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ARCHAEOBOTANICAL ANALYSIS OF ABUNDANT CEREAL FINDS FROM KRAKÓW NOWA HUTA MOGIŁA 62 – GETTING BACK TO THE OLD STORY

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A b s t r a c t. A large assemblage of charred cereal grains was found at the multicultural site Kraków Nowa Huta Mogiła 62 during a rescue excavations performed in the late 1960s. It provided valuable source of material for archaeobotanical and stable isotope studies. Both current botanical analyses of six subsamples and new radiocarbon dates of the top and the bottom of the layer indicated their Middle Neolithic origin (the Funnel Beaker culture). Despite the earlier suspicion that the material was disturbed by the construction work, the field documentation stored in the Archaeological Museum and the new archaeobotanical analyses indicate that the layer with the cereal grains, which was found at the depth of 300–330 cm was in fact, undisturbed. The cereals (mostly emmer with admixture of einkorn) were stored in a form of spikelets (as indicated by proportions of chaff and grains) and the assemblage was a final product of harvest cleaning (as suggested by low number of arable weeds). Values of stable carbon and nitrogen ratios suggest that the storage contained cereals originated from plots of different level of manuring and similar soil moisture, however more isotopic measurements are necessary to confirm that hypothesis. It is also supported by different proportions of taxa in the studied subsamples. Most of the emmer grains were sprouted before charring. We assume the grain was spoilt by excessive humidity of the storage conditions.

K e y w o r d s: storage, sprouted wheats, Neolithic, Funnel Beaker culture, S Poland, museum collection

INTRODUCTION

The plant material was obtained during rescue excavations in the late 1960s in an area rich in traces of prehistoric occupation. The material was briefly analyzed after the discovery (Gluza et al. 1988) and stored in the Archaeological Museum in Kraków. After an archaeological revision (Kluzik 2010), which questioned the previous chronology of the find, the material was in a way abandoned and not mentioned in any other publications. The samples, stored in 6 boxes, contained large number of cereal

grains. The study of documentation in the museum archives, new archaeobotanical analysis of the plant material and radiocarbon AMS dating were performed in order to select plant material for stable isotope analyses, well defined archaeologically and botanically.

DESCRIPTION OF THE SITE

The site is located on the left bank of the Vistula river on the fluvial terrace elevated *ca*. 220 m asl, getting slightly lower to the east. Geographically it is a part of Płaskowyż Proszowicki, which belongs to Wyżyna Środkowomałopolska (Godłowska 1976; Kondracki 1988: 396–397; Kondracki 2000). The whole region is covered by loess on which chernozem soils developed (Kondracki 2000). From the south direction the site is confined by the alluvial valley of the Vistula. Today the streamway is *ca*. 1200 m away from the site. In the west the terrace is confined by the tributary Dłubnia, now *ca.* 600 m away from the site (Kluzik 2010) (Fig. 1).

The site was excavated between 1966 and 1970 under general direction of S. Buratyński, M. Godłowska, M. Kaczanowska, G. Kałka-Tobołowa i R. Zając. The construction work was connected with an enlargement of ironworks (Huta im. Lenina, now the name is changed to Huta im. Sendzimira) and a reconstruction of a public road to Nowe Brzesko (Godłowska 1976; Kluzik 2010). The most intensive work was done in 1966 when more than half of the site area was explored. Due to a use of bulldozers some parts of the site were destroyed by removal of archaeological layers or re-deposition of the upper layers. In the south part of the site the occupation layer was partly destroyed and only lower sections of archaeological features were explored. Due to intensity of the exploration work the site was divided into two

