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BARROW CULTURE TEXTILES AND MATS IN THE MIDDLE DNIESTER AREA

ABSTRACT

The article describes an attempt to identify the raw material of the organic layers – mats identified within the roofs and floors of the graves in the *Yampil Barrow Cemetery Complex*. The use of gas chromatography and infrared spectroscopy combined with microscopic analysis of the extracted "mat" sections significantly supplements our knowledge in the field of weaving of the studied communities.

Key words: mats, textiles, nomads, Bronze Age, Eurasian steppe

INTRODUCTION

For nomadic societies, we have few sources that could illustrate their economic foundations. The small amount of settlement relics makes us thoroughly analyze the most easily accessible sources, ones from the funeral world of prehistoric societies.

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The study presented below is part of a larger research project focused on Podolia as a context of intercultural contacts in the 4th/3rd–1st millennium BC.[1] To study textiles, a diagnostic area on the middle Dniester was selected, administratively confined to the vicinity of Yampil, Vinnytsia *Oblast* (Ukraine). The choice of this location was determined by the high accumulation of the remains of round barrow mounds, forming the north-western range limit of 'Early Bronze' barrows, associated with the steppe and forest-steppe zones of eastern Europe. Moreover, barrows in this location have been exceptionally well explored by conservators.

The quality of available sources for the study of textiles is closely related to the history of research into the *Yampil Barrow Complex*. This history falls into two distinct periods: one covering archaeological investigations carried out in the vicinity of Yampil prior to 2010 and the other lasting from 2010 to 2014. Intensive work performed there since 1984 left as many as 16 barrows explored, but due to an accident – a fire in the regional storage facility of archaeological collections – all osteological materials and organic samples, produced by investigations prior to 2010, have been destroyed. Discussing organic remains from these sites, we are forced to rely solely on available drawings, photographs and descriptions.

A new class of sources for the study of textiles was provided by the Polish-Ukrainian expedition that investigated altogether 7 more barrows in this area in 2010-2014. Importantly, the investigations were interdisciplinary by assumption and enhanced the cultural and biological image of communities characterized by the barrow funerary rite [Litvinova *et al*. 2015, Juras 2014]. The present paper is one of the results of these investigations.

1. THE HISTORY OF RESEARCH INTO TEXTILES IN THE ENEOLITHIC AND BRONZE CULTURES OF THE STEPPE AND FOREST-STEPPE

Eneolithic and Bronze woven and plaited goods have been discussed so far mainly in relation to the steppes around the Caspian Sea [Shishlina *et al*. 2000: 109] and northern Caucasus [Shishlina *et al*. 2003: 331]. The discussions have relied on artefacts kept in the State Historical Museum in Moscow.

The studies of impressions on pottery conducted so far have supplied information on various textiles used to decorate vessels or incidentally leaving traces on them. These studies embrace such questions as yarn formation techniques, fabric structure and weaving technologies. The major technologies included weaving and

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plaiting, with the former supposedly appearing on the steppes already in the Early Eneolithic [Shishlina *et al*. 2000: 112]. The first primitive looms (upright or flat) supposedly appeared there already in the Eneolithic. Classic looms, consisting of a frame, a thread separator and a device for making a second loom shed are associated with the Yamnaya culture, while Catacomb culture looms are believed to have been more diverse.

The determination of raw materials used for making mats has been based so far on examining the samples of well-preserved fragments of goods which permitted a botanical determination of examined remains. For making determinations, palaeo-ecological analyses (of phytoliths, pollen and detritus) have been employed as well. The list of examined materials included various grass varieties, tree and bush branches as well as cereals, sedge and reeds.

The most information was supplied by the study of textile fragments preserved in burials dated to the Bronze Age. Besides identifying the yarn-making and weaving techniques, the major raw materials used for making them were discerned. For the most part, these were fibres designated generally as phytogenic; the use of wool was established as of the second half of the 3rd millennium BC (Middle Bronze Age).

The principal raw materials that were available for making textiles in the area in question were flax and hemp. The wild variety of flax grows in a southern belt from western Europe, across the Mediterranean, Middle East as far as the Caucasus [Chmielewski 2009: 16; Barber 1992: 34]. On the middle Dniester, its occurrence is thus related to the influx of Eneolithic newcomers from the south. That the conditions on the steppes were conducive to the cultivation of flax can be seen in the fact that today Ukraine is the ninth largest producer of this crop in the world.

Hemp is an environmentally flexible plant species whose origin used to be traced to Central Asia, which is not borne out by later findings [Chmielewski 2009: 24]. One of the oldest finds of hemp comes from the context of the Tripolye culture.

2. MATS IN PODOLIA – INCIDENCE, CHRONOLOGY AND CULTURAL IDENTIFICATION

The chronological range of the remains under investigation draws our attention to the final stages of the Neolithic – the Eneolithic and Bronze Age in the studied area. From the archaeometric perspective, this period covers there the lifetime of Eneolithic societies of diverse genetic substrata as well as the Yamnaya, Babyno, Catacomb and Noua cultures. The description of the cultural positions of the features in which the organic remains of mats and textile impressions were recorded are given in Tab. 1.

