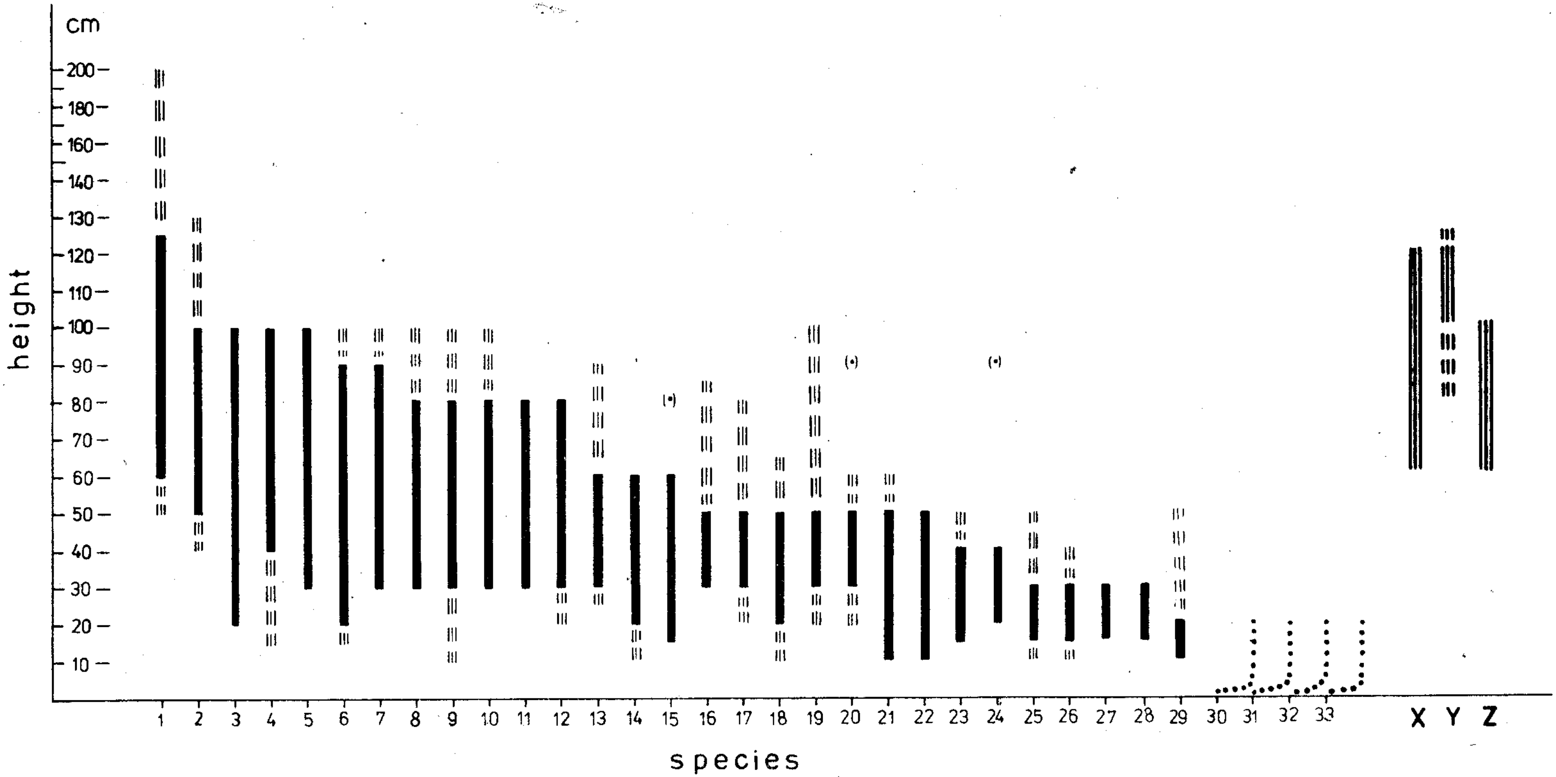

Fig. 9. Present-day hight of wild plants and cereals found in the pit 416. 1 — *Sambucus ebulus*; 2 — *Centaurea scabiosa*; 3 — *Polygonum convolvulus*; 4 — *Polygonum persicaria*; 5 — *Polygonum nodosum*; 6 — *Chenopodium album*; 7 — *Bromus arvensis*; 8 — *Melandrium album*; 9 — *Centaurea jacea*; 10 — *Galium verum/G. mollugo*; 11 — *Bromus sterilis*; 12 — *Echinochloa crus-galli*; 13 — *Chenopodium urbicum*; 14 — *Galium* cf. *boreale*; 15 — *Trifolium* cf. *montanum*; 16 — *Melandrium rubrum*; 17 — *Bromus racemosus*; 18 — *Chenopodium polyspermum*; 19 — *Silene inflata*; 20 — *Linaria* cf. *vulgaris*; 21 — *Digitaria* cf. *sanguinalis*; 22 — *Solanum nigrum*; 23 — *Setaria viridis/S. verticillata*; 24 — *Trifolium hybridum/T. elegans*; 25 — *Plantago media*; 26 — *Viola tricolor/V. arvensis*; 27 — *Ajuga genevensis/A. reptans*; 28 — *Polygonum* cf. *minus*; 29 — *Digitaria ischaemum*; 30 — *Trifolium* cf. *repens*; 31 — *Lotus corniculatus*; 32 — *Polygonum aviculare*; 33 — *Potentilla reptans*; X — *Triticum monococcum*; Y — *Triticum dicoccum*; Z — *Hordeum vulgare*. (·) height rarely attained; other explanations in the text p. 169

lay low, the water level must have been lowered at least throughout the whole growing season.

Attempts were made in palaeoethnobotanic literature to reconstruct the method of the cutting of cereals on the basis of the height of the weeds occurring together with the grain (Knörzer 1971; Natho 1957). A diagram, showing the heights of wild plants and cereals from Mogiła (Fig. 9) has been made to illustrate this question. The heights of dicotyledons are given after Korsmo (1930), Mowszowicz (1975) and Rośliny polskie (Szafer et al. 1967) and, as regards grasses, also acc. to the data presented by Mały przewodnik łąkarski (Petersen 1972) and Trawy uprawne i dziko rosnące (1974). The pieces of information quoted by different authors differ somewhat from each other and for this reason a continuous line is used in the diagram to mark coinciding heights obtained from various sources and a broken line for minimum and maximum heights of species given only in one publication; dots are used for the appropriate height of creepers with ascending stalks. The diagram thus obtained shows a great differentiation in the heights of wild plants.

If, for simplification, we omit the rarely reported heights (broken line), it will turn out that only one species, *Sambucus ebulus*, often reaches a height above 1 m and could overtop standing corn. This species, however, grows on balks rather than in corn-fields. Three groups can be distinguished among the remaining species. The first of them contains high plants, growing above 0.6 m and reaching a maximum of 1 m. There are 11 such species: *Centaurea scabiosa*, *Polygonum convolvulus*, *P. persicaria*, *P. nodosum*, *Chenopodium album*, *Bromus arvensis*, *Melandrium album*, *Centaurea jacea*, *Galium verum*/*G. mollugo*, *Bromus sterilis* and *Echinochloa crus-galli*. The second group of 12 species growing to a height from 0.3 to 0.6 m includes *Chenopodium urbicum*, *Galium* cf. *boreale*, *Trifolium* cf. *montanum*, *Melandrium rubrum*, *Bromus racemosus*, *Chenopodium polyspermum*, *Silene inflata*, *Linaria* cf. *vulgaris*, *Digitaria* cf. *sanguinalis*, *Solanum nigrum*, *Setaria viridis* or *S. verticillata* and *Trifolium hybridum* or *T. elegans*. Low weeds which do not reach 0.3 m belong to the last group; it consists of 5 species with vertical stalks and 5 species of creepers: *Plantago media*, *Viola tricolor* or *V. arvensis*, *Ajuga genevensis* or *A. reptans*, *Polygonum* cf. *minus*, *Digitaria ischaemum*, *Trifolium* cf. *repens*, *Lotus* cf. *corniculatus*, *Polygonum aviculare* and *Potentilla reptans*.

In view of the presence of low weeds in the material it may be assumed that the cereals were at least partly cut low above the ground, which is contrary to the opinions held so far. It is generally supposed that in the Neolithic harvest consisted in the breaking-off of the ears only and the straw left in the field was burnt down to fertilize the soil. In a study on the weed infestation of the Neolithic grain from Rhineland Knörzer (1971) found no diaspores of low weeds in his material, which fact he considered to be a botanic confirmation of this very method of cutting corn. The appearance of diaspores of low weeds in the grain from the Early Iron Age may, in his opinion, indicate a change in the method of harvesting cereals, namely, by cutting them low by means of a sickle.

In order to verify these conclusions, histograms (Fig. 10) have been constructed to show the height differentiation in the weeds obtained from Mogiła 62, a Neolithic locality at Burgliebenau in the D. D. R. (Natho 1957), two early mediaeval samples from Przemyśl (Wieserowa 1967) and three contemporary samples of emmer grain gathered at Horný Tisovnik, Stará Huta and Sobotište in Czechoslovakia (Kühn 1970).

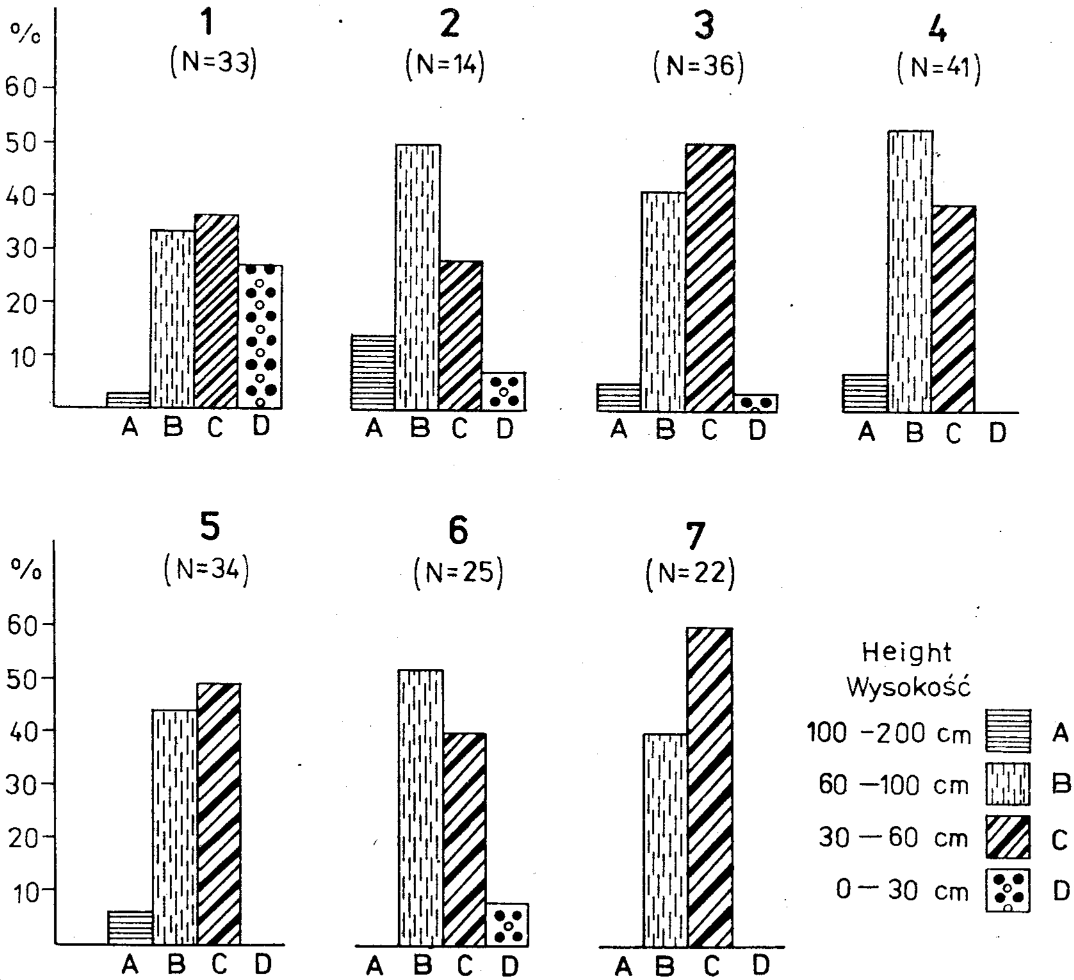

Fig. 10. Percentage number of weed species from different hight-groups in the samples of fossil and present-day grain. 1 — Mogiła 62, pit 416, Neolithic, sample of *Triticum dicoccum*, *T. monococcum* and *Hordeum vulgare* var. *nudum*; 2 — Burgliebenau, D. D. R., Neolithic, sample of *Triticum monococcum* and *T. dicoccum* (Natho 1957); 3 — Przemyśl, 11—12th century A. D., sample of *Secale cereale* (Wieserowa 1967); 4 — Przemyśl, 11—12th century A. D., sample of *Triticum aestivum* (Wieserowa 1967); 5 — Horný Tisownik; 6 — Stará Huta; 7 — Sobotište, Czechoslovakia, present-day samples of *Triticum dicoccum* grain (Kühn 1970)

Two height groups of species, 60—100 and 30—60 cm, form the maximum proportions of all the samples except that from Mogiła 62, in which, in addition to them, there is an almost equal number of low species, below 30 cm.

Studies on the spatial distribution of weeds in today's cereals have allowed the distinction of four height layers (Fig. 11) among them (Tymrakiewicz 1959; Świętochowski 1949). In the contemporary sowing material the diaspores of weeds of the middle layer, reaching halfway up the stems of the cereals or to the level of their ears are distinctly dominant (Tymrakiewicz 1959). As regards the time of fruiting, they come close to the cultivated plants and are gathered ripe together with the corn. In consequence, their diaspores get mixed with the grain and are sown in the field in the next vegetative season. The weeds overgrowing the corn but fruiting in the corn-field are also later sown with the grain. The weeds of the upper layer, overtopping the standing corn, and those of the lowest layer develop independently, they flower and fruit earlier or later than the corn and their fruits are rarely gathered together with the corn.