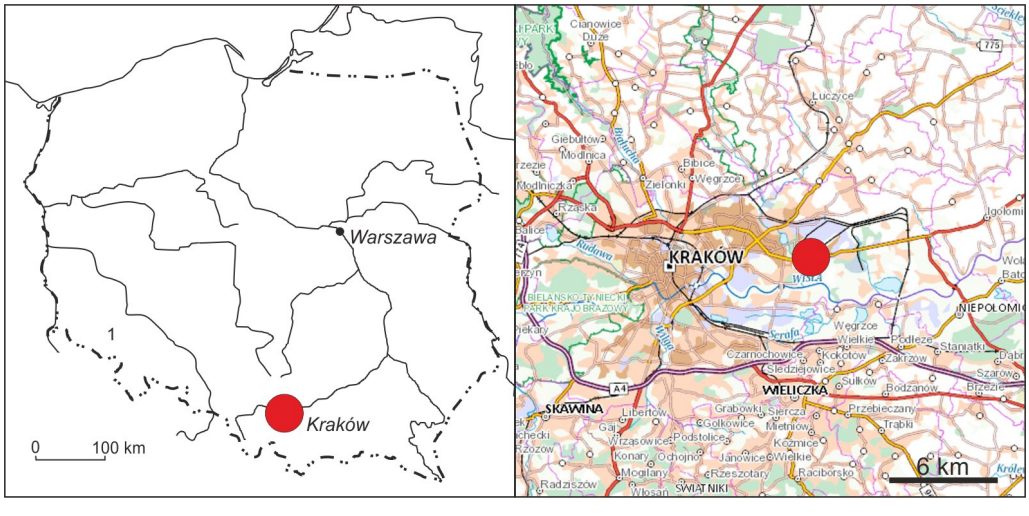

Fig. 1. Location of the site (based on geoportal.gov.pl)

parts: area 62 and 62A. In the undisturbed parts of the site the occupation layer was covered by 20–30 cm of arable soil (humus). The thickness of the occupation layer was 20–60 cm (Godłowska 1976).

In the site Mogiła 62 the artefacts were dated to several archaeological horizons and cultures, including Neolithic (the Linear Pottery culture, the Lengyel-Polgar culture, and the Funnel Beaker culture), the Bronze age, the Iron age, and the Early Medieval times (Godłowska 1976).

MATERIAL AND METHODS

The studied plant material comes from feature 395A which was omitted by Kluzik (2010) in her revision of the Funnel Beaker materials from that site because the feature 395 was multicultural and in some part there were iron items found in deeper layers. However samples presented in this paper were collected from a clear, undisturbed layer of black sediment with visible charred grains (Fig. 2) associated with the layer dated to the Funnel Beaker culture. The samples are stored in Archaeological Museum in Kraków (Muzeum Archeologiczne w Krakowie Odział w Nowej Hucie – Branicach) in separate boxes in a form of almost pure grain. Many times the grains are clustered together, only with small admixture of mineral fraction. The age and unmixed character of the layer visible in museum documentation (J. Bober personal communication) was also confirmed by radiocarbon dates provided for the top and the bottom of the layer (Tab. 1). The material was used for stable carbon and nitrogen isotope analyses (Mueller-Bieniek et al. 2016). The brief archaeobotanical analysis of the material from unknown part of the feature 395 was done by Z. Tomczyńska (Gluza et al. 1988), among six samples studied then, only one was taken from the same level as samples studied by the authors (Tab. 2), however the exact location of the samples within the large feature (a cluster of features) is unknown (Fig. 2).

The feature 395A contained archaeological material belonging to the Funnel Beaker culture (TRB) as well as to the younger cultures and periods thus it was described as a feature of unspecified chronology. The feature belonged the cluster of sub-features 395, 395A, 395B and 395C. On the basis of field documentation it was difficult to recognize stratigraphic relations between them (Kluzik 2010). The separate parts could have been in fact separate pits (Kluzik 2010). The other problem was connected with a depth given in original sample labels and in the field documentation. Their exact correlation was impossible. In this work the depth of the samples is given after the

Table 1. Radiocarbon dates from the feature 395A

Depth	Sample	Plant	Remains	Uncal. data	Lab number	Calibrated data
300–310	Mog6	*Triticum dicoccum*	3 grains	4595 ± 35 BP	Poz-77282	*ca.* 3500–3300 BC
320–330	Mog4	*Triticum dicoccum*	1 grain	4625 ± 35 BP	Poz-82984	*ca.* 3500–3350 BC

