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TRADITIONS OF CERAMIC PRODUCTION IN THE CENTRAL AND EASTERN EUROPE ENEOLITHIC: TRIPOLYE, LATE MALICE AND LUBLIN-VOLHYNIAN CULTURES

ABSTRACT

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In the area of the Podolsk Upland and the Upper Dniester in the second half of the 5th and first half of the 4th millennia BC the communities of three Eneolithic cultures periodically co-existed: Tripolye (stages BII, CI), Malice (late phase) and Lublin-Volhynian (classical phase). For these cultures, the mentioned area was a peripheral zone of ranges upon which various mutual relations, manifested in ceramic and flint production, took place.

The most explicit evidence of intercultural relations are manifested in the pottery production, when the technical and stylistic traditions are diffused among culturally different communities, living on the same or neighbouring territories.

To identify the nature of the intercultural relationship, an analysis of selected ceramic collections was carried out, taking into account the successive stages of production: raw material selection, ceramic mass preparation, forming vessels along with surface treatment, decorating and firing. We also used petrographic analyzes and chromatography-mass spectrometry to determine the organic components of the ceramic painting of the Tripolye and Lublin-Volhynian cultures.

Keywords: pottery technology, Tripolye culture, late Malice culture, Lublin-Volhynian culture, comparative analysis

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INTRODUCTION

Pottery production in prehistoric cultures is a universal indicator of the level, type of development, and social structure of particular societies. By following technological changes in the pottery-making process, one is able to trace population changes and contact with other cultures, as well as the intensity of these contacts.

Between the second half of the 5th millennium and the first half of the 4th millennium BC, a vast territory of Lesser Poland, parts of Volhynia, the Upper Dniester and south of the Podolsk Upland was settled, in chronological order, by populations of the Malice culture (the Hoszcza-Werbkowice or Werbkovice-Kostyanets group – in older Soviet and Ukrainian literature) and the Lublin-Volhynian culture (the Zimno-Złota group). Since stage BII (second half of the 4th millennium BC), and subsequently in later stages CI and CII (2nd half of IV – 1st half of III millennia BC), also representatives of the Tripolye culture inhabited part of those territories. For all the mentioned communities, this area lay at the periphery of their habitats: nevertheless, it turned out to be a zone of intensive intercultural interactions, which became reflected, to a different extent, in the spheres of pottery production and flint industry (Fig. 1).

The populations of the Malice culture penetrated the Upper Dniester region and western Volhynia as early as the half of the 5th millennium BC, during stage Ib/Ic (the classical and late classical phases) (Zakościelna and Gurba 1997, 201-202; Bandriwski 2004, fig. 7). At the subsequent 'early Rzeszów' phase IIa (late 5th millennium BC), they settled in the Upper Horyn basin and remained there until the 'late Rzeszów' phase IIb (early 4th millennium BC) (Kadrow 1996, fig. 19; 2006, fig. 1). The Malice culture was represented in the region under consideration by such settlements as Hoszcza, Kostyanets, Gorev, Yaroslavichi, Ostrov, and Lyshche (Konopla 1990, 17; 1997, 66-69).

The Lublin-Volhynian culture was formed on the basis of the Malice culture late phase and under the influence of the Tiszapolgár culture impulses from the Carpathian Basin. It is evident that centres of its formation included the basin of the middle Styr River in western Volhynia (Kadrow and Zakościelna 2000, 208). The territory of Volhynia, part of the Podolsk Upland and the Upper Dniester region, were inhabited most intensively during the classical phase of the Lublin-Volhynian culture (approximately 4200-3800 BC). A primary factor in this process was the occurrence of high-quality Volhynian flint deposits in the region – a raw material, which was widely used by communities of all the cultural units mentioned above (Zakościelna 1996).

The Tripolye culture reached its greatest territorial range in the early 4th millennium BC, having covered virtually the entire territory of present-day right-bank Ukraine, Moldova, and eastern Romania.

Traces of merging and interaction of different pottery-making traditions are most clearly manifested in ceramic assemblages from the Tripolye culture sites located in the so-called 'contact zones' – border territories between the areas of different archaeological