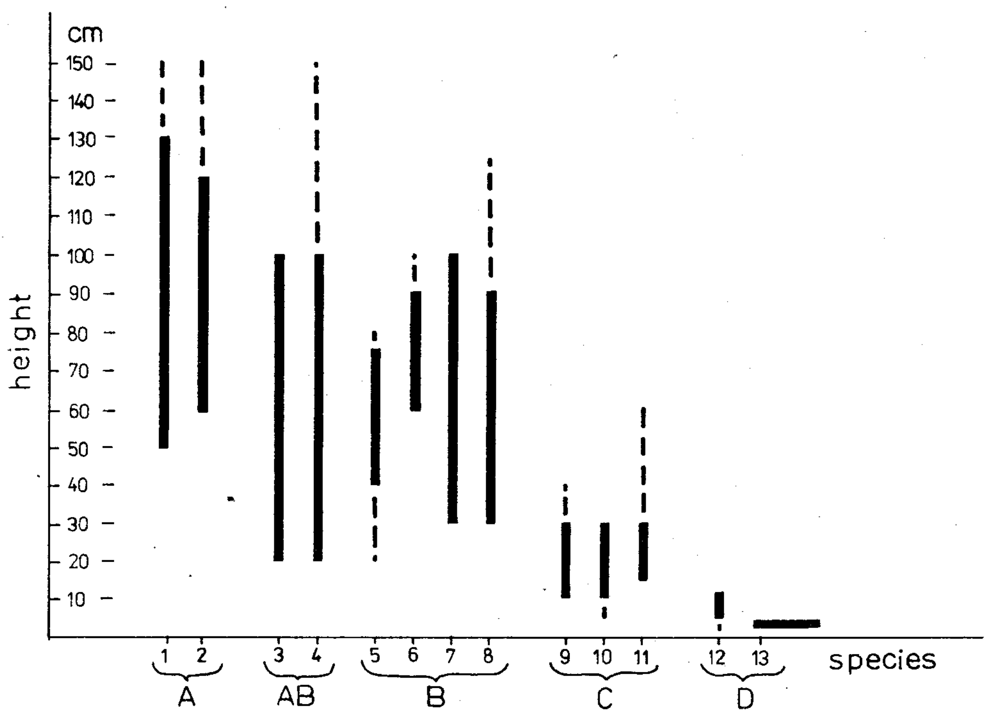

Fig. 11. Special distribution of weeds in the present-day cereals. A — weeds of uppermost layer elevated above the level of standing corn; AB — weeds higher than cereals but flowering at the level of cereals; B — weeds of middle layer; C — weeds of lower layer; D — weeds of ground layer. A, B, C, D acc. to Tymrakiewicz (1959), AB acc. to Świętochowski (1949). 1 — *Cirsium arvense*; 2 — *Sonchus arvensis*; 3 — *Polygonum convolvulus*; 4 — *Galium aparine*; 5 — *Centaurea cyanus*; 6 — *Agrostemma githago*; 7 — *Bromus arvensis*; 8 — *Bromus secalinus*; 9 — *Viola arvensis*; 10 — *Scherardia arvensis*; 11 — *Myosotis arvensis*; 12 — *Sagina procumbens*; 13 — *Herniaria hirsuta*

A comparison of the histograms in Fig. 10 with the diagram in Fig. 11 shows that weed groups B and C, prevailing in the fossil corn samples (except that from Mogiła) and in contemporary samples, correspond to the weeds of the middle layer and so those most commonly contaminating the seed grain now. It seems that a low proportion or lack of weeds of the lower layer and creepers should not be regarded as an unquestionable proof of the high cutting of cereals, because some early medieval and contemporary samples of grain contain no admixture of such weeds, although these cereals have undoubtedly been cut close to the ground.

Concluding these considerations, we should add that we do not know whether in the Neolithic these weeds reached their present height and whether they formed a system of layers in corn-fields. Their present spatial distribution may result from a long-lasting process of adaptation of weeds to the changing methods of cultivation as well as to new varieties and species of cereals. The large number of low weeds at Mogiła might indicate a small height of one of the cereals or the fact of their being cut low (not just below the ear). It is hard to imagine that small fruits of such species as *Potentilla reptans*, *Trifolium repens* or *Viola tricolor* were gathered deliberately and that the more lasting and valuable agricultural product, namely, cereal straw, may have been burnt completely in the field every year. The cutting of corn and not breaking the ears off is to a certain extent evidenced by a large number of flint sikle inserts found at localities representing all phases of the Lengyel Culture in the territory of southern Poland (Kozłowski 1966).

UTILIZATION OF WILD PLANTS

Fairly large deposits of seeds and fruits of wild plants found together with cereal remains draw our attention to another way of food acquisition, i. e. to its collection. In Wiślański's (1969) opinion, it played an important part in the period of Neolithic husbandry.

Many wild species found at the locality of Mogiła 62 could grow not only in corn-fields but also in their close neighbourhood and in fallows. Developing luxuriantly and fruiting in abandoned fields, they may have been collected as important complementary food. However, we have direct evidence of collecting only as regards *Bromus arvensis* and presumably also *B. racemosus*, because the total grain volume of these two species exceeded that of detached cereal grains.

Bromus arvensis is an annual species, 30—100 cm high, readily overgrowing empty places in warm and dry habitats. It has both spring and winter forms (Trawy uprawne i dziko rosnące, 1974). Because it flowers late, chiefly in June and July, it is not a meadow weed (Petersen 1972), wheras it is often met with amidst winter crops, mainly in rye. Most often it grows on sands, rendzinas or other calcium-rich soils. It frequently occurs in fallows, at the roadsides in ditches and on river gravels (Mowszowicz 1975). Many-grained spikelets of this grass, 1—2 cm in length, could be gathered by plucking their panicles. It cannot be ruled out entirely that this grass was sown, but the lack of large accumulations of its caryopsides in other Neolithic localities does not allow us to recognize it as a cultivated species.

Bromus racemosus also occurred in a large number unencountered elsewhere. It is a winter annual plant, growing in moderately moist meadows, on grassy slopes and at roadsides (Trawy uprawne i dziko rosnące, 1974). This brome grass is little sensitive to an excess of water but it does not endure a prolonged drought. It may have been gathered for its fairly big grains, but in moister habitats than was *B. arvensis*.

The caryopsides of *B. sterilis* occurred in small numbers, unsuggestive of their purposeful collection. No remains of *B. secalinus*, described from other Neolithic localities, have been found in the pit under study.

THE NATURE OF THE PIT AND THE PURPOSE OF PLANT MATERIAL ACCUMULATION

Neither archaeology nor botany provides criteria allowing an unequivocal determination of the purpose of the pit. Godłowska (1976), who examined this locality, thinks that the pit may have been related to a cult, because it lay near a grave and resembled pits with corn belonging to the Funnel Beaker Culture and interpreted as connected with sacrifices (Gabałówna 1970). It may also have served for domestic purposes, e. g. as a pit for refuse, or is the remnant of a shallow fireplace over which corn was dried (Godłowska 1976).

A palaeobotanic analysis permits merely the statement that the spikes of the three cereal species were mixed up and that they lay horizontally and in a disorderly manner in the bottom portion of the pit. The corn had not been cleared of glumes or weeds. The grains of all the cereal species were well developed, which indicates that they had been gathered ripe. The grain size graphs in Figs 4 and 7 do not show the usual differentiation of the grains obtained from different populations, and so it may be assumed that the material examined represents an annual crop of each of the cereals. The preservation of fairly large spike fragments shows that the corn was neither thrashed nor prepared for immediate consumption. It may have been a remainder of a crop being dried or an oblation. The absence of greater amount of charcoal among the carbonized remains suggests that the corn had not undergone a carbonization in the bottom of the pit in which it was found.

COMPARISON WITH OTHER NEOLITHIC FINDS

Our knowledge of plants used by people of the younger Danubian Cultures among them of the Lengyel Culture, is rather poor and calls for further investigation. The direct cause of that is the lack of any greater finds of macroscopic remains in the localities of these cultures. It is difficult to compare the reports on the results of studies of plant remains representing this phase of the Neolithic because of the diversity of their preservation forms (impressions on pottery and daub, charred remains) and unequal amounts of the material examined. Figure 12 shows the results of studies of the materials from the

Table 11

Plant macrofossils from Polish sites of the Lengyel Culture

For Mogiła 62 only cereals and most common species were listed as in figure 12. References: II Giżbert 1969, III Gluza 1970, IV Siciny — Klichowska 1971, Brześć Kujawski — Jażdżewski 1938, V Pleszów — Giżbert 1969, Janówek — Klichowska 1969

Regional groups of the Lengyel Culture from Poland: I. Samborzec group; II. Pleszów group; III. Modlnica group; IV. Brześć Kujawski group; V. Wyciąże-Złotniki group

I	II	III	III	IV	IV	V	V	Taxa	Total of sites
Nowa Huta-Pleszów	Nowa Huta-Pleszów	Nowa Huta-Zesławice	Nowa Huta-Mogiła 62	Siciny	Brześć Kujawski	Nowa Huta-Pleszów	Janówek		
		X?		X				*Avena* sp.	2
		X		X			X	*Hordeum vulgare*	3
			X					*Hordeum vulgare* var. *nudum*	1
	X	X				X		*Hordeum* sp.	3
	X					X		*Triticum compactum*	2
	X	X	X			X		*Triticum dicoccum*	4
	X	X	X			X		*Triticum monococcum*	4
		X	X					*Triticum monococcum/T. dicoccum*	2
	X							*Triticum vulgare*	1
	X		X					Cerealia indet.	2
	X					X		*Panicum miliaceum*	2
							X	*Agrostemma githago*	1
			X					*Bromus arvensis*	1
			X					*Bromus racemosus*	1
		X	X					*Bromus sterilis*	2
		X						*Bromus* sp.	1
			X					*Chenopodium album*	1
					X			*Lithospermum officinale*	1
			X					*Polygonum convolvulus*	1
	X		X	X				*Gramineae*	3
			X			X		*Corylus avellana*	2

localities of the younger Danubian Cultures in the territory of Poland, Hungary and Czechoslovakia. It presents a list of the species and genera identified (part C) and a list of the localities in which they have been found (part A). In order to study the quantitative relations, the number of localities is given for each species (part B) and the total of its remains from all localities (part D). The list includes only these species from Mogiła 62 which also occurred at other localities and four other species which were most numerously represented at Mogiła, i. e. *Bromus arvensis*, *B. racemosus*, *Polygonum convolvulus* and *Chenopodium album*.

If the Mogiła 62 locality has been left out of our considerations, wheat remains appear to have occurred most often in the fills at the remaining localities. They are, above all, remains of emmer (*Triticum dicoccum*) and einkorn (*T. monococcum*). They have been found in most localities in the territory of Poland, Hungary and Czechoslovakia and the quantitative predominance of their remains indicates that they were main species grown at that time. The remaining three wheat species — common wheat (*T. vulgare*), club wheat (*T. compactum*) and spelt wheat (*T. spelta*) — have been described from one or two localities each, and they occurred in very small numbers of specimens. Hence, it may be assumed that they were of minor importance to the farming.

Common barley (*Hordeum vulgare*) was found nearly equally often as emmer and einkorn. It occurred in two varieties, a hulled and a naked. Two-row barley (*Hordeum distichum*) has been recorded only from one Hungarian locality, Zengövarkony (Hartyányi & Novaki 1975), where it accompanied spelt remains, the species that did not spread widely before the late phase of the Neolithic and the Bronze Age. Both these corn species have been identified by Gubanyi, but in the above-quoted study the exact number of the remains discovered is not given.

Millet (*Panicum miliaceum*) was also grown at that time. Several impressions and one charred grain of millet were preserved in daub at the Kraków—Pleszów locality (Giżbert 1959). The impressions of husked grains of oat (*Avena* sp.) occurred only in the daub from two Polish localities: Siciny in the Leszno Province (Klichowska 1971) and Kraków—Zesławice (Gluza 1970). They probably belonged to wild oat species.

We know little of vegetables which were then cultivated or gathered from their wild stands. The use of peas (*Pisum sativum* subsp. *arvense*) is evidenced. A large find of peas mixed with the grains of emmer and einkorn has been detected in three cultural horizons of the group Herpály in the Hungarian locality Berettyóujfalu (Hartyányi & Máthé 1979). The lack of species which provided edible vegetative parts or their very small share in the fossil materials is due to smaller possibilities compared with cereals as regards the preservation of their diaspores.