Table 1

Cultural diversity of burials in the Yampil Region. Red colour shows graves with mat and textile remains

Chronology of objects / Sites	Eneolithic	YC	CC	BC	NC	Σ	Σ graves with mats and textile on the site	% graves with mats and textile on the site
Dobrianka 1		4, 5, 6, 7, 8		1, 2, 3, 9, 10, 11		11	2	18%
Klembivka 1	5, 14, 15			1, 2, 3, 6, 8, 10	7, 11, 12, 13	13	3	23%
Pidlisivka 1	1B, 10	1A, 1Aa, 9, 11	4, 7	5, 13		10	7	70%
Porohy 1		1, 2				2	1	50%
Porohy 2		3, 4, 5, 6				4	1	25%
Porohy 3		2, 4		5		3	1	33%
Porohy 3A	14, 18	1, 2, 10, 11, 12, 15, 17, 19, 20			3, 5, 7, 8, 22	16	11	69%
Porohy 4		8		1, 5, 6, 9		5	1	20%
Prydnistryanske I	1		4			2	1	50%
Prydnistryanske III	1, 2, 3					3	1	33%
Prydnistryanske IV	10	3, 4, 6, 8, 9				6	5	83%
Pysarivka 1		1, 2				2	2	100%
Pysarivka 2		3				1	0	0%
Pysarivka 3		1, 2, 3				3	2	67%
Pysarivka 4		1, 2				2	1	50%

Pysarivka 5		1		2		2	2	100%
Pysarivka 6		**1**, **2**, **3**				3	3	100%
Pysarivka 7		2				1	0	0%
Pysarivka 8		2		4		2	1	50%
Pysarivka 9		**2**, 3		1		3	1	33%
Severynivka 1		5		4		2	0	0%
Severynivka 2		1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13		2		12	5	42%
Σ	12	60	3	24	9	108	51	

So far, in the Yampil Region, 108 features have been recorded that may be classified as graves/burials of which most (60 graves or 56%) have been assigned to the Yamnaya culture. It is also with this community that the greatest number of finds of mat remains is associated. Organic materials or their impressions have been found in 51 burials of which 36 have been assigned to the Yamnaya culture.

The predominance is less pronounced when the frequency of mat identifiability within the studied communities is taken into account. The most numerous organic remains in this context have been found in 56 per cent of all Yamnaya culture burials discovered in the studied area. This percentage is comparably high for earlier cultures – Eneolithic ones – where mats were recorded in 7 out of 12 burials. This sets apart considerably these two from the Catacomb culture, the most proximal chronologically in the vicinity of Yampil, for which mats were recorded in one of three burials.

By way of absolute chronology, we have dates only for 17 features from the second stage of investigations (Fig. 1). The oldest date refers to feature 3 from barrow III in Prydnistryanskie and fits into the interval of 3343-3109 BC (68.2%). It dates, in the context of a hypothetical (child?) burial, wood fragments, forming an irregularly shaped layer on the grave chamber bottom. The youngest date, in turn, 1611-1396 BC (68.2%), refers to remains from a Noua culture grave from site Porohy 3A/5.

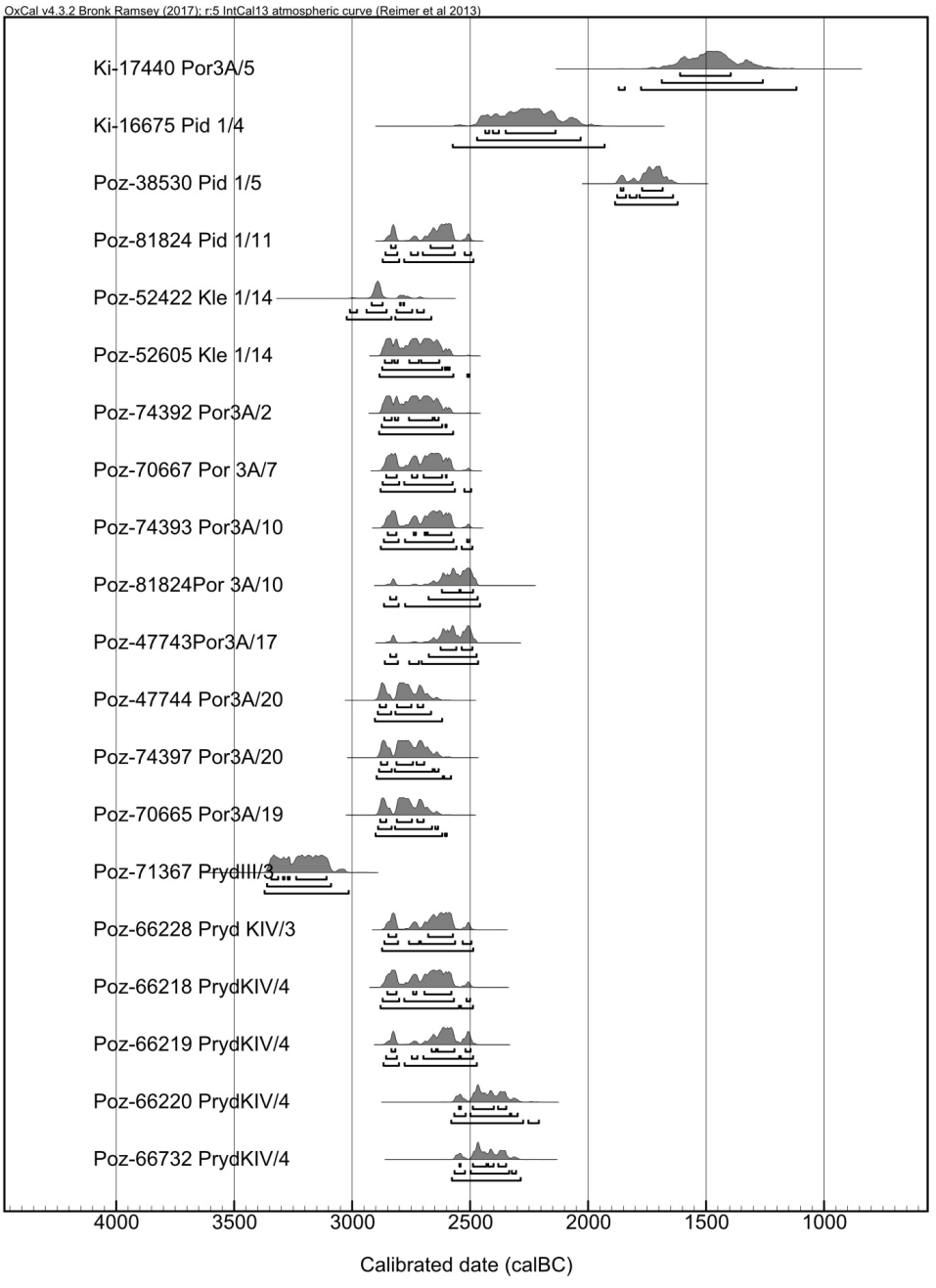

Fig. 1. ^{14}C measurements for Yampil Region graves with mat remains [*after* Goslar *et al.* 2015]

Fig. 2. Porohy, Yampil Region, barrow 3A, feature 17. Grave cover protected by a mat (white remains)

Fig. 3. Prydnistryanske, Yampil Region, barrow IV, feature 4. Stone grave cover protected by a mat from above

3. ARCHAEOMETRIC MAT DOCUMENTATION

In the *Yampil Barrow Complex*, mat remains were recorded in the form of samples of a geological character collected from the ceilings and bottoms of features. The samples were then studied under a microscope to find and identify any textile impressions [Sikorski, Żurkiewicz 2014].