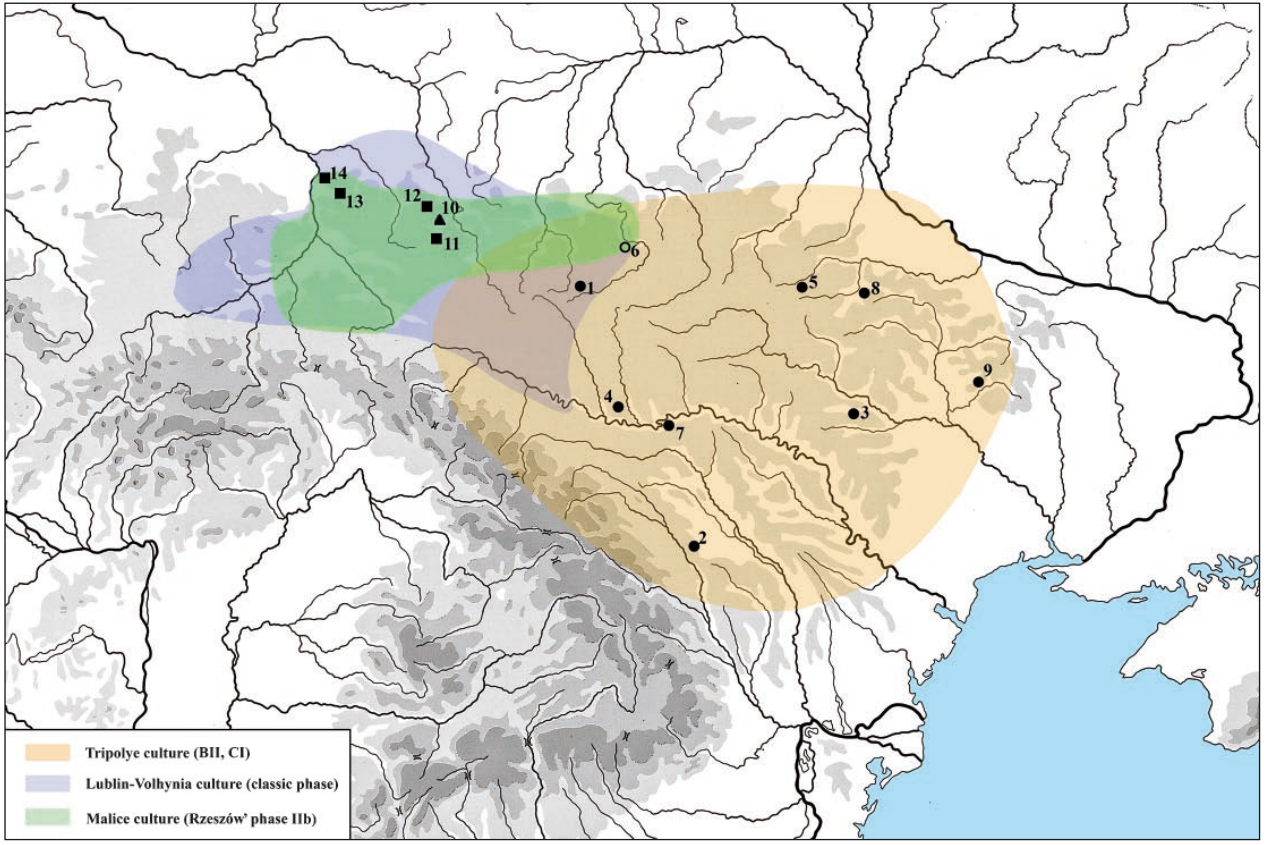

Fig. 1. Ranges of the Trypole, Malice and Lublin-Volhynian cultures settlement. Sites discussed in this study: ● – Trypole culture: 1 – Bodaki, 2 – Cucuteni-Cetăţuia, 3 – Krinichki, 4 – Kudrincy, 5 – Nemirov, 6 – Ostrog-Zeman (mixed complex), 7 – Polivanov Yar, 8 – Popudnia, 9 – Vladimirovka; ▲ – Malice culture: 10 – Werbkowice; ■ – Lublin-Volhynian culture: 11 – Mikulin, 12 – Ornatowice, 13 – Wąwolnica, 14 – Las Stocki

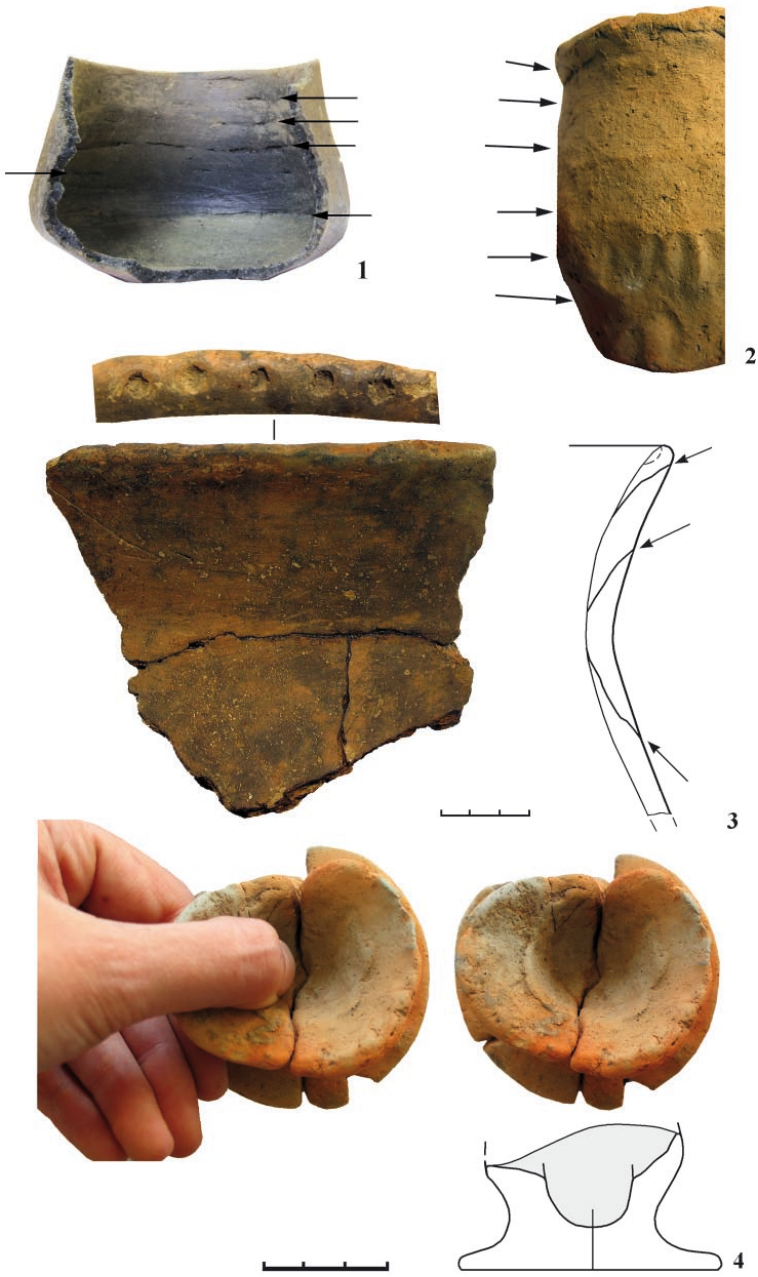

Fig. 2. 1 – the joining of bands visible inside a Lublin-Volhynian vessel (Mikulin 8); 2 – the surface of a Tripolye vessel on which the junctures of the strips and imprints of the potter's fingers are discernible (Cucuteni-Cetățuia); 3 – scheme of coiling the strips on a vessel of the Lublin-Volhynian culture (Wąwolnica 6); 4 – the lower part of the Lublin-Volhynian culture vessel on a flat pedestal (Las Stocki 7)