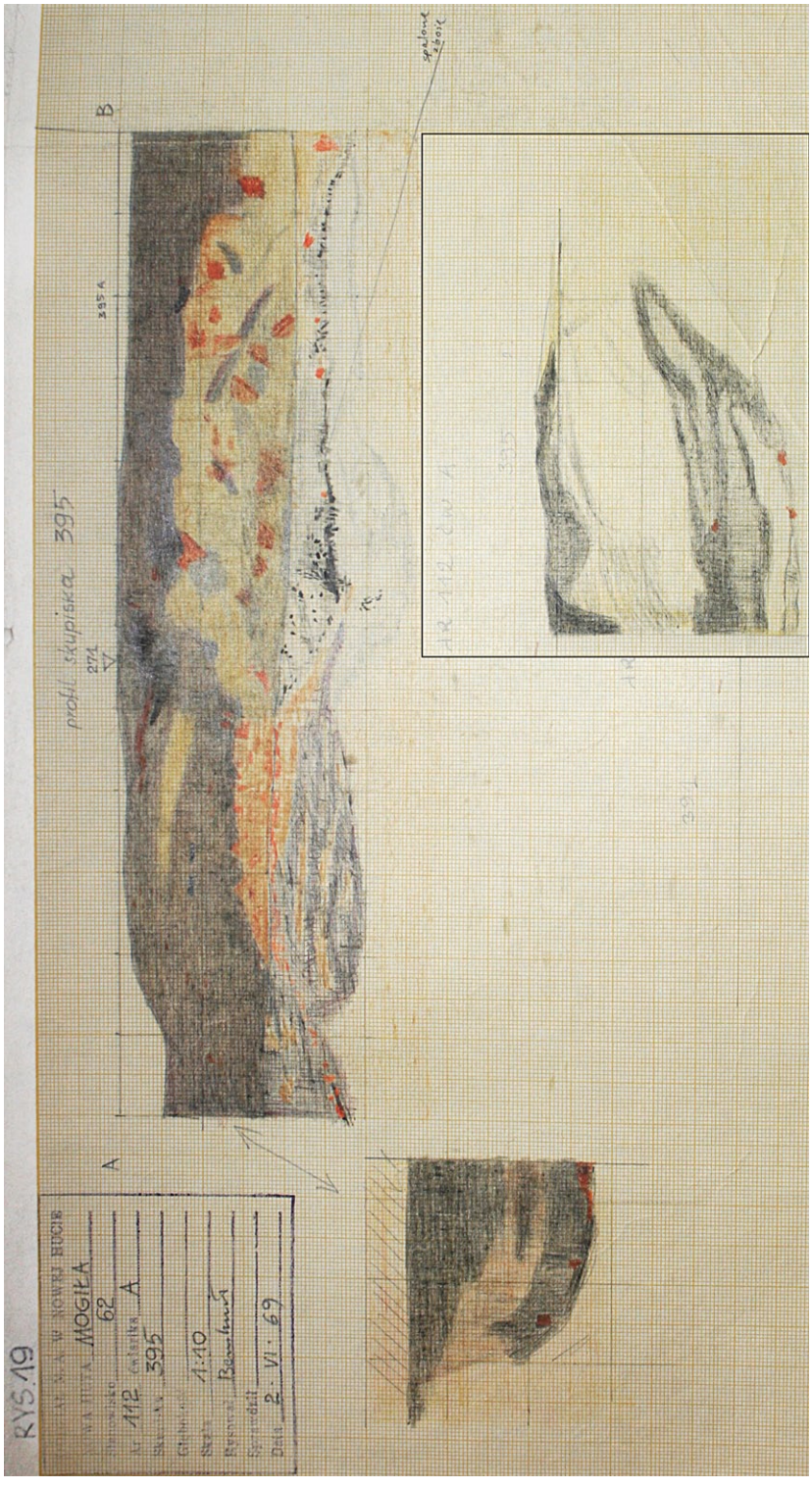

Fig. 2. Probable position of the studied samples, within the black layer marked originally as 'spalone zboże' (*charred grain*) (Courtesy of Archaeological Museum in Kraków, Nowa Huta Branch)

Table 2. Plant composition in subsamples from the studied feature 395A. Number of chaff remains include glume bases and spikelet bases