References made repeatedly in archaeological studies to the cultivation of horsebean (*Vicia faba*) in this area at that time result from an unreliable identification. The only seed of horsebean identified by Lechnicki, was

A																B	C
LOCALITIES																NUMBER OF LOCALITIES	TAXA
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
		X								X						2	Triticum vulgare
										X						1	Triticum compactum
									X							1	Triticum spelta
											X				X	2	T. monococcum/dicoc.
		X			X	X				X	X				X	6	Triticum monococcum
		X	X		X	X		X		X	X				X	8	Triticum dicoccum
	X			X				X		X	•X				X	6	Triticum sp.
									X							1	Hordeum distichum
			X					X			X	X	X			5	Hordeum vulgare
		X													X	2	H. vulgare var. nudum
				X?						X	X					3	Hordeum sp.
											X?	X				2	Avena sp.
										X						1	Panicum miliaceum
X							X			X					X	4	Cerealia indet.
		X														1	Pisum sativum ssp. arven.
										X					X	2	Vicia/Lathyrus
											X				X	2	Bromus sterilis
															X	1	Bromus arvensis
															X	1	Bromus racemosus
											X					1	Bromus sp.
				X						X		X			X	4	Gramineae
															X	1	Polygonum convolvulus
															X	1	Chenopodium album
													X			1	Agrostemma githago
														X		1	Lithospermum officinale
										X					X	2	Corylus avellana
		X														1	Malus silvestris
zw	zw	zw	?	zw	zw	zw	zw	o	zw o	o	o	o	o	n	zw o	Total of specimens	
preservation																	

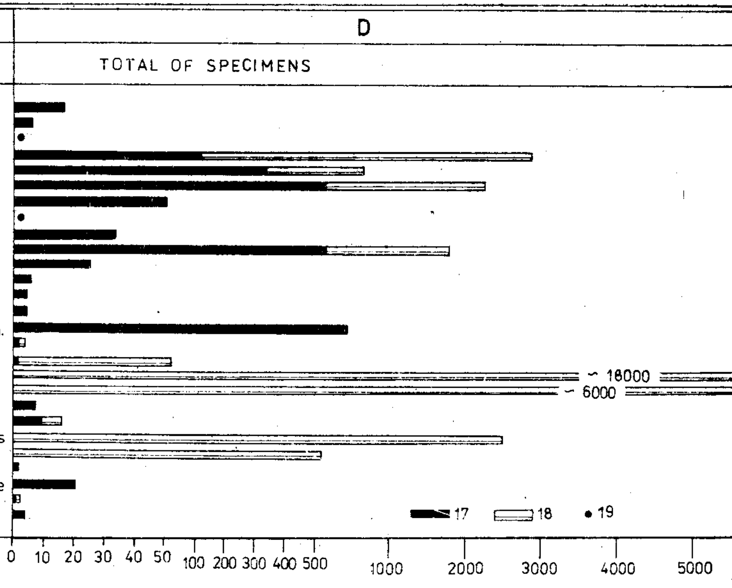

Fig. 12. Plant macrofossils from the localities of the younger Danubian cultures from Poland, Hungary and Czechoslovakia. Localities: 1 — Hódmezövásárhely — Gorzsa-Cucortanya (Kom. Csongrád) — Tisza culture; 2 — Hódmezövásárhely — Kökénydomb (Kom. Csongrád)— Tisza culture; 3 — Berettyóujfalu Hajdu — Bihar — Herpaly group; 4 — Dolni Břežany (west Prague) — Stroked pottery culture; 5 — Opatów, Tarnobrzeg Province — Stroked pottery culture; 6 — Tuchoraz — Lengyel Culture; 7 — Svodin (Štúrovo) — Lengyel Culture; 8 — Polgar (Tiszapolgár — Csöszhalom, Kom. Szabolc — Szatmar) — Polgár culture; 9 — Oborin, okr. Trebišov — Polgár culture; 10 — Zengövarkony (Kom. Baranya) — Lengyel Culture; 11 — Nowa Huta—Pleszów — Lengyel Culture; 12 — Nowa Huta—Zesławice — Lengyel Culture; 13 — Siciny, Leszno Province — Lengyel Culture; 14 — Janówek, Wałbrzych Province — Lengyel Culture; 15 — Brześć Kujawski, Włocławek Province — Lengyel Culture; 16 — Nowa Huta—Mogiła 62 — Lengyel Culture; 17 — total of remains from all localities except for Mogiła 62; 18 — total of most abundant plant macrofossils from Mogiła 62; 19 — number of specimens unknown. References: 1, 2, 8, 10 Hartyányi & Nováki 1975; 3 Hartyányi & Máthé 1979; 4, 6 Tempir 1979; 5 Klichowska 1975; 7, 9 Hajnalová 1977; 11 Giżbert 1969; 12 Gluza 1970; 13 Klichowska 1961; 14 Klichowska 1969; 15 Jażdżewski 1938. Preservation: zw — charred; o — impressions; n — uncharred; ? — no data

reported by Klichowska (1967) from locality 15 at Biskupin, representing the Brześć Kujawski group of the Lengyel Culture. However, in her paper of 1972, she acknowledged this determination to be unreliable.

Some finds of cereals coming from that phase of the Neolithic were accompanied by small numbers of seeds and fruits of wild species. These were most frequently fruits of undetermined grasses. Impressions of grains of *Bromus sterilis* and *Bromus* sp. occurred in the daub from the locality Kraków—Zesławice. The other wild species recognized in the materials of this cultural cycle were *Agrostemma githago* (a seed impression) and *Vicia* sp. or *Lathyrus* sp. (2 seed impressions). The fruits of *Lithospermum officinale* found in the grave of a man at the locality Brześć Kujawski (Jażdżewski 1938) may have been used in the burial rite. Hazel (*Corylus avellana*) nutshell fragments as well as seeds and fruits of wild apple (*Malus silvestris*) found in the materials from single localities are a trace of the gathering of fruits of trees and shrubs.

The localities of the successive phases of the Lengyel Culture discovered in the territory of Poland have provided a small amount of plant material (Table 11). The daub from all the localities of this culture contained chiefly impressions of cereals, with a small number of impressions of weed seeds and fruits. There are no finds at all of plants connected with the oldest phase of this culture — the Samborzec group. The most numerous remains and species have been discovered in the daub from the locality of the Pleszów group at Kraków—Pleszów and that of the Modlnica group at Kraków—Zesławice. The materials from the localities at Brześć Kujawski and Siciny (Góra District), which belong to the Brześć Kujawski group, are very poor in species. The localities of Kraków—Pleszów and Janówek (Dzierżoniów District) represent the last phase of this culture numbered in the Wyciąże—Złotniki group. The daub of the first of them has provided plant impressions, the specific composition of which is more diversified.

The material from the locality Nowa Huta—Mogiła 62 of the Modlnica group contributes very much to our knowledge of the cultivation of cereals and the vegetation composition in the surroundings of the settlement. The composition of cereals agrees in general with the role of their species in the crops cultivated by people of the younger Danubian Cultures in other regions. What differs this find is the large number of wild species represented by seeds and fruits found in unprecedented numbers. The role of these species in the food husbandry of that time is not, as yet, well known. Fruits of two species of the genus *Bromus*, occurring in the largest numbers at Mogiła, suggest that some wild plants were used as food.

CONCLUSIONS

This paper presents the results of a study of the Neolithic plant material discovered in pit 416 at the locality Nowa Huta—Mogiła 62, are 134. The pit is referred to the late stage of the middle phase of the Lengyel Culture (Modlnica group). The absolute age of the remains determined by the radioactive carbon method is 5430 ± 90 B. P. (average of two dates) and lies inside the period of Lengyel Culture colonization in the territory of Poland.

The daub from higher layers of the pit fill and the whole of the charred material from the bottom layer were subjected to a palaeobotanic examination. Three cereal species were found in both these sorts of material: emmer (*Triticum diococcum*), einkorn (*T. monococcum*) and naked barley (*Hordeum vulgare* var. *nudum*). Fragments of burnt spikes of these cereals were preserved in clods of material obtained from the bottom layer. A large number of grains of *Bromus arvensis* and a smaller number of those of *B. racemosus* as well as seeds and fruits of the remaining 31 species of wild herbs occurred together with the cereals (Table 1). Shrubs were represented by few, very small charcoals and nutshell fragments of hazel (*Corylus avellana*).

The paper gives a description of the morphology and the dimensions of diaspores of all the wild and cultivated species. The measurements of cereals are presented in Tables 2—7 and Figs 4—8. Plates 1—14 give photographs and drawings of the cereal remains and Pls XV—XIX drawings of the seeds and fruits of the wild plant species.

The indices of ecological requirements of wild species given by Ellenberg were used to determine the approximate properties of the areas put under cultivation. The cultivated fields most likely occupied mainly dry and fresh soils, with a weakly acid or weakly basic reaction. Some of the fields may have been on soils rich in nitrogen compounds. Moist biotopes and those with more acid soils, poor in nitrogen compounds, were less distinct in the spectrum. The predominance of the species growing on fairly dry and fresh soils indicates that the fields were situated in higher parts of the area or if they were in low-lying parts of the river valley, the water level must have been low throughout the vegetation season. The high proportion of spring therophytes suggests that spring varieties of cereals were mainly grown. This suggestion is supported by the specific composition of the weeds, resembling the communities now encountered in the fields of root crops and spring cereals. This was probably connected with the late ripening season of both the wheats — *Triticum dicoccum* and *T. monococcum* — and perhaps also with the fact that these cereals were sown more sparsely. The presence of diaspores of many perennial species indicates that the tillage was not very careful and corn may have been sown on fallows, grown over by perennial weed species hard to root out. The large number of seeds and fruits of weeds mixed with the corn at Mogiła gives evidence of the lasting use of at least some of those fields.

Twenty four species of apophytes and 6 (+3?) species of archaeophytes were found among the weeds from Mogiła.

The problems of the cultivation of cereals and harvesting of ripe crops are dealt with in more detail and the supposition is put forward that both forms of wheat were sown together and barley separately. Attention has been drawn to the fact that the lack or scarcity of low weeds in the samples of fossil cereals should not be regarded as a cogent evidence of the high cutting of cereals. In the pit at Mogiła numerous low weeds occurred beside those of great and middle height, which suggests either a little height of one of the cereals or the fact that they were cut low, not right by the ear.

The considerable share of caryopsides of *Bromus arvensis*, which in volume exceeded the detached grains of the three cereal species, may prove that fruits of wild plants were gathered as an addition to the food supplies. Caryopsides of *Bromus racemosus* may also have been gathered to this end.

On the basis of the results of this palaeobotanic analysis it is impossible to establish the appropriation of the pit and the plant material in it unequivocally. The material may have undergone a carbonization outside the place in which it was finally deposited. The lack of any distinct differences in shape between the grains of the same species of corn evidences its derivation from an unthrashed crop of one year.

The material from Mogiła has been compared with the plant assemblages so far discovered at the localities of the younger Danubian Cultures in the territory of Poland, Hungary and Czechoslovakia. The remains of wheats from Mogiła do not differ in specific composition and grain proportions from the findings from most other localities referred to the same Neolithic phase. However, remains of naked barley (*Hordeum vulgare* var. *nudum*), hitherto described from only one locality of this cultural cycle, have been found at Mogiła. The assemblage from Mogiła differs besides in composition, for it includes a large number of wild herbs, which provide information about the vegetation of the area utilized by the local population of the Lengyel Culture.

Archaeological Museum, ul. Senacka 3, 31-002 Kraków

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STRESZCZENIE

Artykuł zawiera wyniki opracowania neolitycznego materiału roślinnego odkrytego na stanowisku Nowa Huta—Mogiła 62, ar 134, w jamie 416. Chronologię obiektu określiła dr M. Godłowska na podstawie fragmentów ceramiki występującej razem z materiałem roślinnym. Jama pochodzi z późnego stadium środkowej fazy kultury lendzielskiej (grupa modlnicka). Bezwzględny wiek szczątków, zbadany metodą radiowęglową w Laboratorium Instytutu Fizyki Politechniki Śląskiej w Gliwicach, wynosi 5430 ± 90 B. P. (średnia dwu dat), mieści się w fazie występowania osadnictwa kultury lendzielskiej na naszych terenach.

Badaniom paleobotanicznym poddano polepę pochodzącą z wyższych poziomów jamy oraz całość zwęglonego materiału z warstwy przydennej. W obu materiałach wystąpiły pozostałości trzech gatunków zbóż: pszenicy płaskurki (*Triticum dicoccum*), pszenicy samopszy (*Triticum monococcum*) oraz nagiej odmiany jęczmienia zwyczajnego (*Hordeum vulgare* var. *nudum*). W grudach materiału z warstwy przydennej, obok zwęglonych kłosów wymienionych zbóż, zachowały się znaczne ilości ziarniaków stokłosy polnej (*Bromus arvensis*), mniej liczne ziarniaki stokłosy groniastej (*Bromus racemosus*) oraz nasiona i owo-

ce dalszych 31 gatunków roślin zielnych (tabela 1). Stwierdzono tu poza tym drobne węgielki drzewne i fragmenty łupin orzechów leszczyny (*Corylus avellana*).

W pracy podano opisy morfologiczne i wymiary diaspor wszystkich wyróżnionych roślin dzikich i uprawnych. Wyniki pomiarów zawierają tabele 2—7 i ryc. 4—8. Fotografie i rysunki lepiej zachowanych szczątków zbóż zamieszczono na tablicach I—XIV, a rysunki i fotografie nasion i owoców gatunków dzikich na tablicach XV—XIX.

Wskaźniki wymagań ekologicznych roślin dzikich, podane przez Ellenberga, posłużyły do scharakteryzowania terenów zajętych pod uprawę. Użytkowane pola znajdowały się głównie na glebach suchych lub świeżych o odczynie słabo kwaśnym lub słabo zasadowym. Część pól posiadała gleby bogate w związki azotowe. Mniej wyraźnymi cechami odznaczają się siedliska wilgotniejsze, o glebach nieco bardziej zakwaszonych i uboższych w związki azotowe. Przewaga gatunków rosnących na glebach suchszych i świeżych wskazuje, że pola były położone na wyniesionych częściach terenu, a jeśli były usytuowane w niższej części doliny rzecznej, to poziom wody musiał być obniżony w ciągu całego okresu wegetacyjnego. Wysoki udział terofitów jarych dowodzi, że w osadzie prowadzono przede wszystkim uprawę jarych odmian zbóż. Przemawia za tym także odmienna gatunkowo lista chwastów występujących w obecnych zbożach ozimych. Składem były one zbliżone do zbiorowisk występujących we współczesnych uprawach roślin okopowych i w zbożach jarych. Prawdopodobnie wiązało się to z późnym okresem dojrzewania obu pszenic — *Triticum dicoccum* i *T. monococcum*, a może również z mniejszą gęstością siewu tych zbóż. Obecność diaspor wielu gatunków wieloletnich sugeruje niezbyt staranną obróbkę ziemi i prawdopodobny wysiew na odłogach, gdzie rosły trudne do usunięcia gatunki wieloletnie. Duża ilość nasion i owoców chwastów towarzyszących na stanowisku Mogiła 62 szczątkom zboża świadczy o długotrwałym użytkowaniu przynajmniej części uprawianych pól.

Wśród szczątków roślin dzikich znaleziono diaspory 24 gatunków rodzimych (apofity) oraz 6+(3?) gatunków obcych (archeofity). Wyróżnione gatunki obce dotarły w rejon Mogiły wraz z zapoczątkowanymi tu uprawami rolnymi.