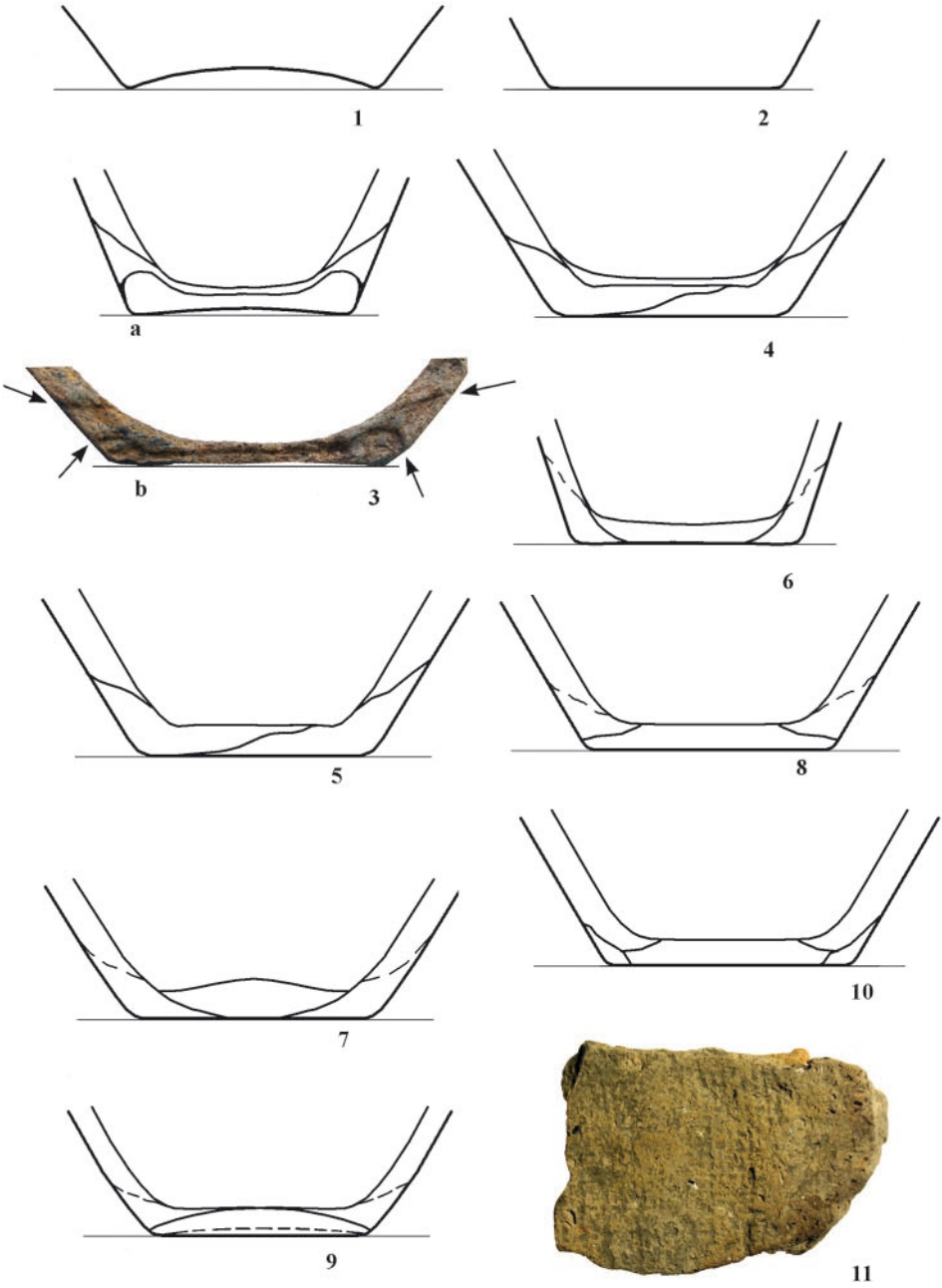

Fig. 3. 1-2, 4-10 — schemes and techniques for shaping vessel bottoms in the Malice, Tripolye and Lublin-Volhynian cultures; 3a-b — variant of the Lublin-Volhynian vessel's bottom modeling (Las Stocki 7); 11 — imprint of the textile on the bottom of Tripolye-Cucuteni vessel (Vladimirovka)

Fig. 4. 1 – Tripolye bowl with a hole (Popudnia site); 2 – miniature vessel of the Tripolye culture with two holes near the spout, possibly for hanging; 3 – holes in a Tripolye helmet-shaped lid (Kudrincy); 4 – Tripolye culture vessel with two holes, possibly for fastening the lid (Polivanov Yar); 5 – holes for repair in a Tripolye bowl (Popudnia); 6 – handle with two holes, vessel of the Malice culture (Werbkowice); 7– handle on pins, vessel of the Tripolye culture (Polivanov Yar II); 8 – handle on pins, vessel of the Lublin-Volhynian culture (Las Stocki 7)