Plant name	Depth	300–310	310–315	310–315	310–315	310–320	320–330
	Sample	Mog6	Mog1	Mog3	Mog5	Mog2	Mog4
	Type of remain						
Triticum dicoccum	sprouted grains	38	80	22	89	109	82
	chaff	31	67	49	33	72	87
T. dicoccum/monococcum	grains	5	2		1	11	1
T. dicoccum/spelta	grains			2	7		
	chaff	1	1			5	13
Triticum monococcum	grains	15	15		13		12
	sprouted grains		1				3
	chaff	10	29	12	29	51	34
Triticum sp.	grains	1	27				
	sprouted grains	137	202	60	192	350	227
	chaff	70	12		44	61	75
Cerealia indet	grains		4				5
Agrostemma githago	fruits/seeds		2			1	2
Bromus arvensis	grains					4	
B. racemosus	grains	9	11	2	23	47	35
	sprouted grains		1				
Bromus sp.	grains		2				
Fallopia convulvulus	fruits/seeds	3	2	1	3	4	2
Poaceae *Phleum* type	grains	1	5			4	1
Poaceae indet.	grains		2		2	5	
Polygonum lapathifolium	fruits/seeds				1	1	
Stipa sp.	awn fragments	1	1				
Indet.	fruits/seeds		4	3		8	1
	sprouts	1	19	1	32	11	6
	buds			1			

labels stored together with the samples in the Archaeological Museum in Kraków (Tab. S1[2]). The currently studied material was taken in a form of 6 subsamples from the boxes (museum samples) from the depth: 300–310, 310–315, 310–320, 320–330 cm. Volume of the subsamples varied from 150 to 400 ml. The material was water sieved using a manual flotation method, over sieves with 0.2 mm and 0.5 mm mesh size.

[2] Supplementary materials available on page http://dx.doi.org/10.18150/repod.7038933

The samples were sorted as three fractions A – light (floating) fraction from 0.5 mm sieve (items larger than 0.5 mm), B – light fraction from 0.2 mm sieve, C – heavy fraction sieved with 0.5 mm mesh size (detailed results are given in Tab. S2). Fraction B did not contain any recognizable macroremains.

The material was charred and rather well preserved, no uncharred plant remains were noted. Apart from plant macroremains also small archaeological artifacts were noted (flints, daub, potsherds) as well as small bones. The plant material was identified in W. Szafer Institute of Botany, Polish Academy of Sciences using modern and subfossil reference collections as well as relevant keys, seed atlases and archaeobotanical publications (Kulpa 1974; Młodzianowska 1981; Gluza 1984, 1977; Kohler-Schneider 2001; Bieniek 2005; Neef et al. 2012). Names of cultivated plants follow *Domestication of Plants in the Old World* (Zohary et al. 2012) but in the text and tables shorter, traditional names are used; names of wild growing plants follow *Flowering Plants and Pteridophytes of Poland* (Mirek et al. 2002).

RESULTS AND DISCUSSION

The samples contained similar plant taxa but their proportions varied. The assemblage was dominated by grains of emmer (*Triticum dicoccum*) with admixture of einkorn (*T. monococcum*). Large numbers of chaff remains were also found, suggesting that the grain was stored in spikelets. The remains of weeds and other wild plants were very scarce, except of brome grass (*Bromus racemosus*) (Tab. 2), some of the remains were preserved both in the light and the heavy fraction (A and C in Tab. S2). In addition to seeds and fruits, sprouts and awn fragments were also found. Most of the emmer grains were sprouted before charring. The measurements of cereal grains and chaff remains are given in Table S3 as L – length, B – breadth, T – thickness. Twenty grains (without embryo) and 10 spikelet bases were measured manually with the use of calibrated measure bar located in the binocular.

DESCRIPTION OF PLANT REMAINS

Cereals

Triticum turgidum L. subsp. *dicoccum* (Schrank) Thell. (=*T. dicoccum* Schübl.) – emmer wheat (Fig. 3a,b; Fig. 4a,b)

Grains are oval in outline, dorsal side flat or slightly concave. On the dorsal side a deep furrow which separate that part into two slightly convex halves is visible, on the bottom of that furrow hilum is located which is not visible in the charred grains. The ventral side is strongly convex. In lateral view the grain is broadest in the lower half of the grain, just above the embryo. On most of the grains sprout or imprint left