Szerzej w pracy potraktowane jest zagadnienie uprawy i zbierania dojrzałych zbóż w badanej osadzie neolitycznej. Wykorzystano w tym względzie informacje zawarte w literaturze rolniczej i botanicznej oraz własne obserwacje współczesnych upraw zbożowych. Wcześniejsza pora dojrzewania nagiej odmiany jęczmienia zwyczajnego w stosunku do pszenic oplewionych oraz większa łatwość uzyskiwania ziaren z kłosów tej odmiany pozwalają sądzić, że jęczmień był wysiewany oddzielnie. Mogła to być jara lub ozima odmiana. Obie pszenice, tj. płaskurka i samopsza owocują znacznie później i niemal równocześnie, co umożliwia ich wspólne wysiewanie i zbieranie. Duża przewaga jednorocznych chwastów w badanym zbożu wskazuje na wysiewanie jarych odmian wspomnianych gatunków pszenic, podobnie jak to ma miejsce obecnie. Przeprowadzono dyskusję nad przypuszczalną wysokością zbóż neolitycznych i sposobem ich zbierania. Posłużono się opiniami paleobotaników, warstwowo-przestrzennym układem chwastów we współczesnych łanach zbóż i dzisiejszą wysokością chwastów występujących w materiałach z różnych okresów archeologicznych. Stwierdzono, że całkowity brak lub tylko nieznaczny udział niskich chwastów w kopalnych próbach zbóż nie może być uznawany za nie budzący wątpliwości dowód wysokiego ścinania zbóż. W jamie z Mogiły 62 razem ze zbożem wystąpiły obok chwastów wysokich i średniej wielkości także liczne chwasty niskie, co wskazuje na małą wysokość któregoś ze zbóż lub niższe ścinanie zbóż, ale nie tuż poniżej kłosa.

Znaczne ilości ziarniaków stokłosy polnej (*Bromus arvensis*) objętością przewyższające łączny udział luźnych ziaren trzech gatunków zbóż mogą być dowodem, że zapasy uzupełniano, zbierając owoce roślin dziko rosnących. Być może celowo zbierano również ziarniaki stokłosy groniastej (*Bromus racemosus*).

Na podstawie przeprowadzonej analizy paleobotanicznej nie można było jednoznacznie rozstrzygnąć jaki był charakter jamy i przeznaczenie znalezionych w niej szczątków roślin. Materiał ten mógł ulec zwęgleniu poza miejscem jego ostatecznego złożenia. Brak wyraźniejszych różnic morfologicznych w budowie szczątków poszczególnych gatunków świadczy o pochodzeniu zbóż z jednorocznego, nie młóconego zbioru.

Porównano także materiał z Mogiły z dotychczas poznanymi znaleziskami roślinnymi w obiektach młodszych kultur naddunajskich na terenie Polski, Węgier i Czechosłowacji. Gatunki i proporcje udziału szczątków obu pszenic z Mogiły nie różnią się od analogicznych danych dotyczących większości znalezisk z tej fazy neolitu. W Mogile stwierdzono szczątki jęczmienia formy nagiej (*Hordeum vulgare* var. *nudum*), opisanego dotychczas z jednego stanowiska tego cyklu kulturowego. Odmienność składu szczątków z Mogiły zaznacza się w wystąpieniu dużej ilości diaspor dzikich roślin zielnych, co jest ważnym uzupełnieniem wiadomości o składzie roślin na terenach użytkowanych przez ludność kultury lendzielskiej.

PLATES

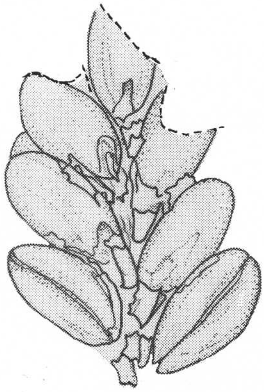
Plate I

Lump of earth with fragments of charred cereal spikes

1. *Triticum dicoccum*
2. *T. monococcum*
3. *Hordeum vulgare* var. *nudum*

Scale equals 5 mm

Phot. R. Łapanowski



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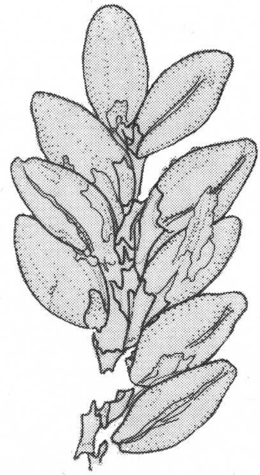

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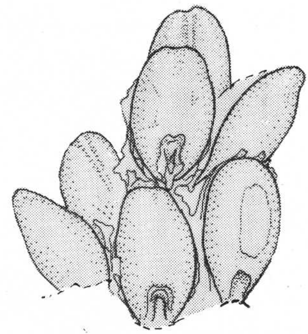

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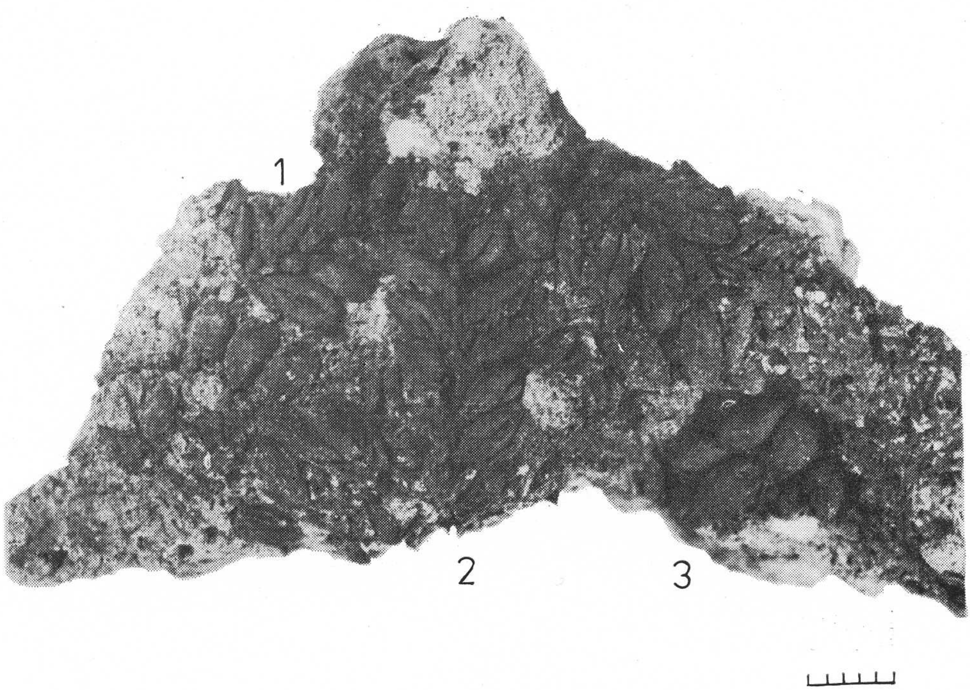
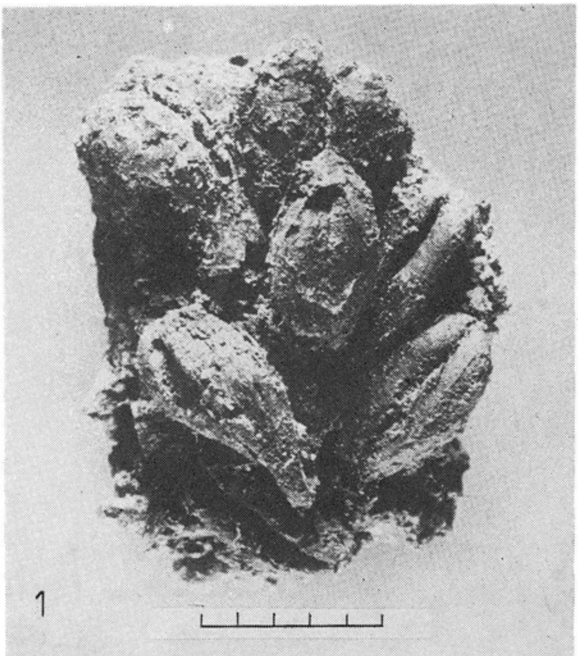


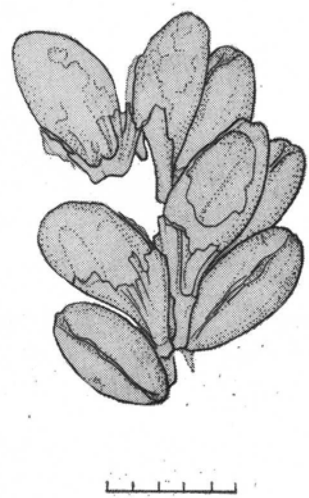
Plate II

1, 2. Two fragments of *Triticum dicoccum* spike

Scale equals 5 mm

Phot. L. Dziedzic





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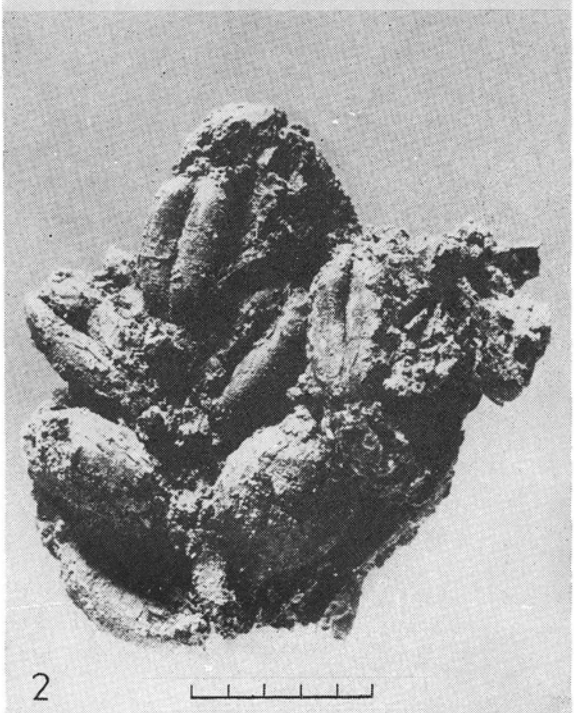

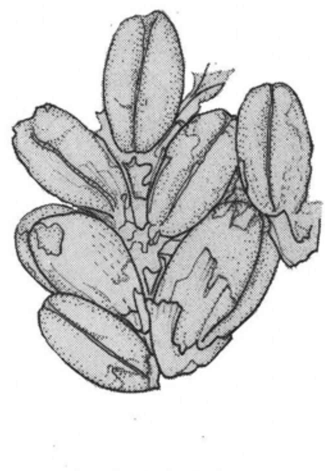

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Plate III

One fragment of *Triticum dicoccum* spike

Scale equals 5 mm

Phot. L. Dziedzic

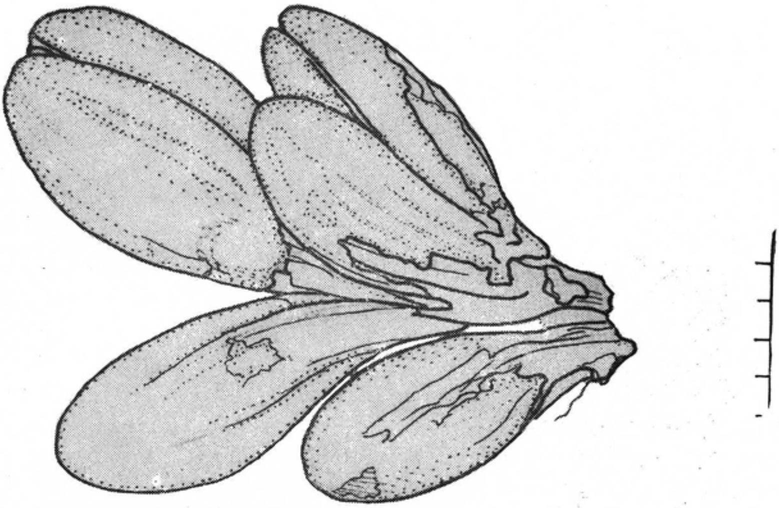

Plate IV

1. Lump of earth with spike fragments of the two wheat species, upper left — spike of *Triticum dicoccum* with remnants of glumes, lower left — spike of *T. monococcum* (horizontal)
2. Spike of *T. dicoccum* without remnants of glumes
3. Lump of earth with three spike fragments of *T. dicoccum* without glumes; upper left — detached grains of *Bromus arvensis* and *B. sterilis*

Scale equals 5 mm

Phot L. Dziedzic

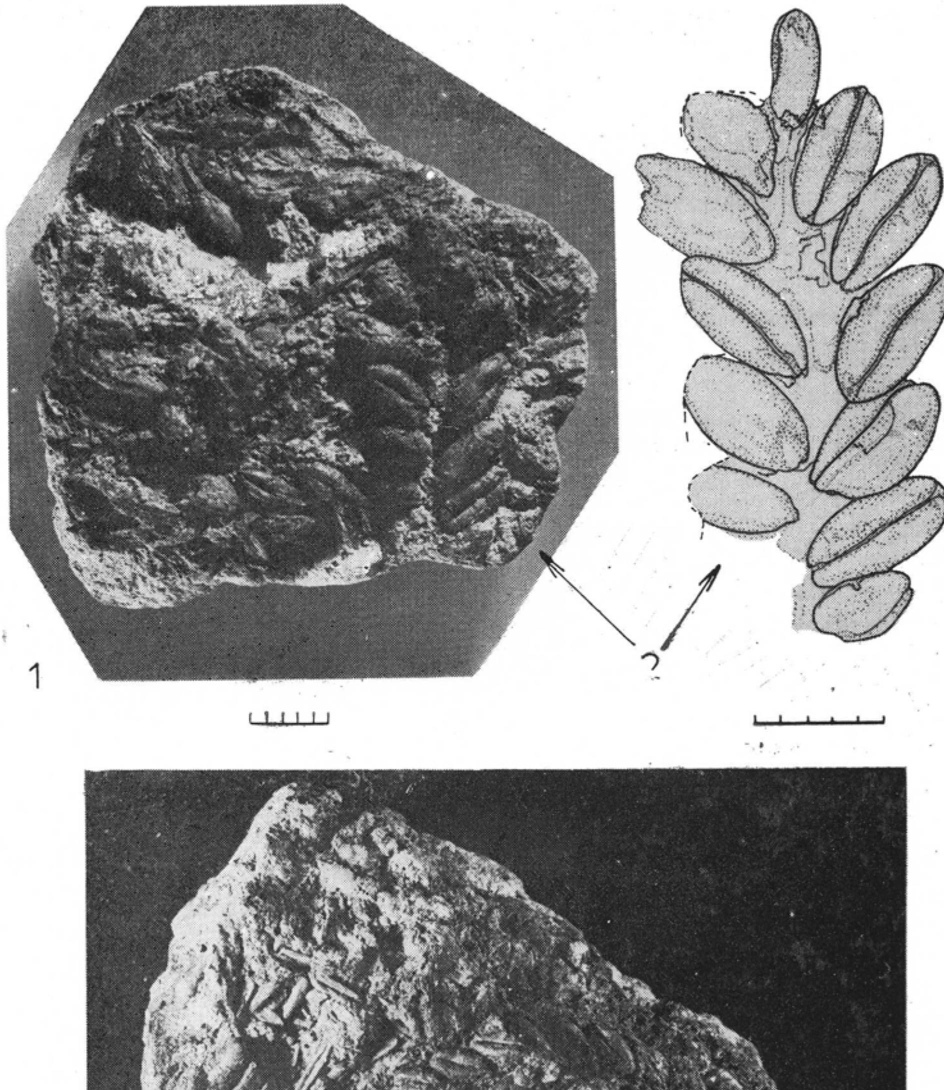

Plate V

1—4. *Triticum dicoccum,* fragments of spikes
5—11. *Hordeum vulgare* var. *nudum*
5. Six-row barley
6, 7, 8. Four-row barley
9. Central grains from the two neighbouring triplets
10. Symmetrical grain (upper row) and slightly twisted grain (bottom row)
11. One fragment of charred spike rachis
Scale equals 5 mm