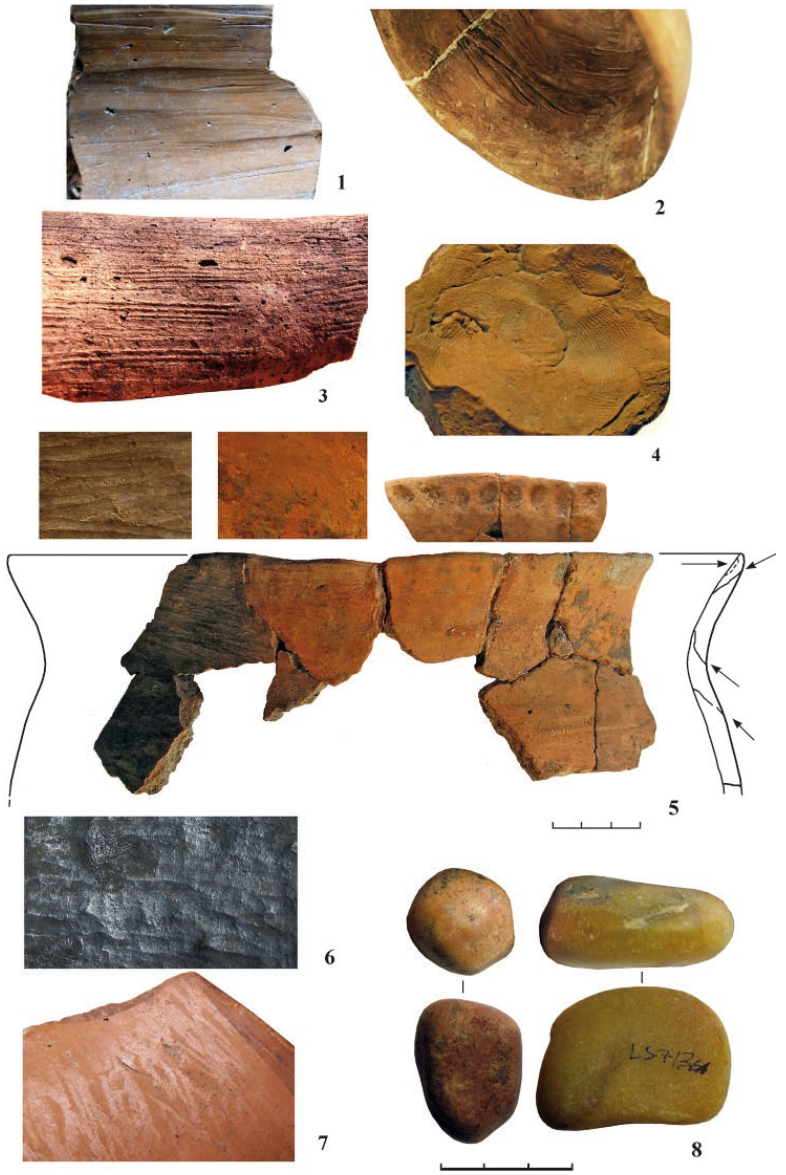

Fig. 5. 1 – finishing of the bottom of a Tripolye vessel from inside with a bone spatula (Vladimirovka site); 2 – traces of working of the surface of a Tripolye vessel with a wooden spatula (Popudnia); 3 – traces of working of the surface of a Tripolye vessel with the edge of a *Unio* sash shell (Kudrincy); 4 – shaping of the bottom of a Tripolye vessel with application of additional clay cakes on the inside (Cucuteni-Cetățuia); 5 – vessel of the Lublin-Volhynia culture with partly preserved traces of polish (Wąwolnica 6); 6 – traces of polishing over a dried surface on a vessel of the Lublin-Volhynia culture (Wąwolnica 6); 7 – traces of polishing over a dried surface on a vessel of the Tripolye culture (Nemirov); 8 – polishers, Lublin-Volhynia culture (Las Stocki 7)

Fig. 6. 1 – example of painting over an undercoating on a Tripolye vessel (Nezvisko site); 2 – coating of a Tripolye bowl with brown paint (Popudnia); 3 – cover; Tripolye culture, painted on engobe (Popudnia); 4-5– examples of the surface of ware of the Malice culture (Werbkowice); 6 – miniature vessel of the Lublin-Volhynia culture with flaking-off plaster slip (Las Stocki 7); 7 – vessel of the Lublin-Volhynia culture with holes in the bottom (Wąwolnica 6)