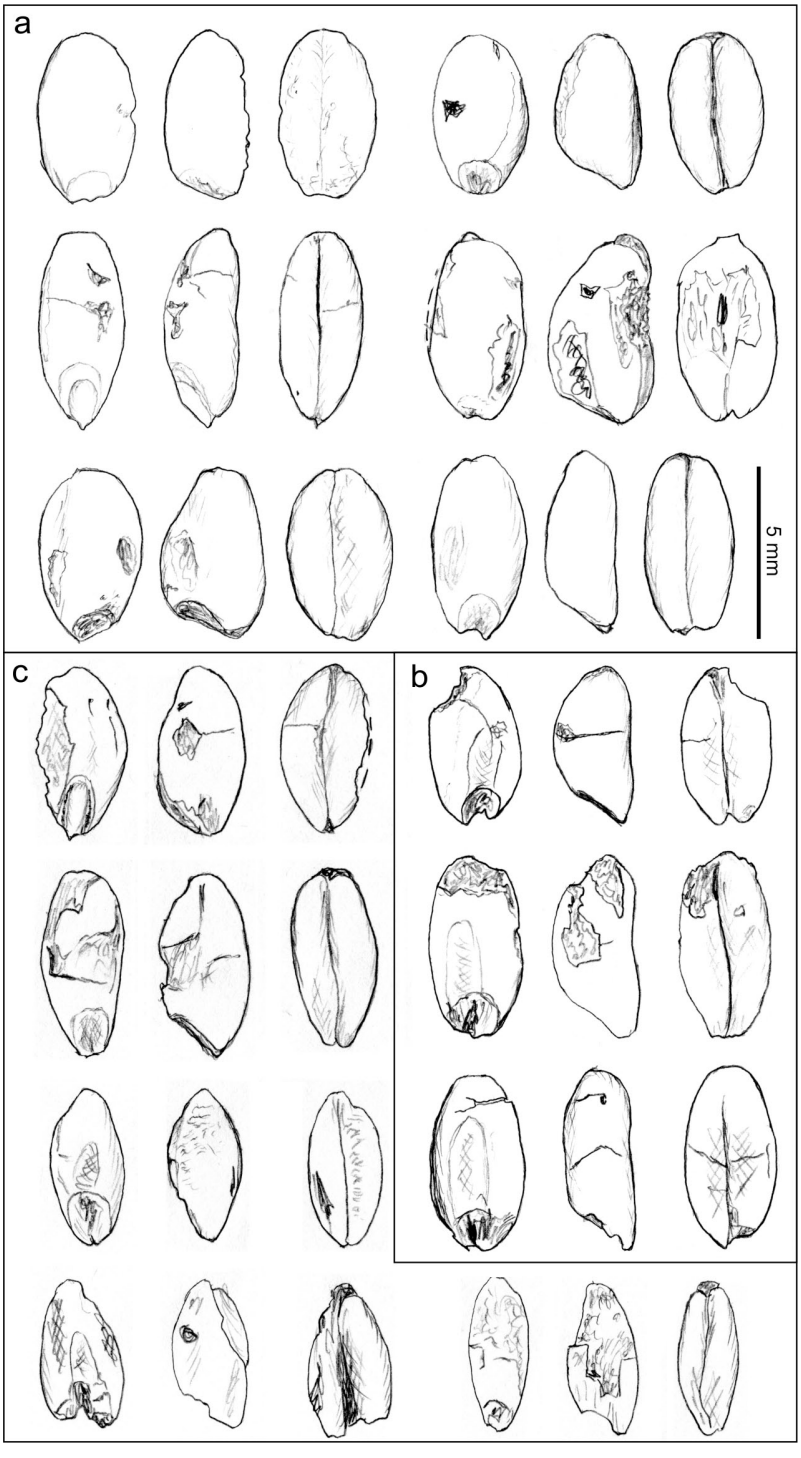

Fig. 3. Grains which were used for isotopic analyses visible in 3 views: dorsal, lateral and ventral. a, b – emmer (*Triticum dicoccum*), c – einkorn (*T. monococcum*), (drawings A. Mueller-Bieniek)

Fig. 4. Plant macroremians from feature 395A. a, b – emmer (*T. dicoccum*), visible sprouts still attached to the grains (b); c – brome grass (*Bromus racemosus*); d – einkorn (*T. monococcum*); e – wild buckwheat (*Fallopia convolvulus*); f – emmer/spelt spikelet base (*T. dicoccum/spelta*) (photos M. Szewczyk)

by a sprout (radicle) is visible (Fig. 4b). Size: L – 5.2–6.9 mm; B – 2.2–3.3 mm; T – 2.2–3.2 mm; average: 6.18 × 3.06 × 2.73 mm.