Fig. 4. Prydnistryanske, Yampil Region, barrow IV, feature 4. Mat impressions on the bottom side of a stone grave cover

3.1. GRAVE COVERS

This category of finds is related solely to burials classified as Yamnaya culture ones. In their case, the grave chamber was usually rectangular in outline with its design being sometimes enhanced by a step. Furthermore, in most graves, a wooden roofing or cover of the grave could be seen. It was made of planks placed in parallel or perpendicularly to the longer wall of a feature. In selected features, as part of this structure, organic substances were commonly used, probably in the form of

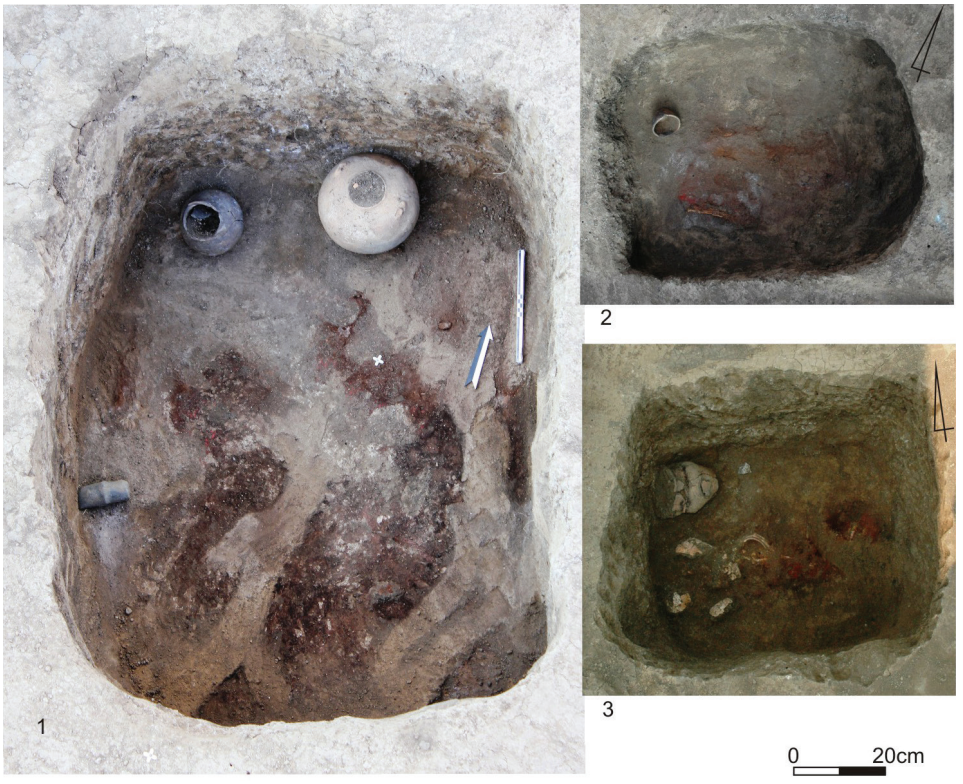

Fig. 5. Mat remains in Eneolithic burials: 1 – Prydnistryanske III/3; 2 – Porohy 3A/18, 3 – Pidlisivka 1/10

mats, to seal the grave roofing surface. In some cases, the considerable distances that separated individual roofing planks indicate that a mat was an important structural element of the ceiling (e.g. Porohy 3A/15). Mats can be seen on the level of discovery as a contrasting white thin layer (Fig. 2). The greatest number was recorded on site Porohy 3A in features 1, 10, 11, 15 and 17. Possibly, the remains of a mat are identifiable too, albeit somewhat less distinctly, in features 3 and 7 on this site and in Prydnistryanske IV/6. From archival data, which do not show this category of remains as a separate entry, relying however on available photographs, it can be concluded that this form of grave sealing was used on sites Porohy 2/6, Porohy 3/2 and Pysarivka 5/1.

The situation in Prydnistryanske, barrow IV, feature 4, differs from the source category described above. There, as a grave cover, stone slabs were used that were protected from above with an organic mat of a rather considerable thickness and pink-white colour. Under the stone cover, plaited branches had been placed which left traces on rock fragments (Figs. 3, 4). A microscopic scrutiny of samples col-

lected from a stone cover (samples nos. 12, 13, 14, 16) reveals that this layer may have been built from reeds, calami (sweet flag) or tree leaves, tightly packed in several layers across the stone structure. Whereas, on boulders, on their bottom side, perpendicular impressions can be seen — traces of wrapping of around sticks placed lengthwise over the grave pit (Fig. 4). The combination of fatty acids determined in a sample collected from a layer recorded on the stone cover (sample 8) reflects their proportion characteristic of such foodstuff residues that are most commonly preserved on pottery. Moreover, the phytogenic origin of the raw material from which the 'mat' had been made was confirmed.

3.2. MATS UNDER A SKELETON

Other examples of the use of textiles come from the level of a burial. In this category, we have samples that have been subjected to physicochemical and microscopic analyses, and on which traces – mat and fabric impressions – have been identified and the type of remains, forming today a 'mat' layer under the skeleton, have been discerned. Organic remains on the level of grave bottom were recorded in Eneolithic and Yamnaya burials and ones dating to the later periods of the Bronze Age.