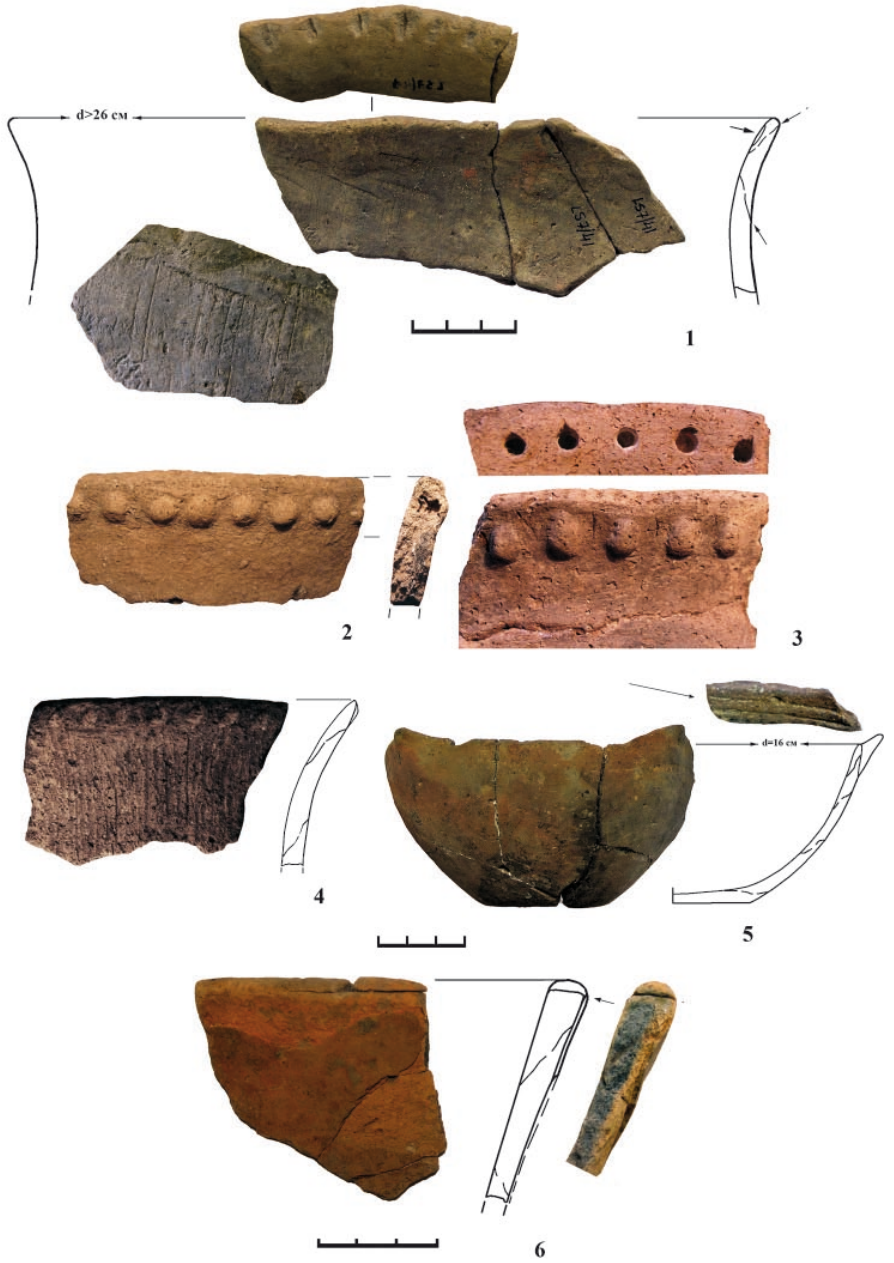

Fig. 7. 1 – vessel of the Lublin-Volhynia culture with fingernail imprints on the internal surface of the rim and combing on the throat (Las Stocki 7); 2-3 – 'pearls' on Tripolye vessels (Polivanov Yar II); 4 – vertical combing on the throat of a Tripolye cooking vessel (Krinichki); 5 – bowl of the Lublin-Volhynia culture with additional fixation of the clay strip of the rim from inside (a trace left by a tool) (Las Stocki 7); 6 – leveling of the top of a Lublin-Volhynian vessel by means of an additional clay strip (Las Stocki 7)