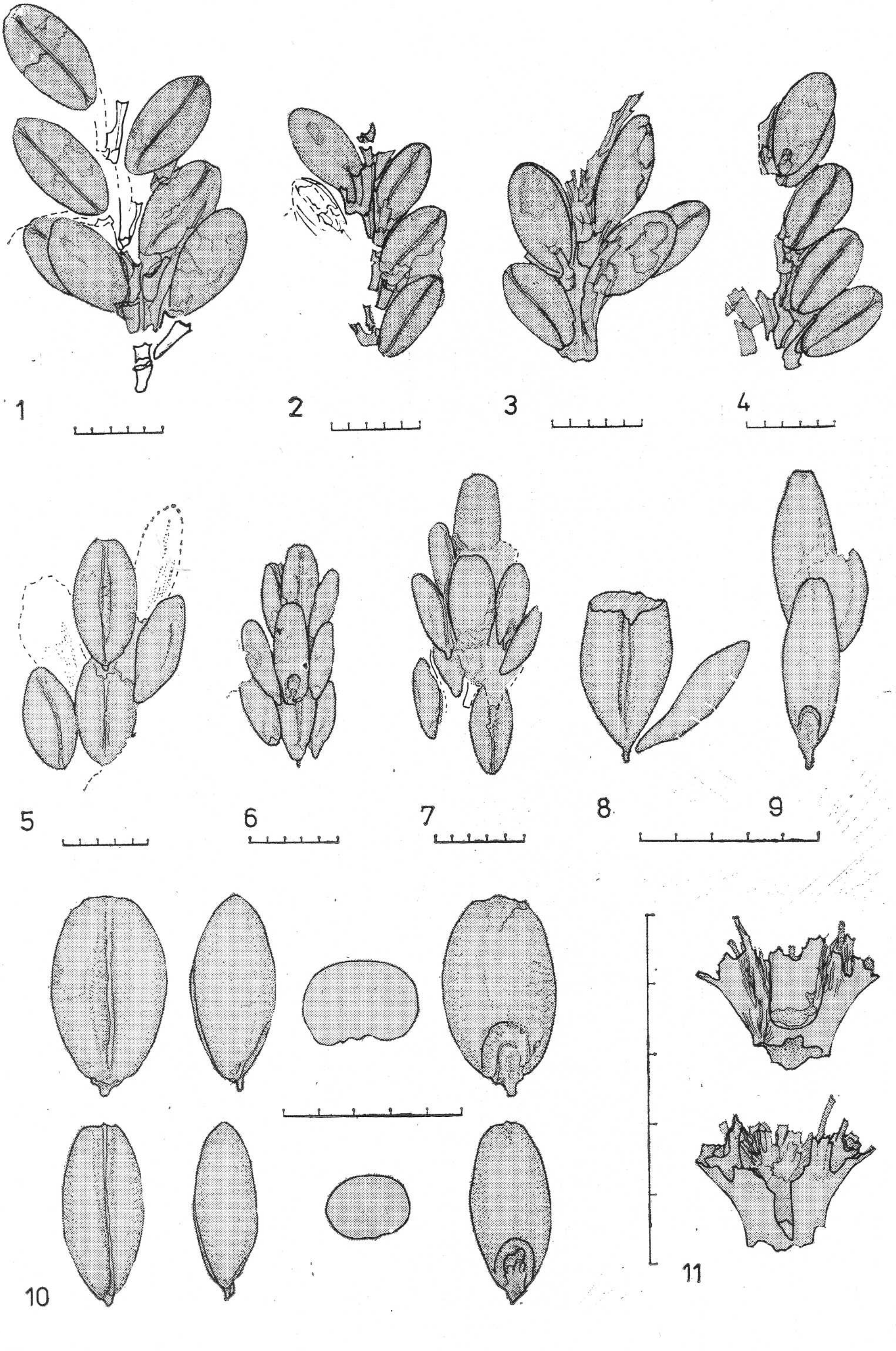
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Plate VI

Casts of three cereal species

1. *Triticum monococcum,* spikelet
2. *T. dicoccum,* spikelet
3, 4. *Hordeum vulgare* var. *nudum,* two fragments of spike rachis with remnants of lemma and palea

Scale equals 5 mm

Phot. L. Dziedzic

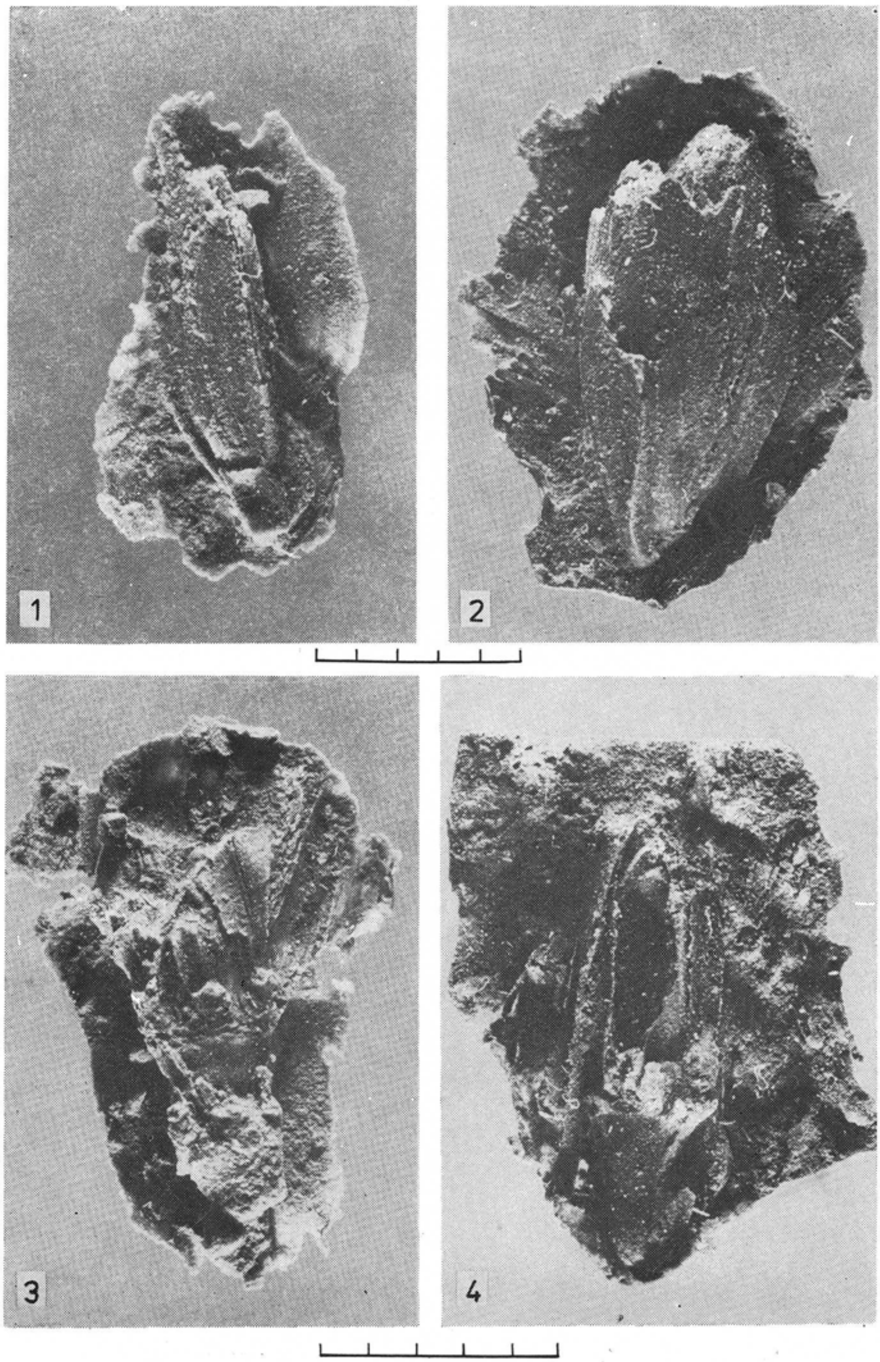
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Plate VII

1. *Triticum dicoccum*, charred grains
2. *T. monococcum*, charred grains

Scale equals 5 mm

Phot. L. Dziedzic

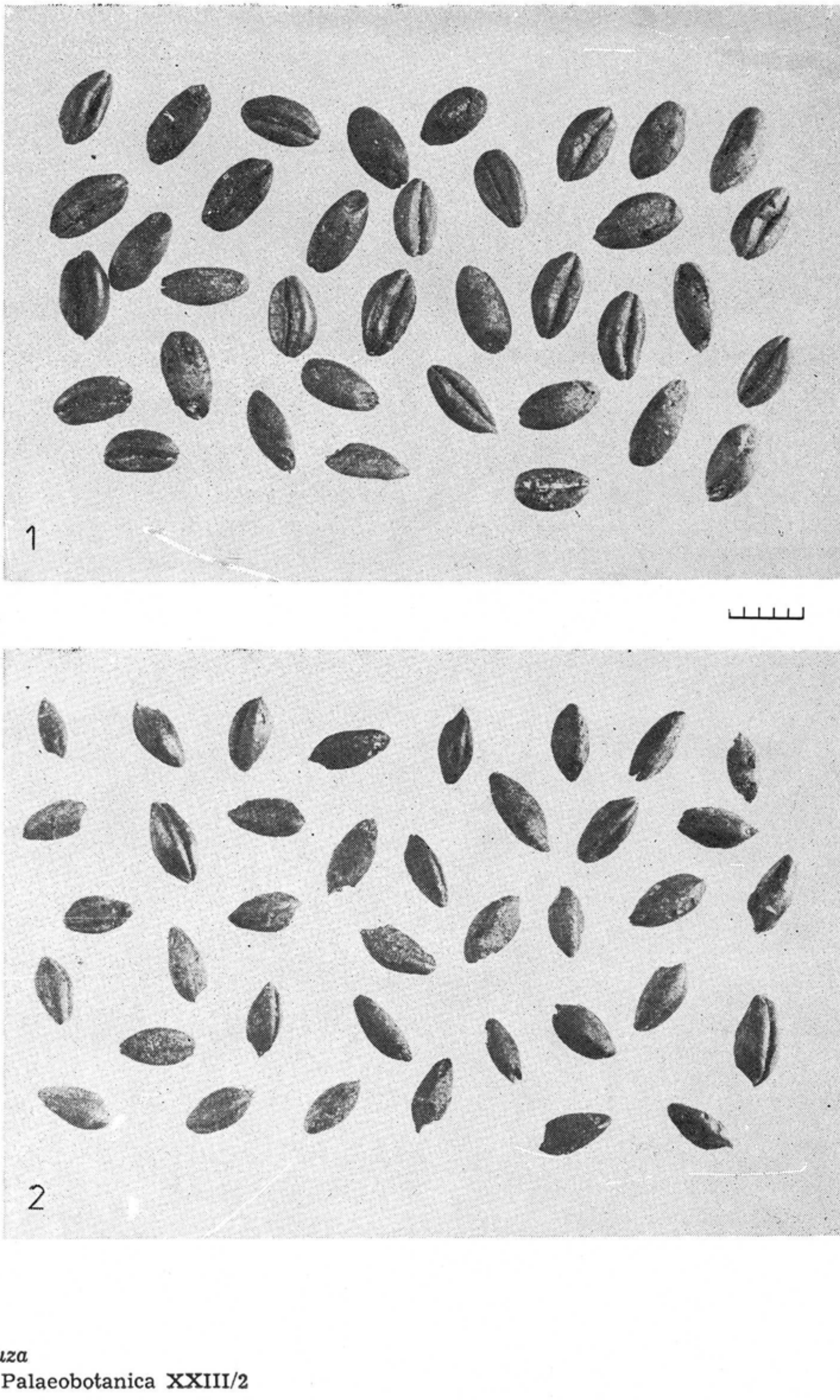

Plate VIII

Triticum dicoccum

1. Typical grain
2—5. Spikelet fragments
6. Two grains from one spikelet and basal part of this spikelet
7. Base of one-grained spikelet and the grain from this spikelet; shape of grain resembles *T. monococcum*
8. Spikelet base and one grain