3.2.1. ENEOLITHIC

In the seven Eneolithic features in which organic substances were recorded at the skeleton, two categories can be seen. The first includes 3 child burials from sites Pidlisivka 1/10, Porohy 3A/18 and Prydnistryanske III/3,[2] in which, on grave chamber bottoms, almost square in shape, organic remains were recorded in various states of preservation and distinctly red in colour, owing probably to the use of a large amount of ochre (Fig. 5).

Out of the features listed above, Prydnistryanske III/3 yielded a mat (sample 13) for which organic compounds were determined, suggesting the plant (most likely grasses) origin of the sample. Furthermore, as many as three biomarkers were identified, indicative of beeswax and a compound found in saffron or flax. No significant differences were found in the content of organic compounds making up the mat in comparison to culturally and chronologically different features subjected to the same examinations.

[2] In this feature, no bone remains have been recorded but relying on feature parameters and analogies, it can be concluded that it was a child burial.

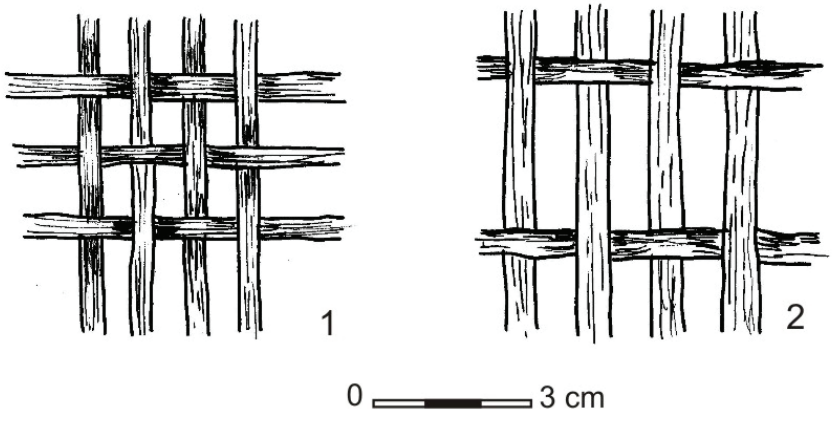

Fig. 6. Pidlisivka, Yampil Region, barrow 1, feature 1B. Drawing reconstruction of mats the impressions of which have survived at the burial level

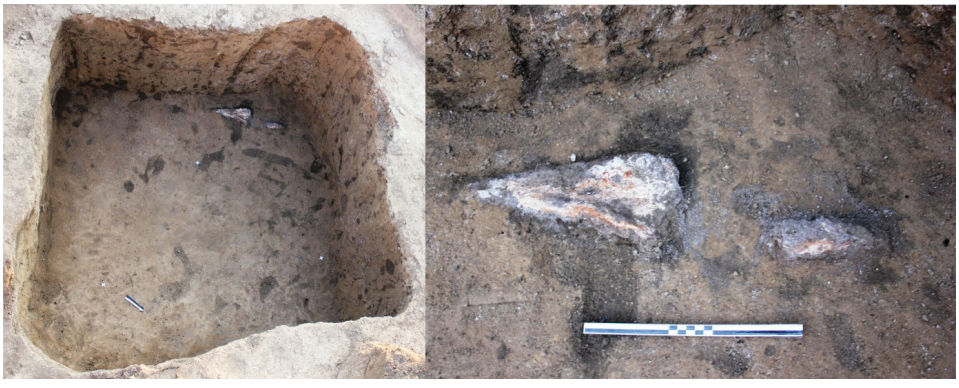

Fig. 7. Prydnistryanske, Yampil Region, barrow I, feature 1. Remains of an 'object' located on the feature bottom

A microscopic scrutiny of sample no. 48, collected from the bottom of the feature, exposed shallow (2.0-2.3 cm) depressions, left probably by a mat, on the lump surface (max. dimensions: 7.5 × 11.0 × 4.8 cm). Judging by discoloration, mat thickness can be estimated to have been 0.5 cm. On the mat impressions and in gaps between the strips of this artefact, strongly pressed impressions of a thick cloth of 1/1 plain weave, grade IV, were identified.

On a few small lumps (measuring 16 × 13; 12 × 8 mm), collected from the vicinity of the skull from feature 10, site Pidlisivka 1 (sample 18), fabric remains left impressions. The fabric had been woven of unidirectional ZZ yarn with an average warp thread thickness of 0.68 mm (fibre twist angle [fibre thickness of 0.016 mm?]

of 32°; [minimum/maximum measurements: 0.57-0.82 mm]); weft – 0.75 mm (26°; [minimum/maximum measurements: 0.57-0.82 mm]). Structure: 1/1 plain weave – baize (3 weft weaves); kind IV (warp – 8 threads/1 cm; weft – 6 threads/1 cm). It appears that in the lumps, two or possibly even three layers of fabric have survived (fold, hood, shroud?).

The second type of Late Eneolithic burials in which mats were recorded is graves of adults (Pidlisivka 1/1B, Klembivka 1/14, 1/15, Prydnistryanske I/1). Mat remains survived best in the feature from Pidlisivka 1/1B (Fig. 6). Sample-sections of a distinct cream-white layer, readily observable in places immediately touching bones, were collected for microscopic analyses. Probably, the fragments of three kinds of goods were identified: two kinds of mats and a fabric.