In most of the chaff specimens primary and secondary keels are well visible. In lateral view, between keels, nervation is clear in upper part of the glume while it is indistinct close to its base. In some specimens at the base of the glume, in place where the nerves

are ending, a horizontal, thin furrow is visible. In lateral face the glume is slightly convex. When the whole spikelet bases (spikelet forks) are preserved, usually wide angle between glumes is visible. The spikelet bases of emmer are more massive than those of einkorn from the same sample. Disarticulation scar is short and wide, ellipsoid, usually slightly protruding from the surface of spikelet. Size: B of spikelet base – 1.5–2.0 mm, average 1.65 mm; B of glume base – 0.5–0.9 mm, average 0.66 mm.

A few spikelets (*T. dicoccum/spelta*) are W-shaped (Fig. 4f), with no rachis internode preserved, more massive, with keels not so distinct like in typical emmer specimens. Disarticulation scar is not preserved. Side nervation (ridged surface) similar to *T. spelta* however keels are to distinct for that taxa. No typical, well preserved specimen of spelt was noted.

Triticum monococcum L. subsp. *monococcum* (=*T. monococcum*) – einkorn wheat (Figs 3c, 4d)

The grains are laterally flattened, lenticular in lateral view, dorsal side strongly convex, ventral convex as dorsal but only when the grains were not strongly swollen due to charring. In grains strongly deformed by high temperature those characters are not so well visible. However the angle of the embryo, the overall shape and sharp upper end allow identification of the grains. Some of the grains were also sprouted before charring. Size: L – 5.6–7 mm; B – 2.0–2.8 mm; T – 2.2–3 mm; average 5.78 × 2.43 × 2.51 mm.

The glumes are narrow at the base, widening to the upper parts. Both primary and secondary keels are very distinct. Some of the glumes look like splitting to the upper parts, when keels are still present and the tissues between them are destroyed. In spikelet forks rachis internode is relatively massive in relation to the glumes. The angle between glumes usually much narrower that in emmer. Disarticulation scar wide and narrow, usually visible as a line. Only in few cases the whole rachis internode was preserved. Size: B of spikelet base – 1–1.1 mm, average 1.19 mm; B of glume base – 0.4–0.5 mm, average 0.48 mm.

Most of the grains were identified to the genus level (*Triticum* sp.) as they were fragmented and destroyed. Most of them belong to the species described above.

Bromus racemosus L. – brome grass (Fig. 4c)

Bromus grains were identified to the species level according to the criteria given by I. Gluza (1977) and modern comparative material collected by Gluza as well as Neolithic collection described by her. The main characters well visible in the studied material were the size and shape of the grains and the shape of embryo, which is typical for *B. racemosus*. Some of the grains were identified as *B. arvensis* L. It cannot be excluded that the slightly destroyed grains included here to the group *B. racemosus* belong also to other species from that genus. Both *B. racemosus* and *B. arvensis* are very rare in Polish flora today (Kaźmierczakowa et al. 2016). *B. racemosus* is a plant growing in moisture, fertile meadows (Calthion palustris) while *B. arvensis* is a typical weed of crop fields (Centauretalia cyani) (Matuszkiewicz 2001). Grains of *Bromus* are frequently found in prehistoric samples, which is interpreted as their importance

as source of human food (Gluza 1984; Kohler-Schneider 2001; Lityńska-Zając, Wasylikowa 2005; Behre 2008; Lityńska-Zając et al. 2017).

The other wild plants, including *Agrostemma githago*, *Fallopia convolvulus*, *Phleum* type, *Polygonum lapathifolium* and *Stipa* sp., are scarce in our assemblage and usually represented by a very few or single specimens. They are known as weeds and ruderals as well as grassland plants and obviously they do not represent the whole original content of the plant assemblages, harvested in the fields together with crops but rather the last stage of crop processing ('fine sieve product' according to Jones 1987, 1984).

The plant assemblage, despite it comes from a thick layer, represents a cleaned crop, a mixture of hulled wheats, mostly emmer with some addition of einkorn (Fig. 5, Tab. 2). As most of the grains are sprouted and only some percent of their remains was directly identified to the species level it is difficult to state the exact proportion of the various cereals. However taking into account the whole material divided into separate samples it was about 3:1 to 5:1 mixture of emmer and einkorn with some addition of brome grass which grains are more numerous than typical einkorn grains (Tab. 2). Most of the grains were sprouted before charring. The reason of that process was unclear. It would have happened accidentally and the assemblage was a result of cleaning. A possibility that it is a waste of some stage of food (or drink) processing also cannot be excluded.