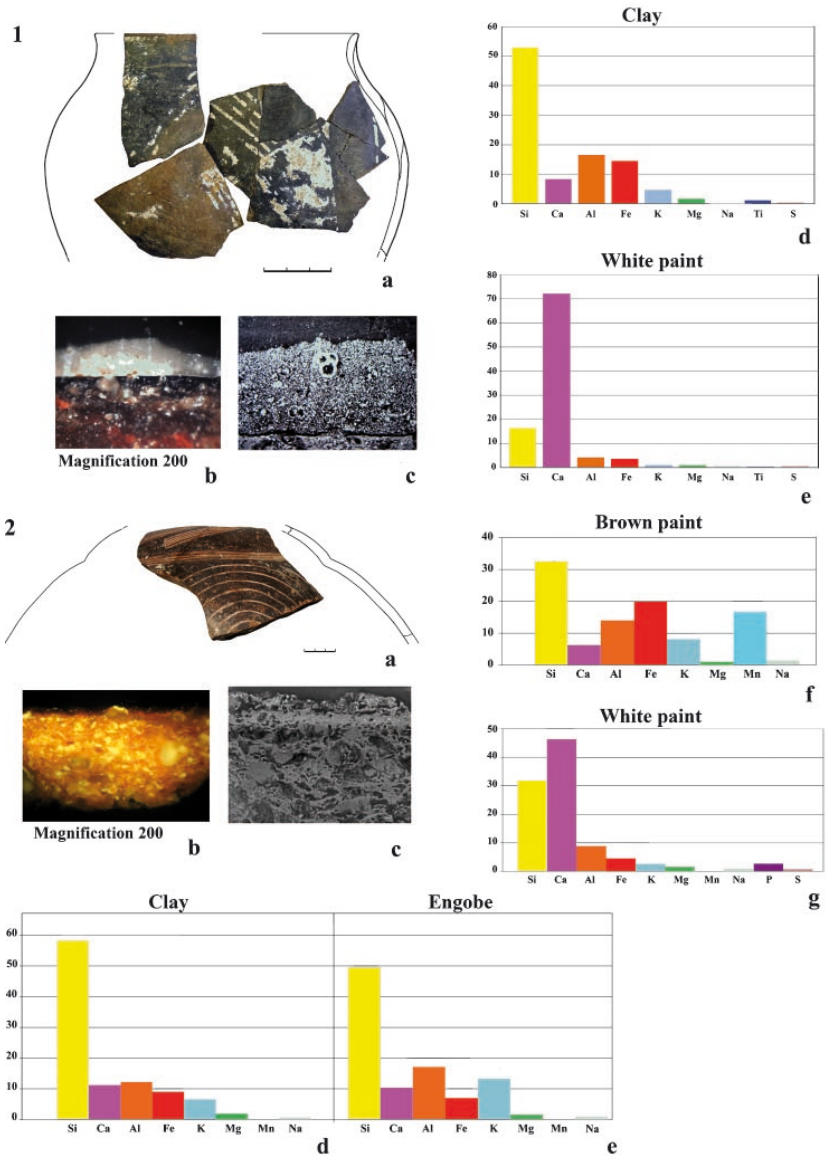

Fig. 8. 1a – vessel of the Lublin-Volhynia culture painted in white (Wąwolnica 6); 1b – thin section of a layer of white painting; photograph from an electronic microscope (magnification x 200); 1c – inclusions of shells in the painting layer on a vessel of the Lublin-Volhynia culture (magnification x 200); 1d – percentage ratio of the elements in clay mass composition; 1e – percentage ratio of elements in the painting layer composition; 2a – vessel of the Tripolye culture painted in white and brown (Polivanov Yar); 2b-c – thin section of a layer of white and brown painting; photograph from an electronic microscope (magnification x 200); 2d – percentage ratio of elements in clay mass composition; 2e – percentage ratio of elements in the engobe composition; 2f – percentage ratio of elements in the brown paint composition; 2g – percentage ratio of elements in the white paint composition.

cultures. Thus, in the ceramic collection from the Tripolye settlement at Bodaki, the pottery differs from the local ware, both in the morphology and technological characteristics, constitutes a separate group. It was manufactured from dense, finely structured clay, tempered with fine-grain sand. The surface is carefully finished, polished, and decorated with recessed and stamped patterns (Skakun and Starkova 2003; Starkova 2011, 18).

A mixed ceramic collection was also found at an Eneolithic cemetery, situated 50 km north-east of Bodaki, on the left bank of the Viliya River, near the present-day town of Ostrog. This burial ground was excavated in 2006 by Ukrainian archaeologists. The pottery collection from the cemetery includes traditional Tripolye beakers as well as pots, finished inside with stamped patterns, which can be associated with the traditions of western Eneolithic cultures (Pozikhovskiy and Samolyuk 2008).

The presence of imports and influences from the Malice and Lublin-Volhynian cultures, which is visible in the Tripolye culture pottery collections and can be identified on the basis of shape and decoration, has been noted in archaeological literature more than once (Tkachuk 2000; Tkaczuk 2005; Movsha 2000; Tsvek 2000; Starkova 2009).

It is now possible to indicate a new direction in the studies of archaeological cultures. This approach may be based on comparative analyses of technological characteristics of their ceramic collections. In order to identify more explicitly the direction and character of connections between particular cultures, it is necessary to analyse and compare the ceramic technologies used by the representatives of the Tripolye, Malice and Lublin-Volhynian cultures. The comparison applies to all the consecutive stages of pottery production: selection of raw materials and preparation of clay for modelling, modelling and shaping of the vessels with subsequent treatment of the surface, ornamenting, and firing.

This paper is based on the Tripolye culture materials from the collection of the State Hermitage Museum in St. Petersburg: Polivanov Yar II, Nezvisko, Nemirov, Krinichki, Vladimirovka, as well as materials from the late phase of the Malice culture – site in Werbkowice and the settlement of the classical phase of Lublin-Volhynian culture in Las Stocki and Wąwolnica, from the collection of the Institute of Archaeology, Maria Curie-Skłodowska University in Lublin. The ceramic collections of the Tripolye, Malice, and Lublin-Volhynian cultures differ not only in the aspects of vessel form and decoration, but also in the technique of pottery-making.

COMPOSITION OF CERAMIC ASSEMBLAGES AND FEATURES OF CLAY PASTER

The Tripolye pottery collection can be subdivided into two main groups: painted ware and pottery with stamped relief patterns (i.e. “fineware” and “coarseware”). The painted pottery is represented by beakers, truncated-conical and semi-spherical bowls, bi-conical jars, amphorae, krateres, pear-shaped vessels with helmet-shaped lids and

so-called “binoculars”. The coarseware comprises mostly pots with an S-shaped profile and deep bowls.

The painted ware was manufactured of dense, well elutriated clay with no or very little temper.

Coarseware at Tripolye sites of stage BII was made of coarsely kneaded clay, with large amount of tempers – grog, grit, sand, crushed shells, plant admixtures and other organic material.

The ceramic assemblage of the late phase of the Malice culture differs essentially from that of the preceding classical phase. Pottery with pricked ornamentation, characteristic of the classical phase, is absent in the late phase assemblage, while the division into thin-walled fineware and thick-walled coarseware also becomes less distinct. The most characteristic forms of this period are represented by sharply profiled bowls with a rib, semi-spherical bowls, deep vases and small cups with a spherical or pear-shaped body (Kadrow 1996, figs. 2-7; 2006, 65-69, fig. 5). Some of the bowls have hollow pedestals of different height. Large vessels are represented by bi-conical jars with sharp or smooth profiles.

The most common decorative motif found on sharply profiled bowls is a row of incisions or imprints made with a rounded cross-section tool and concentrated on the shoulder. The bowls on pedestals were also ornamented with rounded imprints forming a pattern of hanging triangles, and which were made with similar implements. Plastic ornamentation of rounded or semi-spherical cones, located on the vessels’ shoulders and combined with fingernail imprints, was also fairly common (Kadrow 2006, fig. 4).