The first object was plaited of thin twigs or roots (3.28-3.61 mm thick), using the simplest 'criss-cross' weave. This technique 'involves interlacing twigs as in a fabric, that is, at the right angle' [Moszyński 1967: 332]. Importantly, vertically, they were recorded on an average every 0.6-0.7 cm, whereas horizontally spaces were larger: every 1 cm [Podlewski 1960: 495, Fig. 302; Zeylandowa 1963: 281, 282] (Fig. 6: 1). The second mat might have been differently made. It appears that it was made of twigs of a larger diameter (0.6-0.7 cm), arranged in parallel to one another (every 0.8 cm) and joined by horizontal stabilizing elements. It is very likely that it resembled a mat from Bruszczewo [Kneisel 2010: 724, 728, Abb. 4] or another one built making use of 'ribs' 'between which short twigs, sticks or branches are vertically interlaced' [Podlewski 1960: 480, 481] (Fig. 6: 2). Of course, it was stiffer and more durable than the first mat; it was a kind of bier – about 1.0 cm thick – on which a corpse could be carried and/or placed in a grave pit. Thus, the feature held at least two objects that might have served different purposes: the criss-cross plaited object might have covered the head, while the mat could have been a bier. On the traces of the plaited object and mat, pressed negatives of a 'fabric' have survived (clothing or shroud).

In the samples collected from feature 1B (samples 14 and 15), fabric impressions were identified as well. The fabric was made using a 1/1 plain weave with a belt(s) of baize. In addition, the fabric was thick, of kind IV (6-8 threads/1 cm). It could have been made of elementary fibres about 0.016 mm thick (unfortunately, the raw material is not known). Similar fibres may have been used to make right-twisted yarn (ZZ) in both thread systems, that is, warp (Wp) and weft (Wf). From thinner, better twisted Wp threads (average of measurements: 0.63-0.7 mm; elementary fibre twist angle: 35°) and appropriately thicker Wf threads (0.72-0.77 mm), a thick decorative plain 1/1 fabric was woven with baize elements, that is, with perpendicular (weft) sheds, owing to which on the fabric surface, characteristic longitudinal belts are (alternately?) formed [Chmielewski 2009: 233-235, Fig. 129].

It still remains a riddle how to interpret the remains found at the bottom of the Eneolithic feature in Prydnistryanske I/1 (sample 11). A pit of an almost square outline most likely is an excavation, destroying an earlier feature associated with

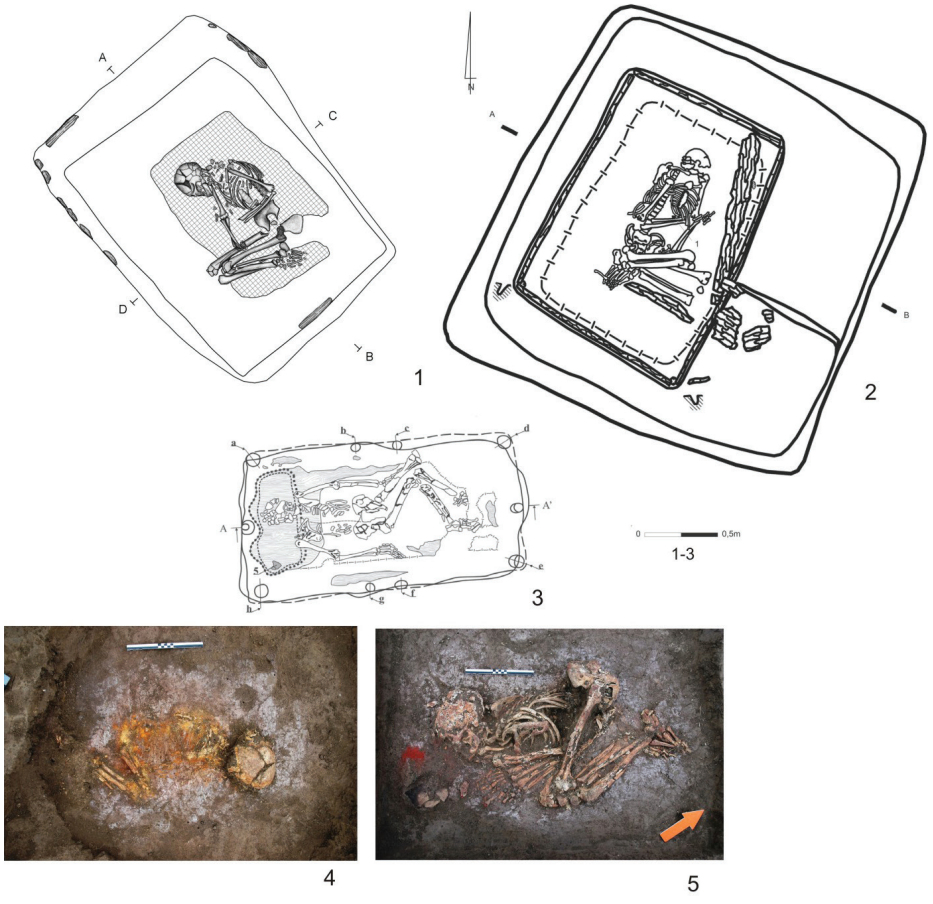

Fig. 8. Yampil Region. Examples of mats at the burial levels: 1 – Prydnistryanske IV/9, 2 – Porohy 3A/11, 3 – Pisarivka 6/2, 4 – Porohy 3A/3, 5 – Porohy 3A/7

the Tripolye-Gordineşti culture. The feature fill yielded two Tripolye pottery shards while at the feature bottom, a distinct outline of an object made of an organic substance could be discerned (Fig. 7). It was used to procure a ^{14}C measurement for this feature. The analysis of its organic compound content shows that it closely resembles that of the residues interpreted here as mats.

3.2.2. YAMNAYA CULTURE

Most mat samples from the burial level subjected to analyses are associated with the Yamnaya culture. Their state of preservation varies. In most cases, their

colour, varying from cream through white-pink to brown clearly stands out against the loess substratum into which graves had been dug. In some cases, the mat colour changes in the immediate vicinity of the bones of a skeleton and around it (e.g. Porohy 3A/15). Their relatively small thickness of up to a few millimetres contributed to the frequent obliteration of mat outlines by post-depositional processes or in the course of tricky exploration of such features. Nevertheless, the intention of grave builders to cover the entire bottom of a grave chamber with a mat is discernable (e.g. Dobrianka 1/5, Pysarivka 1/2, 3/3, 5/1, Porohy 3A/11 Fig. 8: 2) or the immediate surroundings of the burial itself (e.g. Prydnistryanske IV/9, IV/8) (Fig. 8: 1).