Scale equals 5 mm

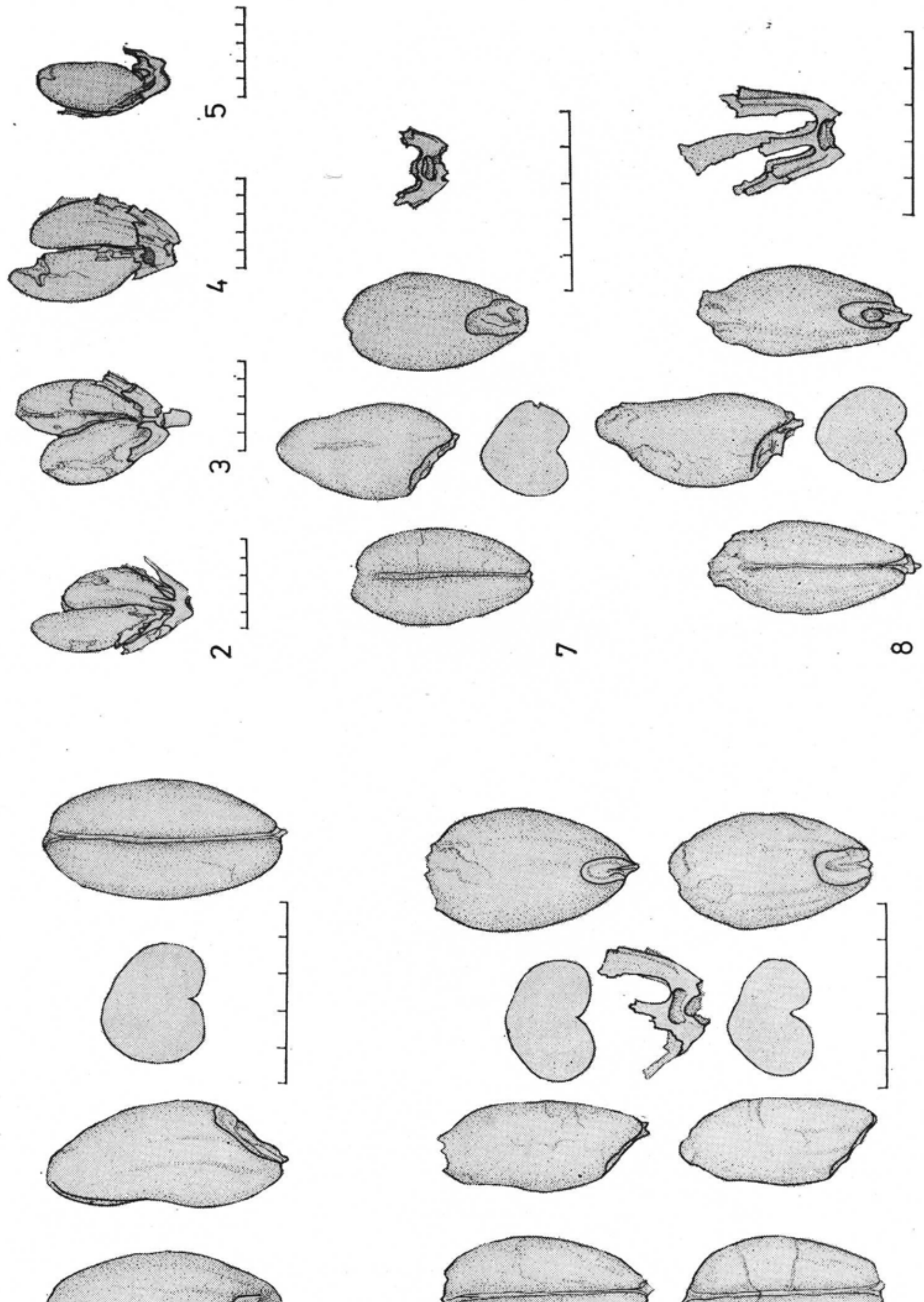

Plate IX

Fragment of charred spikelet of *Triticum monococcum*. The same specimen is shown in Plate I

Scale equals 5 mm

Phot. L. Dziedzic

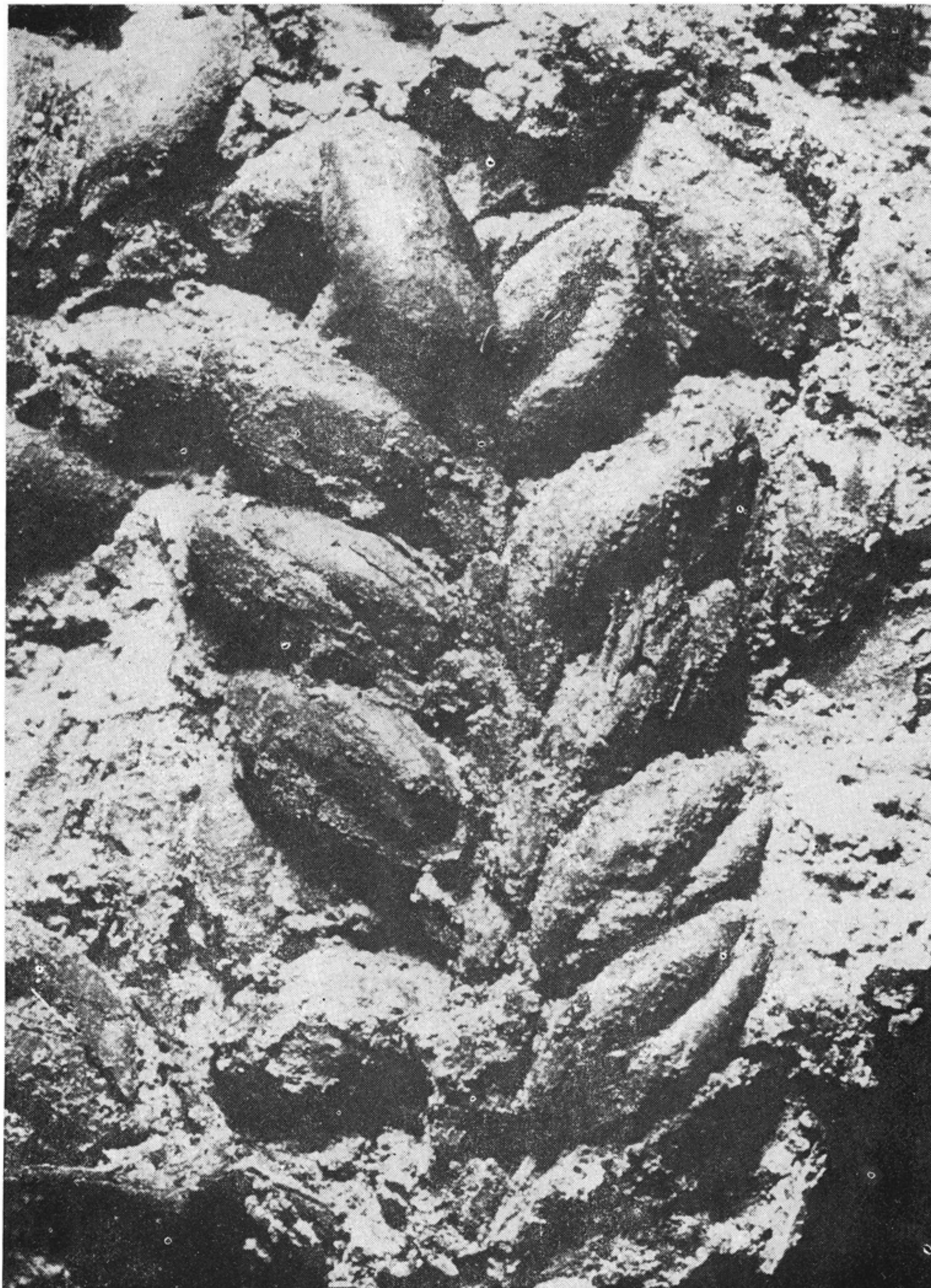

Plate X

Two spike fragments of *Triticum monococcum*

Scale equals 5 mm

Phot. L. Dziedzic

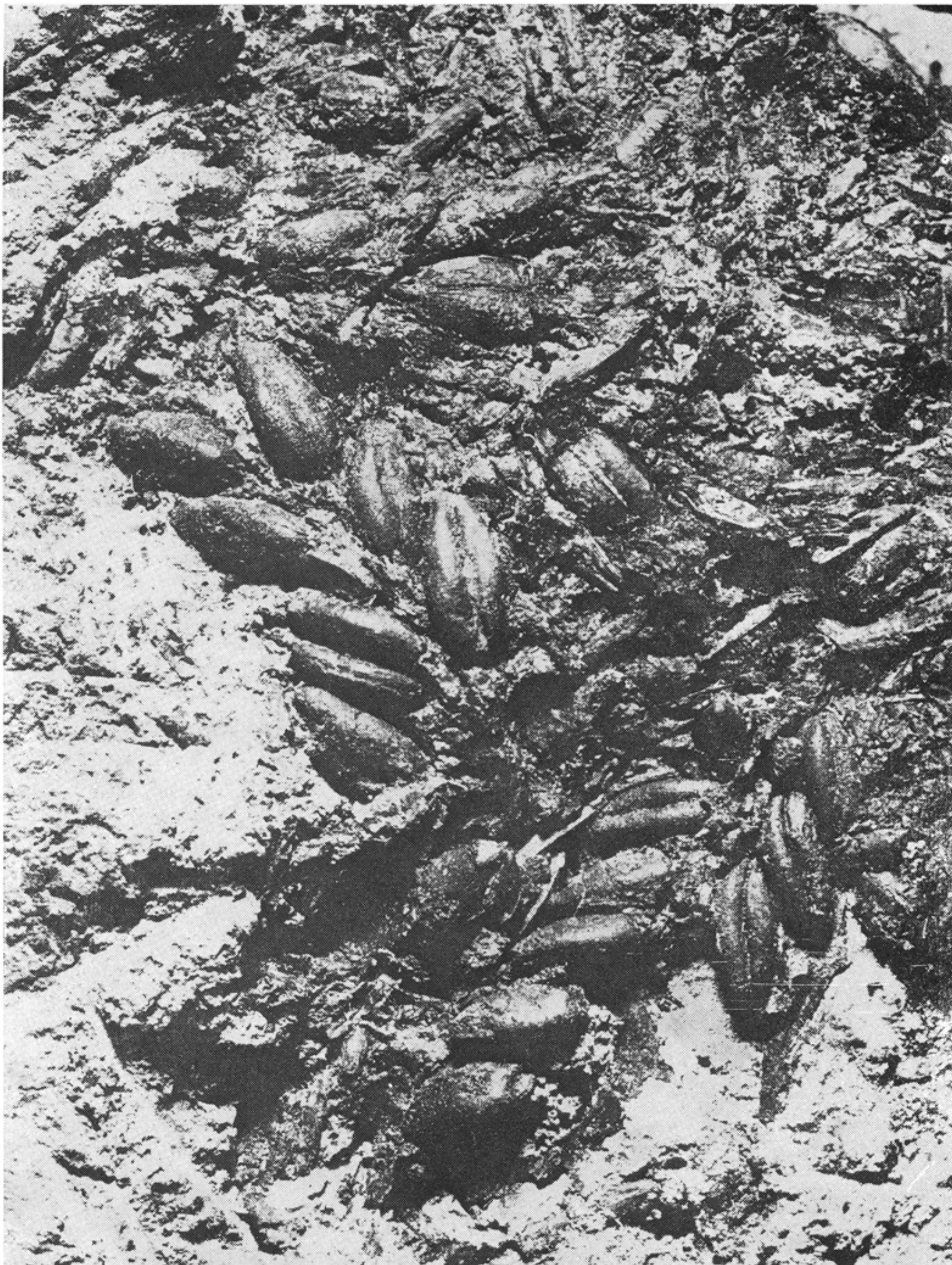

Plate XI

Triticum monococcum

1. Typical grain
2. Base of a spikelet and its grain
3—13. Spike fragments
4, 7. Spike fragments with shrivelled grains
11, 12. One specimen of spike

Scale equals 5 mm

Phot. L. Dziedzic

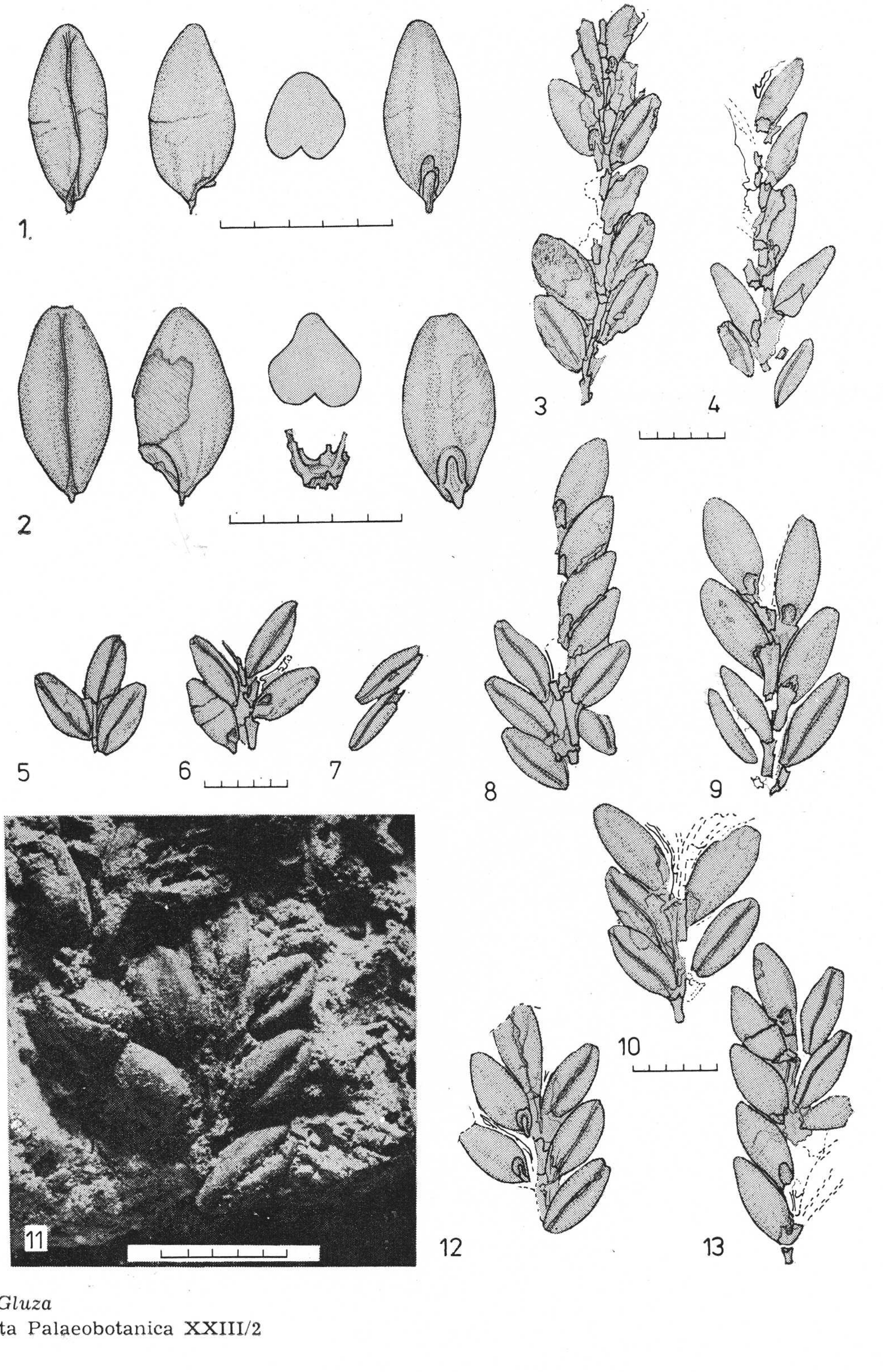
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Plate XII