The find can be compared with other large cereal assemblages from the territory of Poland, dated to the same period (after Lityńska-Zając unpubl., Tab. 3, Fig. 6).

Based on the presented data as well as results of studies coming from analyses of imprints in daub (Lityńska-Zając 2002; Wasylikowa et al. 2002; Mueller-Bieniek 2016) and soil samples taken from several archaeological contexts (for example (Moskal-del Hoyo et al. 2018) the find is not exeptional in presence of cereals and wild growing plants showing almost the same proportions as Parchatka 12 site. The presented 'old' data from the site Mogiła 62 (Gluza et al. 1988) showed different

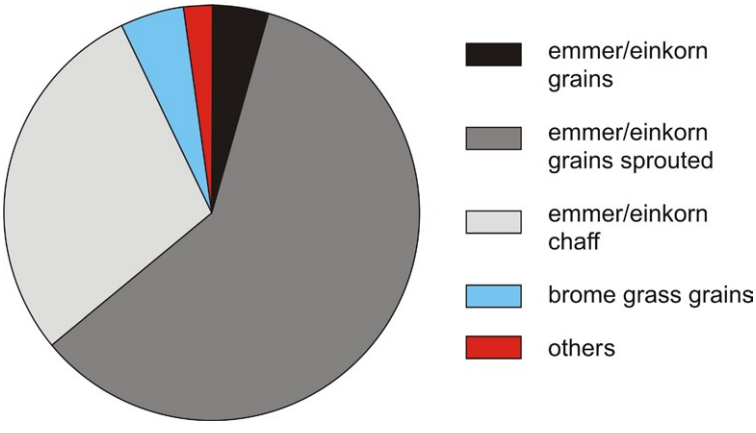

Fig. 5. Composition of plant remains in the whole material

Table 3. Number of emmer, einkorn and brome grass grains found in the assemblages and accompanying diaspores of weeds and wild plants. In the case of new study from Mogiła 62 the number of *Triticum* sp. grains was divided to emmer and einkorn proportionally to the directly identified items (*)

Site	Commune	Voivodeship	Emmer	Einkorn	Brome	Others	Literature
Kraków Nowa Huta Mogiła 62		Małopolskie	1028	11	212	60	Gluza et al. 1988
as above (new study)			420	95	134	60	
as above (recalculated*)			1472	203	134	60	
Kraków – Prądnik Czerwony		Małopolskie	15000	163	40	4	Rook, Nowak 1993; Lityńska-Zając unpubl.
Parchataka 12	Kazimierz Dolny	Lubelskie	1152	199	85	36	Lityńska-Zając 1995; Lityńska-Zając 2001
Opatowice 12	Radziejów	Kujawsko-Pomorskie	28320	8	32	7	Klichowska 1972
Radziejów Kujawski 1	Radziejów	Kujawsko-Pomorskie	62685	280	2	15	Klichowska 1970
Zarębowo 1	Zakrzewo	Kujawsko-Pomorskie	2950	800	2	180	Klichowska 1972