In the reports on older investigations (conducted prior to 2010), the questions of textiles are treated rather descriptively. Finds of a 'plant lining' (Pysarivka 1/2, 3/1, 3/3, 4/1, Porohy 4/8) are mentioned in general terms as are bark mats (Pysarivka 8/2, 9/2) and bark and flax mats (Dobrianka 1/5). To the exceptional complexity of this grave furnishing testifies the description of a burial from Pysarivka 6/2. According to the investigators, a record was made there of a mat constructed from 'reeds sprinkled with ochre of a raspberry colour. On the mat, a layer of bark was spread and sprinkled with the same ochre. In the vicinity of the head, on a burnt bedding, a leather pillow was placed and sprinkled with brown ochre' [Harat *et al*. 2014] (Fig. 8: 3).

Alas, we do not know if the above interpretations were supported by specialist consultations. Due to the misfortune mentioned earlier, these findings cannot be verified.

Below, the results of microscopic and chemical analyses of samples collected from Yamnaya culture features excavated in 2010-2014 shall be presented to explain the questions of raw materials identification and weaving techniques.

The microscopic findings may be illustrated by the study of samples from Pidlisivka 1/11 (sample 19). A sample collected from the bedding underneath the legs showed very shallow depressions (negatives) on three lumps of a dry substratum (measuring 23 × 20; 15 × 12; 11 × 11 mm). The impression survived on darker and brighter surfaces (of a dark red-grey and brown shade – 5YR 4/2 and 10YR 5/3). Most likely, the impressions were left by the remains of clothing (?) or a shroud (?) woven from elementary fibres 0.013-0.016 mm thick (good quality raw material of a plant or animal origin!). The yarn was poorly right-twisted (ZZ) both in the warp (Wp) and weft (Wf) and partially defibrated (elementary fibre twist angle: Wp – 25°, Wf – 21°, it had a similar thickness (Wp – average 0.64 mm [0.57-0.73 mm]; Wf – average 0.67 mm [0.65-0.73 mm]). Structure: 1/1 plain weave – baize (in belts?); kind IV (Wp – 8 threads/1 cm; Wf – 6/8 threads/1 cm).

On site Prydnistryanske IC, on the floor of the grave pit of feature 4, on samples collected from various places within the grave pit (samples 36-39), finds were made of impressions of a cloth of 1/1 plain weave, woven from dextrorotatory yarn in both thread systems (ZZ). As expected, yarn O was thinner (average thick-

ness: 0.9 mm) than yarn W (1.1 mm), Tab. 8-10. These results differ from cloth measurements in barrow III (sample 48) in which traces of a thicker cloth were identified, woven from doubled Z/2S yarn (O density = 8 threads/1 cm; W density = 6 threads/1 cm). The physicochemical examinations of a sample collected from the bottom of this grave (sample 9) left no doubt that the mat was of a phytogenic origin and suggested grasses growing in a waterlogged environment as the raw material. They also showed traces of chemical compounds characteristic of propolis, beeswax and substances found in saffron or flax seed oils on the bottom of the grave.

Porohy 3A. In feature 1, there could have been a mat plaited using the band-cross technique, either straight or diagonal (Pisowicz 2009: 99-102), from bark strips/grass leaves 0.9-1.2 cm wide (samples 3, 15, 31). The small surface of the samples prevents a certain interpretation of the impressions, because the crossing withes/reeds/grass leaves or perhaps calamus (suggestion by Barbara Wielgus, M.A.) – more or less packed – may also result from an alternating arrangement without any stabilizing interweaving element (*see* Prydnistryanske IV/4 ; samples nos. 12, 13, 14, 16). On small sample surfaces, in both cases, similar 'crossings' of bands/grass leaves will be impressed. Similar observations and conclusions apply to samples from feature 10 (sample 26 [bands/stalks/leaves – up to 2 cm]) and feature 17 (sample 48).

Shallow impressions of a 1/1 plain-weave thick cloth of grade IV [Kamińska, Nahlik 1958: 80], were recorded in features 1, 10, and 17 on site Porohy 3A (Tab. 1-6, photo 3a). Although the measurement results – quite understandably – do not reproduce original characteristics [due to sample drying and subsequent shrinkage of negatives – Kaczmarek 2015: 263], permit several observations. The textiles were woven from dextrorotatory yarn (Z), varying in the thickness of warp (O) and weft (W) threads. In each feature, O threads were thinner and more tightly twisted than W ones (average of measurements: feature 1: O – 0.87; W –1.1; feature 10: O – 0.8, W – 0.9; feature 17: O – 0.8, W – 0.95 mm). Generally speaking, these thicknesses are comparable with thread impressions on above all Eneolithic and Early Bronze pottery (sometimes also in the 'ceramic body' – clay, Chmielewski 2009: 232) not only from Poland [Chmielewski 2009: 233; Podkańska 2012: 213; Sikorski 2016: 371, Tab. 12.4, 12.5]. Traces of cloths made using the simplest weave with a relative high incidence of spindle bobs and loom weights show that not only spinning but also weaving were common crafts [Łaszczewska 1966: 26] 1/1 plain weave cloths and their derivatives are considered the most popular in the Eneolithic [Chmielewski 2009: 233-236].

The physicochemical analysis of a mat sample (sample 5, feature 1, sample 4, feature 10) has found the same chemical compounds as those revealed in earlier analyses (*see* part 4).