Hordeum vulgare var. *nudum*, fragment of a spike of four-row form

Scale equals 5 mm

Phot. L. Dziedzic

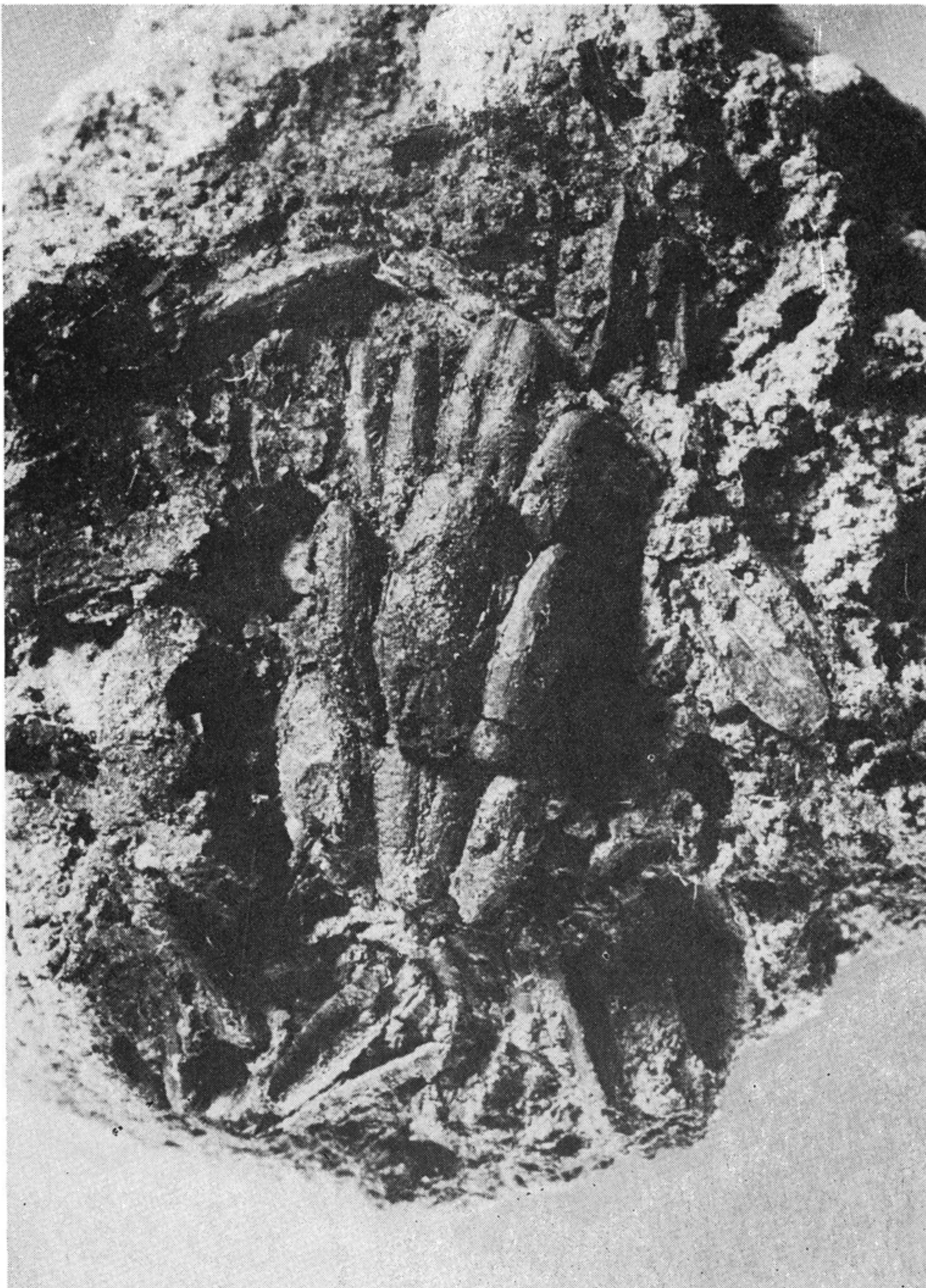

Plate XIII

Hordeum vulgare var. *nudum,* fragment of a spike of six-row form. The same specimen is shown in Plate I

Scale equals 5 mm

Phot. L. Dziedzic

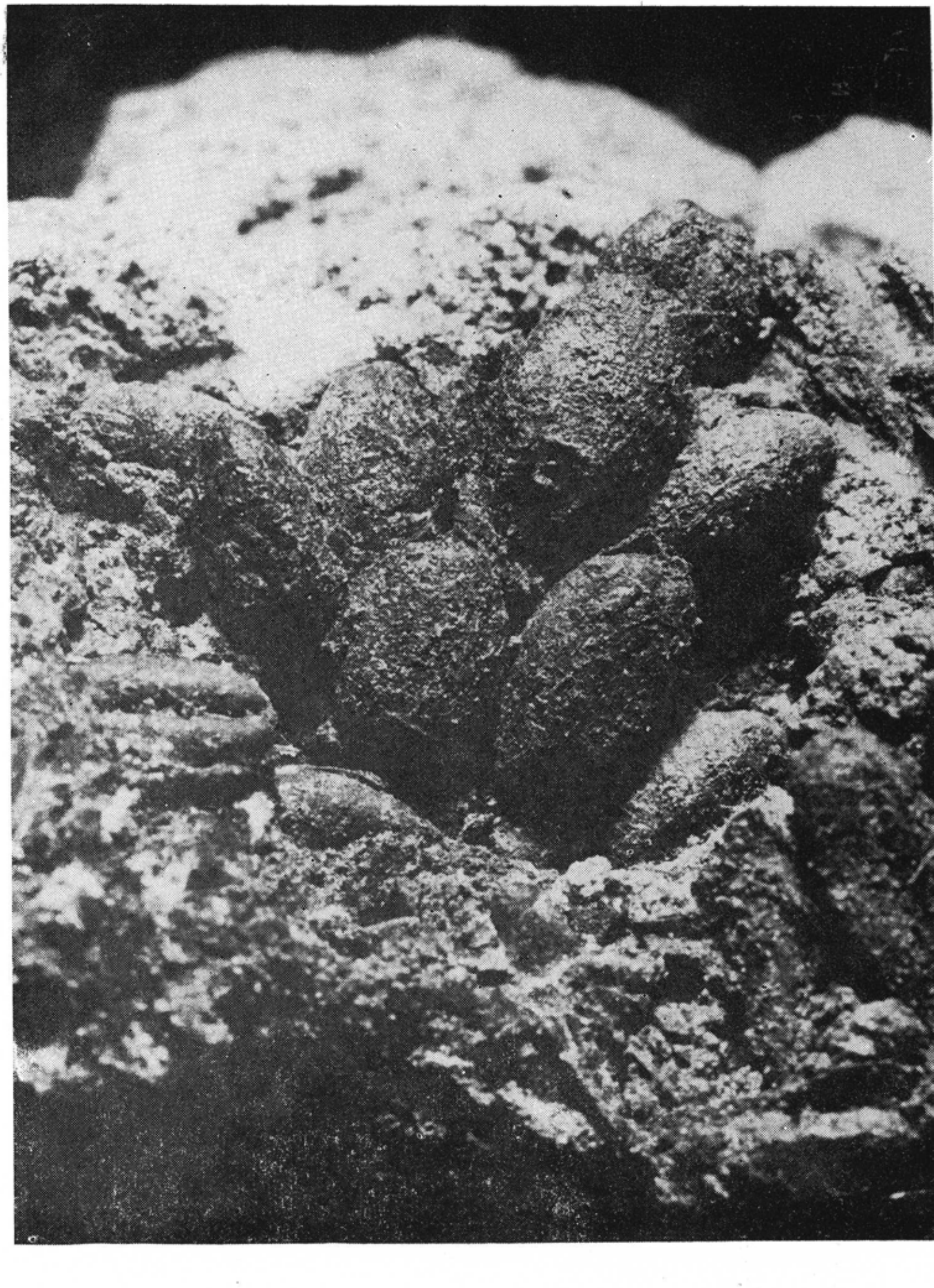

Plate XIV

Hordeum vulgare var. *nudum*

1. Cast of the impression of the top part of stem and three lowermost spike rachis internodes
2. Charred grain

Scale equals 5 mm

Phot. L. Dziedzic

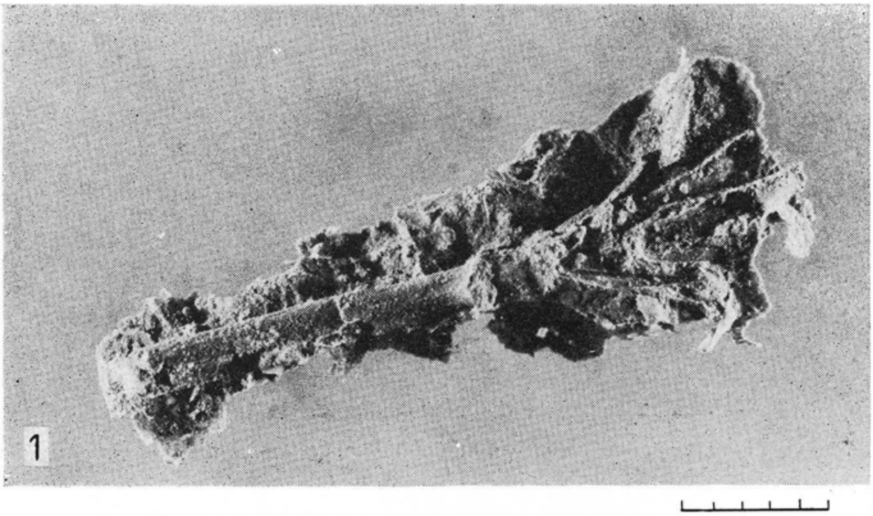

Plate XV

Charred grains from the ventral, lateral and dorsal sides

1. *Bromus arvensis*
2. *B. sterilis*
3. *B. racemosus*

Scale equals 5 mm

Phot. L. Dziedzic


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Plate XVI

1. *Polygonum aviculare*, fruit
2. *P.* cf. *minus*, fruit
3. *P. convolvulus*, fruit
4. *P. convolvulus*, seed
5. *P. nodosum*, fruit
6. *P. persicaria*, fruit
7. *Chenopodium polyspermum*, seed
8. *Ch. urbicum*, seed
9. *Chenopodium* sp., seed without testa and embryo
10. *Chenopodium* sp., seed without testa
11. *Ch. album*, seed

12—13. *Potentilla reptans*, two fruits

14. *Melandrium rubrum*, seed
15. *Silence inflata*, seed
16. *Melandrium album*, seed

Scale equals 1 mm

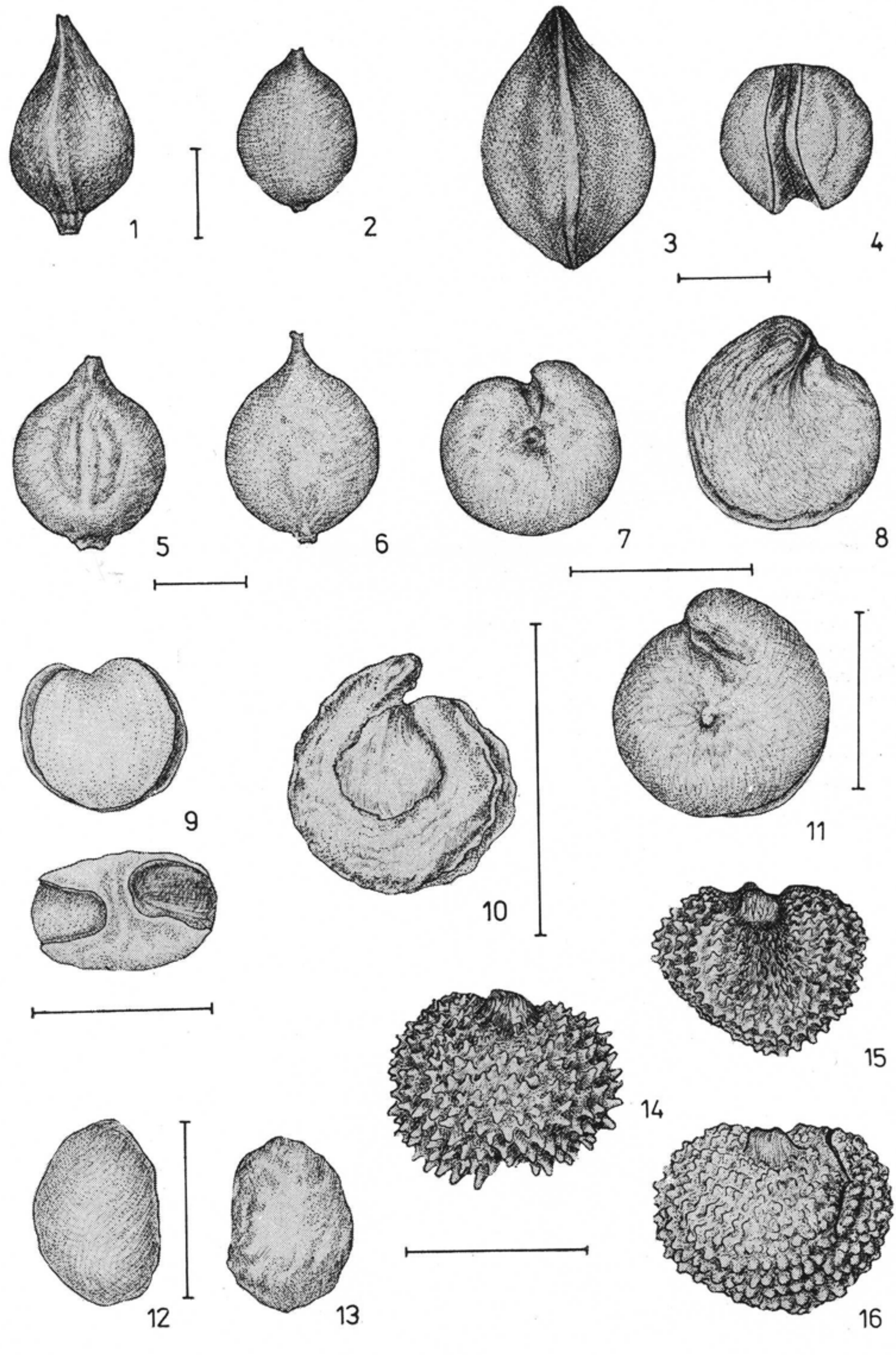
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Plate XVII