The ceramic collection of the classical phase of the Lublin-Volhynian culture comprises thin-walled beakers with a spherical or pear-shaped body, deep bowls, conical and semi-spherical-shaped bowls, amphorae with ear-shaped handles located on the broadest part of the body or beneath the rim, and S-shaped profile pots. Less frequent are bowls on hollow pedestals and large spherical-shaped bowls with horn-shaped handles attached to the broadest part of the body (Zakościelna 2006, 82-84, fig. 3). Some of the beakers and bowls on hollow pedestals were painted white. They were ornamented with small and large triangles, arranged chequer-wise and separated by vertical bands (Zakościelna 2006, figs. 3: 2, 3, 18). The pedestals were sometimes decorated with pricked motifs. They were arranged in combinations of pendant triangles and horizontal bands (Zakościelna 2006, figs. 3: 8, 19). The deep bowls were also characterised by four symmetrical bulges located on the external side of the rim (Zakościelna 2006, figs. 3: 6, 8, 10). The amphorae and S-shaped profile pots often had ear-like handles with horizontal or vertical piercing. Finger pinches were located around the rim edges. Occasionally, the upper parts of the rims were decorated with grooving and imprints of fingernails or fingers (Zakościelna 1986, figs. 9: 1, 2; 10: 5; 13: 1-4).

To enable comparisons, a petrographic analysis was conducted on the samples of Tripolye pottery, discovered at settlement sites of the middle phase located in different regions: Bodaki (Podolsk Upland) (Kovnurko *et al.* 2005), Polivanov Yar II (Middle Dniester region), Nemirov (Bug area), Krinichki (Bug area), and Vladimirovka (Dnieper).

These studies have demonstrated no distinct correlation between the vessel forms and the composition of the clay pastes. Only a few regularities can be pointed out.

For example, for modelling fineware, lean clays tempered only with finely ground grog (mostly dark-red) were used most often. At the settlements of Polivanov Yar II, Nemirov and Krinichki, dried clods of raw clay served as grog, while crushed pottery served that purpose at Vladimirovka as well as at Bodaki. It is possible that dried clay had been used at the earlier stages of site occupation, when not enough broken pottery was yet available. Fineware was always fired at high temperatures (up to 1100°C), which are only attainable in special pottery kilns.

At the settlements of Nemirov, Krinichki and Vladimirovka, tableware was made by the use of fat hydromica clays with various artificial tempers: crushed shell or limestone (carbonates) in some cases, and river sand and quartz grains in others. However, such practices were uncommon. An analysis of a tableware sample from the Polivanov Yar II site demonstrated that the studied vessel had been manufactured from lean clay, typical of fineware, although the clay was less carefully kneaded and was artificially tempered with quartz sand and finely crushed limestone slate. Moreover, the pot was fired in oxidising conditions, although the temperature did not exceed 750°C. In other three cases (Nemirov, Krinichki and Vladimirovka), the investigated samples were fired in reducing conditions but at temperatures considerably lower than those used for firing fineware.

The pottery of the late Malice culture was made of fat clay, without temper or tempered with fine grog (grain size below 0.5 mm) and fine sand. The grains of grog added to the clay fabric of large thick-walled jars were coarser, up to 1 mm in size. Organic tempers were rather uncommon (Kadrow 1996, 65; 2006, 65 ff.; Kadrow and Rauba-Bukowska 2017b, 422, 427).

Petrographic studies of the Malice culture pottery were conducted on samples from the earlier classical phase. It has been determined that grog, quartz and feldspar sand were most frequently used as clay tempers, but the exact make-up of the natural constituents varied in different regions. Thus, in one of the regions it was the muscovite that predominated, whereas the biotite was more frequent in others (Pawlikowski 1996, 30-32; Kadrow and Rauba-Bukowska 2016, 68, 70). Since both these minerals are varieties of mica, the qualitative characteristics of raw clay were similar in different regions and, correspondingly, the artificial tempers were also practically identical. Judging by the grey or dark-grey colour of the fired clay, the pottery of the classical phase of the Malice culture was fired in reducing conditions at 750-800°C (Kadrow and Rauba-Bukowska 2016, 30-32).

The majority of the pottery of the Lublin-Volhynian culture was made of fat clay, mixed with grog and fine sand, and occasionally fine gravel. Dried clay fragments and crushed pottery were used as grog. Petrographic analysis of this culture ceramic samples confirmed the presence of a fraction of quartz sand and feldspar in the clay mass, as well as ceramic gravel and dried clay pellets (Kadrow and Rauba-Bukowska 2017a, 271; 2017b, 422, 423). In all of the studied samples, the grog was light-yellow. The amount of tempers added depended

on the vessel's size and the thickness of its walls. For instance, thin-walled beakers and small bowls were made of finely structured clay without any discernible admixtures. Fine sand, with grains no larger than 0.2-0.25 mm, was identified in the clay of the majority of the ware. Possibly, it was a natural component of the raw clay, since it has been found that sand fractions with grain size below 0.25 mm are not suitable as tempers because they decrease the plasticity of the clay. On the other hand, coarse sand fractions, similarly to grog, increase the thermostability of the clay (Glushkov 1996, 24).

Summing up, the studies of the composition of raw clay have revealed, that there is no distinct correlation between the forms of vessels and the composition of the clay in either of the three above mentioned pottery-making traditions. The ceramic collection from the Tripolye settlement of Bodaki is an exception: petrographic analysis enabled the researchers to identify imported pottery, which differed primarily in the aspect of the natural composition of the clay (Kovnurko *et al.* 2005).

The selection of raw materials and procedures of clay paste preparation were obviously influenced by the properties of locally available raw clay and the corresponding local manufacturing traditions. The moulding and decorative techniques were relatively stable within the frames of these cultures.