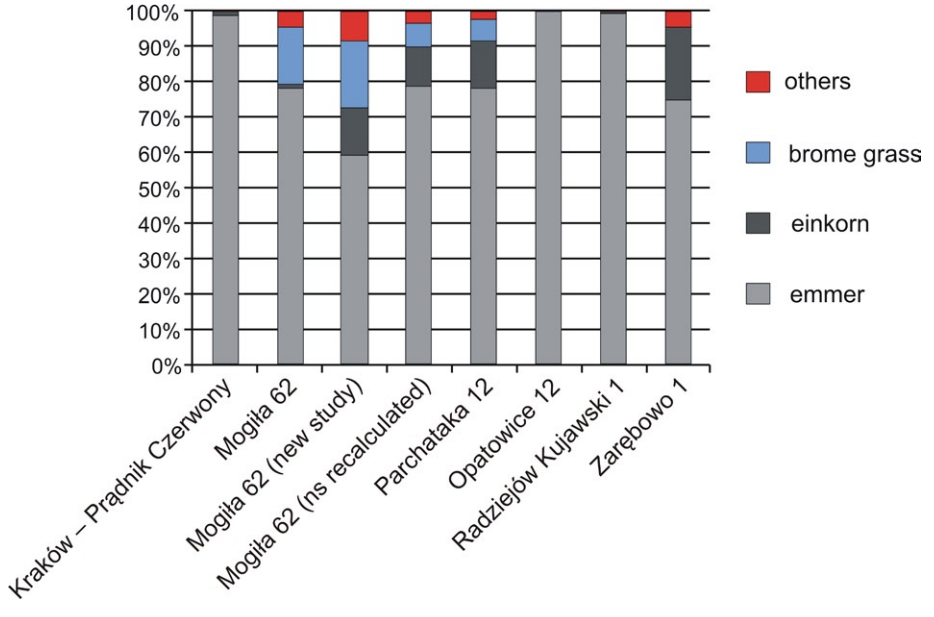

Fig. 6. Proportions of emmer, einkorn and brome grass grains in the large cereal assemblages (Tab. 3). Grains identified as Cerealia indet., *Triticum* sp. or *Triticum monococcum/dicoccum* as well as single items of bread or spelt wheats are not included with one exception (* in Tab. 3)

pattern than the data currently studied, however the comparison indicate that strict archaeological data describing exact location of the studied samples is crucial. In one of the 'old' samples (depth 380–390 cm) charcoal of *Carpinus betulus* was noted confirming a mixed character of a part of the complex feature 395 (Gluza et al. 1988; Kluzik 2010).

The appearance of *Agrostemma githago* and *Bromus arvensis* in limited weed composition of that storage suggests rather winter field cultivation (Lityńska-Zając 2005). The composition of stable carbon and nitrogen isotopes in grains from that assemblage implies that studied emmer and einkorn grains would have come from different plots characterized by different soil fertility and similar moisture. We have received the values: for emmer $\delta^{15}N = 7.3$ (sd = 0.18) and $\delta^{13}C = -23.6$ (sd = 0.087; $\Delta^{13}C = 17.7$) and for einkorn $\delta^{15}N = 5.7$ (sd = 0.18) and $\delta^{13}C = -24.3$ (sd = 0.087; $\Delta^{13}C = 18.4$) (Mueller-Bieniek et al. in preparation). These data suggest that the emmer grains were grown in more fertile (high level of manuring) soil than einkorn (Bogaard et al. 2013) and in similar, well watered plots (Wallace et al. 2013). Following these results we can conclude that the plant assemblage from the studied layer in feature 395A in Kraków Nowa Huta Mogiła 62 represents a large portion of cleaned cereals that were harvested from various plots. That suggestion is also confirmed by differences in plant proportion in six subsamples (Tab. 2). However the scarcity of isotopic data and subjectivity of morphological studies of such variable taxonomical group as *Triticum* make us to take those conclusion with caution. At the same time however, this situation inspires us to continue the isotopic and the morphometric studies of the TRB assemblage and their comparison with other sites.

Sprouted grains were also noted in TRB feature in Zakrzowiec site 6/8, near Niepołomice (Jarosz et al. 2012; Lityńska-Zając et al., n.d.) as well as at few medieval sites from the Czech Republic, where such finds were usually connected with beer production (Cymbalak et al. 2013; Foster et al. 2013; Kočár, Kočár 2014). In the case of the find from Mogiła 62 the food production process cannot be excluded however no archaeological or chemical evidence can support such possibility.

CONCLUSIONS

Our current study proved that the plant material originating from the feature 395A at the multicultural site Kraków Nowa Huta Mogiła 62, which was excavated more than 50 years ago, does belong to the Funnel Beaker culture. Both archaeobotanical analyses and radiocarbon dating confirmed that the layer located *ca.* 3 m below the surface was not disturbed by younger construction work, as it was implied by former studies. The sample contained product of the last stage of cereal threshing, i.e. cleaned storage of emmer, einkorn and brome grass grains with only small admixture of other wild growing plants, including feather grass (*Stipa* sp.). The number of brome grass grains in comparison with einkorn wheat grains suggests that the grass would have been used as food in addition to emmer and einkorn wheat. It confirms earlier observations

about the use of brome grass grains as a source of food. Most of the crop remains were sprouted. Proportions between grains and chaff remains indicate storage of whole spikelets. The crop was probably wasted/spoiled due to anomalous storage conditions which caused sprouting of the grains. However some intentional activity associated with food preparation cannot be excluded.

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