1. *Trifolium* cf. *repens*, seed
2. *T.* cf. *montanum*, seed
3. *T. hybridum/T. elegans*, seed
4. *Lotus corniculatus*, seed
5. *Linaria* cf. *vulgaris*, flower bud
6. *Scrophularia* sp., three capsules in different stages of development

7—8. *Scrophularia* sp., two seeds

9. *Ajuga genevensis/A. reptans*, fruit
10. *Verbascum* sp., seed
11. *Plantago media*, seed
12. *Veronica* sp., seed
13. *Viola tricolor/V. arvensis*, seed

Scale equals 1 mm

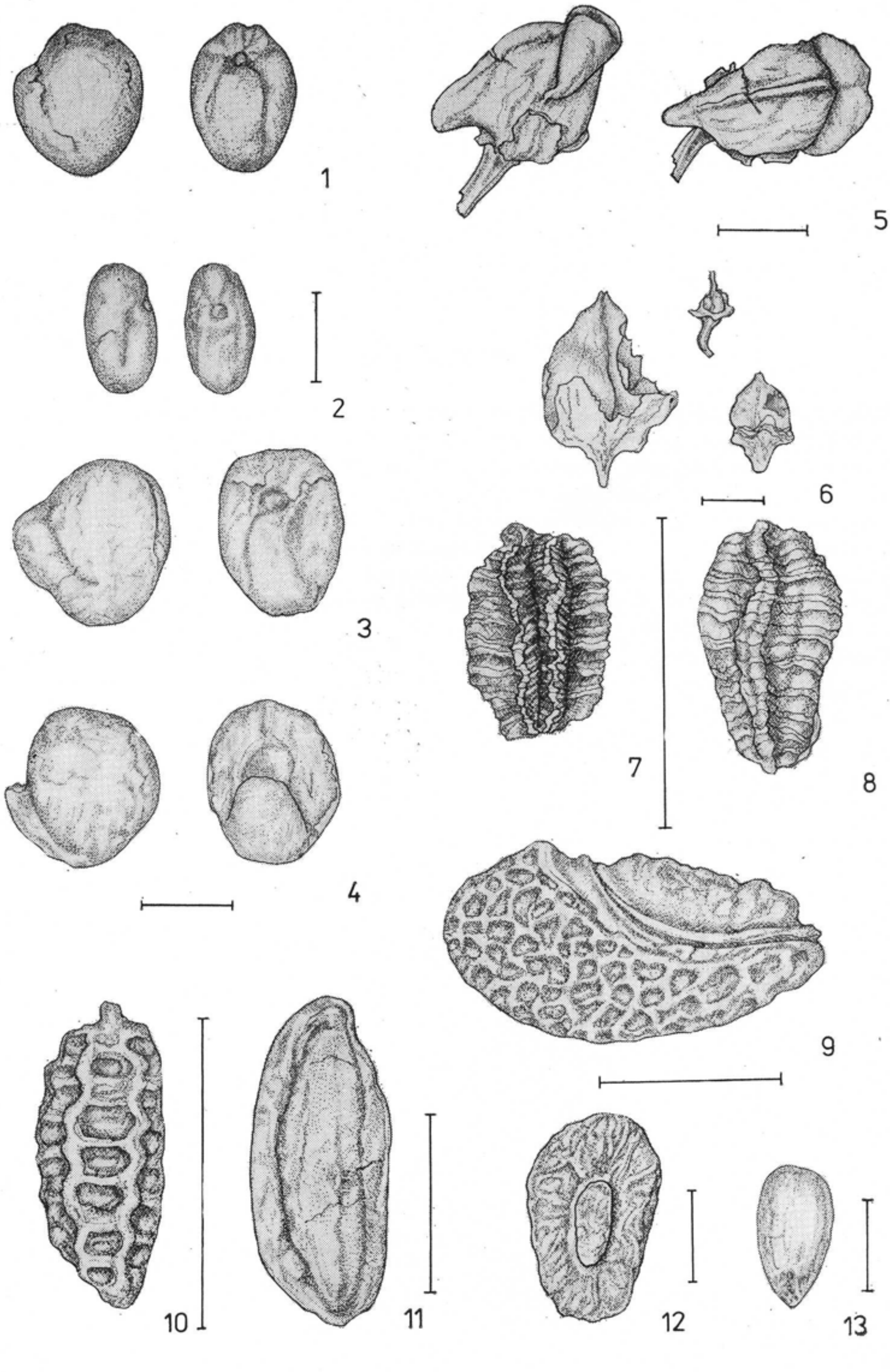
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Plate XVIII

1. *Digitaria* cf. *sanguinalis*, one caryopsis from ventral, dorsal and lateral sides
2. *D. ischaemum*, one caryopsis from ventral, dorsal and lateral sides
3. *Echinochloa crus-galli*, one caryopsis from ventral, dorsal and lateral sides
4. *Setaria viridis*/*S. verticillata*, one caryopsis from ventral, dorsal and lateral sides
5. *Galium* cf. *boreale*, one fruit from ventral and dorsal sides
6. *G. verum*/*G. mollugo*, one fruit from ventral and dorsal sides
7. *Centaurea scabiosa*, one fruit with partly damaged outer layer of pericarp
8. *C.* cf. *jacea*, fruit with damaged outer layer of pericarp

9—10. *Solanum nigrum*, two seeds

11. *Sambucus ebulus*, seed

Scale equals 1 mm

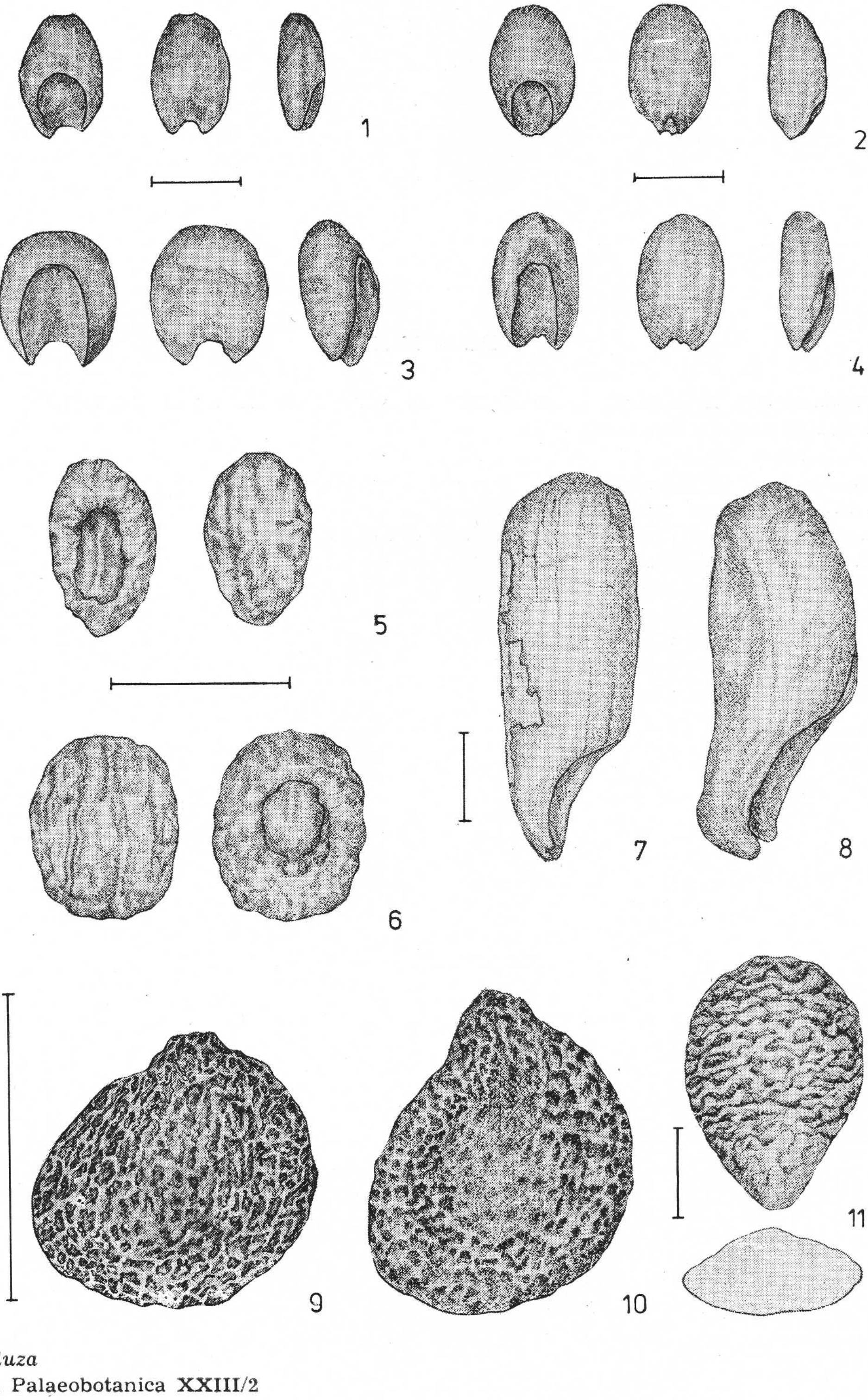
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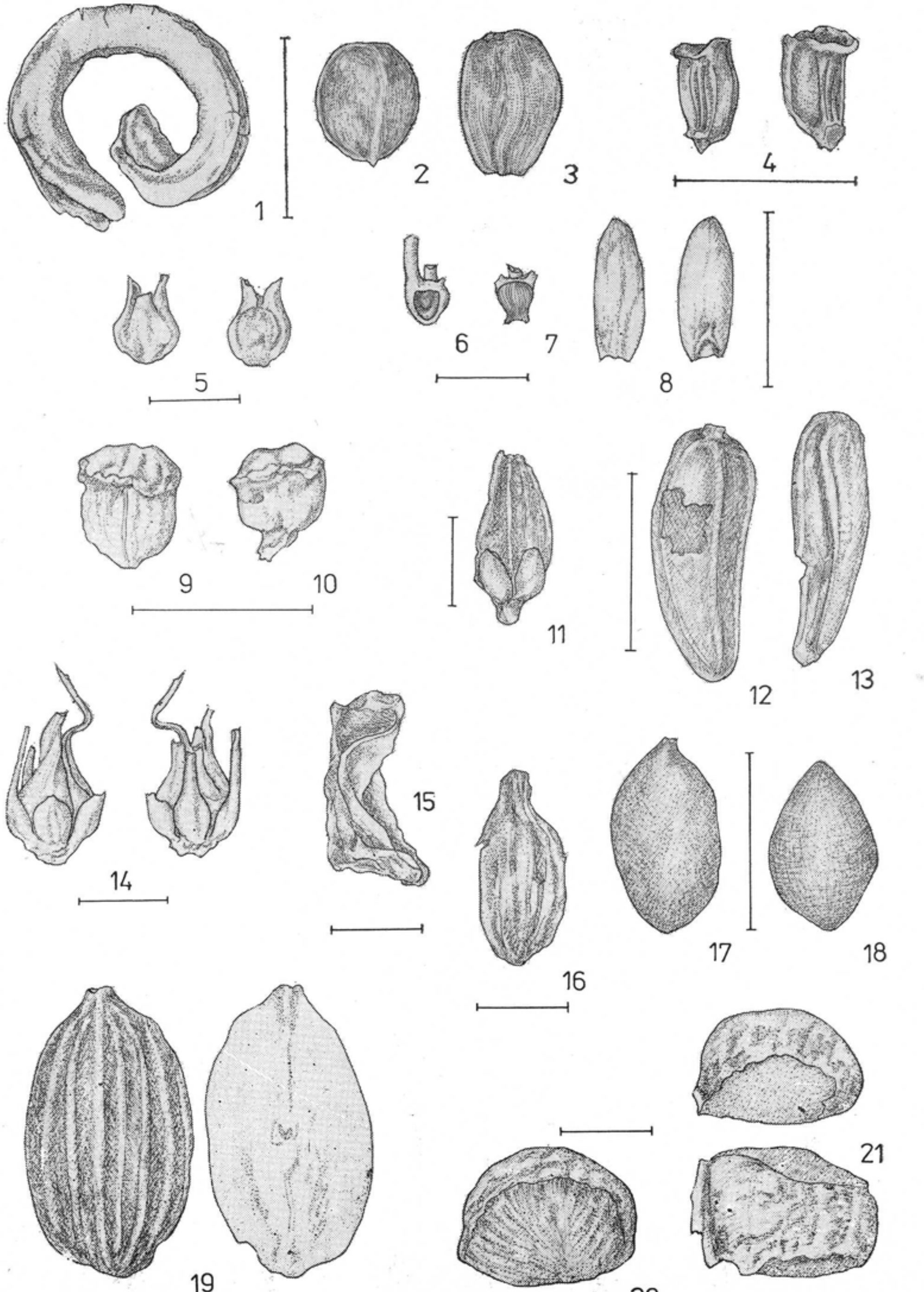
Plate XIX

1. *Campanulaceae,* hygroscopic sclerenchymatous spring from the septa of a capsule
2—3. *Campanulaceae,* two seeds
4. Undetermined fruit
5. Undetermined (*Rubiaceae?*)
6—7. *Gramineae,* basal parts of spikelets
8. *Gramineae,* one caryopsis from ventral and dorsal sides
9—10. Undetermined (*Rubiaceae?*)
11. Flower or capsule, undetermined
12—13. *Compositae,* fruits
14—18. Undetermined plant remains
19. Undetermined (*Umbelliferae?*)
20—21. Undetermined plant remains

Scale equals 1 mm



I. Gluza