In a single Catacomb culture feature from Pidlisivka 1/4, hardly noticeable mat remains were found. Under a microscope, traces of animal skin (samples 16, 17) were identified (a fatty darker spot on a lump), as well as those of wool (?), bast and/or grass (?). Of this raw material, lightly right-twisted threads (ZZ) were made. Their average Wp thickness was 0.57-0.69 mm, while the fibre twist angle was about 35°, whereas their Wf thickness was 0.67-0.71 mm and the fibre twist angle was 35-45°. Structure: 1/1 plain weave – baize; kind IV (Wp – 6 threads/1 cm; Wf – 5/6 threads/1 cm). In the lump, at least two layers of fabric were indentified (fold, hood, shroud). In addition, a thin (0.08-0.1 mm) ochre film clearly stood out against the substratum throughout.

In three Babyno culture features, a record was made of the poorly preserved traces of an organic grave-pit bedding (Dobrianka 1/9, Pysarivka5/2, Pidlisivka 1/5). Due to the poor quality of samples, however, no specialist analyses could be performed.

The youngest of the preserved mats are associated with the Noua culture (Klembivka 1/13, Porohy 3A/3, 3A/5, 3A/7). They were preserved best on the Porohy site where they form a distinct pink-white layer in features 3A/3 and 3A/7 (Fig. 8: 4, 5). The chemical analyses of their samples show them to be very similar in terms of the compound content to such residue samples collected from Eneolithic and Yamnaya culture features in spite of their cultural and chronological differences.

4. CHEMICAL ANALYSES

Thirteen samples from archaeological sites in Porohy and Prydnistryanske were analyzed for fatty acids and compounds characteristic of the lipid profile, and most frequent in mat samples. Moreover, the lipid fraction was examined using infrared spectroscopy.

The determined percentage content of an organic acid is not directly used to make conclusions about the source of organic residues, because the presence of a single acid is not characteristic of a given type of food (of plant or animal origin). The conclusions presented here rely on the proportions of fatty acids proposed by the American archaeologist, Eerkens, from the University of California. Having studied many historical vessels and fresh and decomposed food, and relying on the information obtained by traditional archaeological methods, he found the proportions of selected fatty acids to differ greatly, depending on whether food was of animal or plant origin. It must be kept in mind, however, that he studied

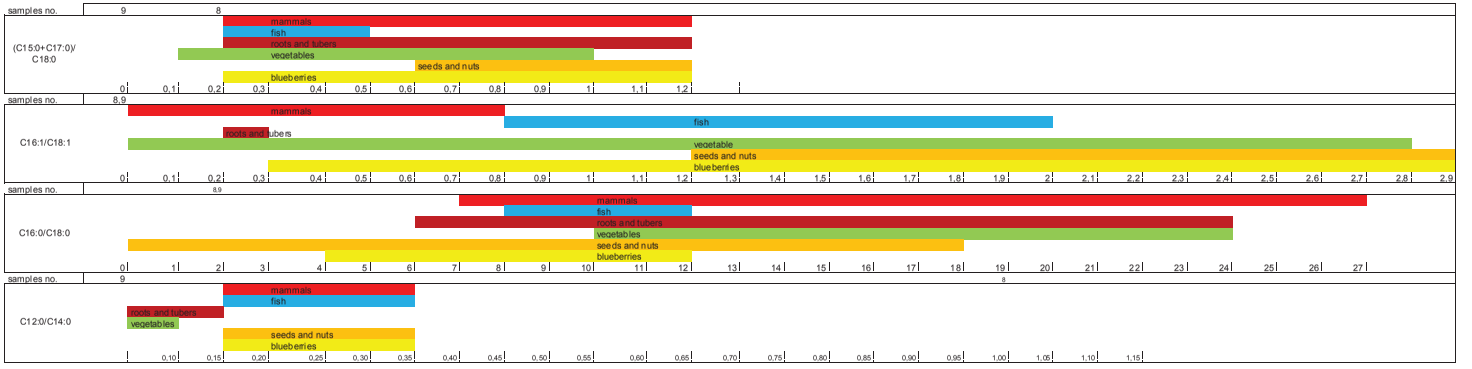

Fig. 9. Fatty acid proportions used to distinguish between food types. Data for decomposed products

Table 2

The most common compounds characteristic of a lipid profile

Name of the chemical compound	Sample no.												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Benzoic acid i pochodne	+	-	-	+	-	+	+	+	+	-	+	+	+
17-Pentatriacontene	+	+	-	+	+	+	+	-	-	+	-	-	+
1-Monolinoleoylglycerol trimethylsilyl ether	+	-	+	+	-	+	+	+	-	-	-	-	-
Hentriacontane	+		+	-	+	+	+	+	+	+	+	+	+
Trilinolein	+	+	+	-	+	+	+	+	+	-	+	+	+
2-Monostearin trimethylsilyl ether	+	+	+	+	+	+	+	+	+	-	+	+	+
9,12,15-Octadecatrienoic acid, 2-[(trimethylsilyl) oxy]-1-[[(trimethylsilyl)oxy] methyl]ethyl ester, (Z,Z,Z)-	-	-	+	+	-	+	+	-	-	-	-	-	-
9,12-Octadecadienoic acid, (2-phenyl-1,3-dioxolan-4-yl) methyl ester, (Z,Z)	+	+	-	-	+	-	+	+	+	-	+	+	+
Tetrapentacontane, 1,54-dibromo-	+	+	-	-	-	+	+	+	-	-	-	-	+

organic residues on pottery. With this reservation, the proportions of appropriate fatty acids in Porohy and Prydnistryanske samples were calculated according to the method suggested by Eerkens [2005] (Fig. 9).

If interpretations are based on fatty acid content proportions, all the samples are in principle of plant origin. However, relying solely on fatty acids, the proportions of which are characteristic of food residues on pottery, it would be difficult to determine the origin of mat samples. Therefore, the most suitable for this purpose compounds known as potential archaeological biomarkers may provide an answer if the mats were made of a plant material (e.g. straw, grass, wicker) or an animal one (e.g. animal skin) [Kałużna-Czaplińska *et al*. 2016]. The concept of archaeological biomarker can be defined as a substance found in analyzed organic residues on, for instance pottery; and which supplies information on past human activity and tradition. Biomarkers are used to determine unequivocally the source or the kind of sources of food kept and/or processed in pottery. For instance, the presence of cholesterol is the positive proof that meat came into contact with the studied object, whereas sitosterol (phytosterols, generally) is a biomarker indicative of plant food.

Tab. 2 shows compounds characteristic of a lipid profile that were the most frequent in the studied mat samples. Relying on chromatographic analyses and infrared examinations; as well as a careful study of relevant scholarly literature, we have found that the examined mats were made of plant raw materials such as, most likely, seaweed or some other water plants (algae). The presence of glycolipids and compounds resulting from the biotransformation of fatty acids, such linoleic and oleic acids, to Octadecatrienoic acid, 2-[(trimethylsilyl)oxy]-1-[[(trimethylsilyl) oxy]methyl] ethyl ester, (Z,Z,Z) and 9,12-Octadecadienoic acid, (2-phenyl-1,3-dioxolan-4-yl) methyl ester, (Z,Z) may potentially indicate seaweed (e.g. *Zostera marina L.*) which even today is found in the Black Sea and is known for its use in plaiting. Examinations have shown the composition of this seaweed species to resemble that of the mats under investigation [Kawasaki *et al*. 1998, Dembitsky *et al*. 1991].

The plant material of which the mats were made was most likely covered by a viscous resinous substance of a plant origin but produced by bees, that is, beeswax (propolis). It could serve as glue but today it is also known for its bactericidal properties. This is evidenced by the presence of two compounds: benzoic acid and 17-Pentatriacontene, which even today are considered ingredients of beeswax characteristic of the Black Sea Region [Erturk *et al*. 2016; Çelemli 2015].

Other compounds such as 1-Monolinoleoylglycerol trimethylsilyl ether or trilinolein (Trilinoleina) are in all likelihood of plant origin. The former is a steroid characteristic of, among others, sea or shore plants [Sheela, Uthayakumari 2013]. The latter is found in saffron and flax seed oils. Hentriacontane, an alkane, found in plants is also present in arabic gum and forms 8-9 per cent of beeswax. Interestingly enough, it is characteristic of specific Black Sea deposits [Sinninghe *et al*. 1995].

The analysis of the lipid fraction using infrared spectroscopy showed only small differences in the spectra of examined samples (Fig. 10). The readings confirm the presence of fatty acids and their derivatives in the mat samples.

5. CONCLUSIONS

Summing up, it should be stressed that mats and textiles were important for ritual scenarios. Statistically, the now observable use of mats and textiles in the burials found in the forest-steppe around Yampil seems to suggest that the practice has been more important for Eneolithic and Yamnaya communities than the taxa associated with the Catacomb, Babyno and Noua cultures.

The study of weaving techniques and materials used indicates considerable continuativeness in these respects shown by communities belonging to various cultures settling the area in question between 3300 and 1300 BC. Moreover, the study

supplies palaeo-environmental data, which have been unavailable for this area until now.

The methods that have been applied enabled us to analyze the remains that have not been useful in the study of mats and textiles so far. The microscopic study of fabric and plait impressions observable on organic remains helps draw conclusions on how they were made, without having an access to the woven goods themselves or their impressions left on pottery, and as such is a major development in the methodology of such analyses. Finally, the chemical analyses also point to new ways of studying such remains next to palaeo-ecological ones applied so far.

CATALOGUE OF SAMPLES

Site	Feature	Culture	^{14}C dates	Impression analyses	Chemical analyses
Pidlisivka 1	1B	Eneolithic	Ki-16674 3680 ± 90 BP	smp 14, smp 15	
Pidlisivka 1	4	CC	Ki-16675 3810±80 2436-2139	smp 16, smp 17	
Pidlisivka 1	10	Eneolithic		smp 18	
Pidlisivka 1	11	YC	Poz-81824 4085±30 2836-2575	smp 19	
Porohy 3A	1	YC		smp 3, 10, 13, 15, 31, 34	smp 5
Porohy 3A	2	YC	Poz-74392 4140±35 2864-2632 2736-2626		smp 1
Porohy 3A	3	NC			smp 2
Porohy 3A	7	NC	Poz-70667 4115±35 2856-2601 2864-2731		smp 3
Porohy 3A	10	YC	Poz-74393 4105±35 2850-2687 2632-2572 4.8 3.19 Poz-81824 4040±35 2619-2490 2632-2572	smp 25, 26	smp 4
Porohy 3A	20	YC	Poz-47744 4190±35 2884-2700 2785-2676 Poz-74397 4175±35 2879-2695 2785-2676		smp 6
Porohy 3A	19				

Site	Feature	Culture	^{14}C dates	Impression analyses	Chemical analyses
Porohy 3A	17			smp 48	
Porohy 3A	15				
Porohy 3A	18				
Prydnistryanske KI	1	Eneolithic	Poz-66235: 13390 ± 70 BP (wood?); Poz-66214: 4700 ± 70 BP (wood)		smp 11
Prydnistryanske KIII	3	Eneolithic	Poz-71367 4510±40 3343-3109 3289-3138	smp 48	smp 13
Prydnistryanske KIV	3	YC	Poz-66228 4090±35 2847-2574 2671-2586		smp 7
Prydnistryanske KIV	4	YC	Poz-66218 4105±40 2851-2580 2621-2489 I/4 (M) Poz-66219 4070±35 2834-2499 2564-2467 13.6 n.m. Poz-66220 3940±40 2548-2348 2564-2467 1 1.0 n.m. I/4 (F?) BIS Poz-66732 3940±35 2548-2348 2564-2467 as above	smp 12, 13, 14, 16, 36, 37, 38, 39	From stone cover smp 8 and grave bottom smp 9
Prydnistryanske KIV	6	YC	Poz-70673 4090±40 2850-2573 2861-2682 7.0 3.07 (wood) Poz-66231 4185±35 2882-2698 2861-2682		smp 10
Prydnistryanske KIV	8	YC	Poz-66232 4090±35 2847-2574 2671-2586		smp 12

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