METHODS OF FORMING THE VESSELS

The pottery of the Tripolye middle period was modelled exclusively by means of the use of the band technique (Zhurakovskiy 1994; Ryzhov 2001, 7-8; Palaguta 2006). The width of the clay strips did not exceed 2-3 cm and their edges were usually bevelled in order to increase the area of the juncture. Most often the vessels burst at the connection points of the stripes, which allows the manner of production to be recorded. Sometimes, if the surface is not finished well enough, the strip contacts are visible on it (Fig. 2: 2). As a rule, the upper edge of the strip was bevelled on the inside, and the lower one, on the outside of the vessel – this was because the strips were joined together from the inside. Exceptional in this respect was an additional coil located at the juncture between the bottoms and walls of larger vessels, which was applied from the outside. The number of strips varied between 2 and 7-8, depending on the size of the vessel.

The small bowls were either moulded from a single lump of clay or were modelled from two chunks: the bottom and the lower section of the wall were shaped from one, while the other was applied from above as a separate clay strip, forming the upper part of the wall with the rim.

Also the pottery of the Malice and Lublin-Volhynian cultures was manufactured using the band technique. The vessels were relatively large with S-shaped profiles. Most of them were modelled from 6-7 strips of clay; the deep semi-spherical bowls were made from 4 coils of clay. Both the external and internal surfaces of the vessels were carefully finished, and on some forms (bowls) they were even shiny. In rare cases, the connections of the

stripes are clearly visible on the inner surface (Fig. 2: 1). Noteworthy is the fact that the bevels of the strips at their joints were not always made in the same way as it was observed in the case of the Tripolye vessels. In the case of large jars, most often the juncture of two strips is found in the opposite direction (Fig. 2: 3).

The bodies of the small vessels of the Lublin-Volhynian and Malice cultures were occasionally formed from a single lump of clay. For instance, the lower part of the miniature vessel on a flat pedestal was modelled in this way. The stages of the moulding process are easily traceable in this case (Fig. 2: 4). The lower body, judging by its dimensions, was modelled with two thumbs from a single piece of clay. Another strip was attached from below, forming the support.

The vessels from the collections of the three cultures mentioned in this paper were shaped on a flat or slightly concave pedestal (Fig. 3: 1, 2). Occasionally, the potters of the Tripolye culture placed pieces of textile on their pedestals. The imprints of these textiles are still discernible, indicating that the bottom received no additional finishing (Fig. 3: 11) (Markevich 1981, 122; Ryzhov 2001, 13). The thickness of the vessels' bottoms was sometimes increased by the application of single 'clay cakes' on the internal side of the bottom (Fig. 3: 4). Occasionally, the bottoms of a small diameter were modelled from two clay plates placed upon each other with an overlap, with the lower part of the wall or the flange pulled out from them, followed by the application of the lowest clay strip of the body (Fig. 3: 4, 5).

A similar technique of modelling the bottom with overlapping plates can be observed in the ceramic collections of the Malice and Lublin-Volhynian cultures. In the Malice culture, the most widespread method of shaping the bottom was the modelling of a clay cake on a flat or slightly concave pedestal to form the base, and attaching a strip serving as a bond to the wall (Fig. 3: 6-9).

The same technique of modelling the vessel bottoms was also common in the Lublin-Volhynian culture. Occasionally, clay cakes with thickened edges, resembling bowls, were used as material for shaping the bases of the Lublin-Volhynian ware. A second cake with the lower section of the wall was inserted into these 'bowls' (Fig. 3: 3a-b). Moreover, still another method was used: an additional cake was applied to the 'bowl' from above, and the lower part of the wall was pulled out from it. The bottoms of the large vessels were occasionally strengthened with an additional strip of clay, like in the Tripolye culture assemblages (Fig. 3: 10).

In the Tripolye culture, by the end of the middle period, a tendency to standardise the forms of vessels can be observed. Possibly, the truncated-conical bowls and the lower parts of the large amphorae and pear-shaped jars were modelled according to common patterns (the lower parts of already finished vessels and bowls may have been used as moulds) (Shepard 1956, 57-58; Palaguta 2006, 78). This trend is most visible during the next CI stage, when the vessels acquired sharp ribs due to the unification of modelling from large parts. The latter were made using a number of methods. This standardisation, and the

resulting simplification of the modelling technique, resulted from the concentration of the population in large settlements and the necessity which arose of increasing the volume of pottery production.

Large vessels were most probably assembled from separate parts: first, a bowl (mould) was modelled, then the upper body with the rim, composed of 3-4 strips of clay, was applied onto it. The reconstruction of the two-step process of modelling of large bi-conical vessels was first proposed by Ernst R. von Stern, basing on materials from the settlement of Petreny (Shtern 1907, 20-23).

TECHNOLOGICAL HOLES IN VESSELS AND FEATURES OF FASTENING OF CONSTRUCTIVE DETAILS

The diameter of the truncated-conical bowls is often identical to that of the rims of the amphorae and bi-conical jars. This suggests the possibility that the bowls may have been used as lids for the amphorae. Therefore, the rims of the latter were moulded according to the same pattern as the truncated-conical bowls so that the bowl could have been inserted into the throat of the amphora, closely fitting to its rim, and sometimes additionally fixed by cords put through holes made for that purpose (Gusev 1995, 133; Kozhin 2007, 101). The presence of holes in the rims of some of the bowls, amphorae and lids seems to confirm this supposition (Fig. 4: 1: 2, 3). On the other hand, the vessel was sometimes moulded with the idea of use with a lid, which can be determined by the clay remnants around the holes, indicating that they were made in wet clay (Fig. 4: 4). However, it cannot be ruled out that those holes may have served the role connected with the suspension of the vessels, for example, a miniature vessel from the Polivanov Yar settlement, which – judging by the very small diameter of the bottom (it cannot be ruled out, that the vessel has round bottom) was unstable, and the holes in the spout served to thread the cord (Fig. 4: 2). Similar pairs of holes were also found on the edges of some of the bowls that presumably had been used as lids. On the other hand, this coincidence of identical dimensions of certain parts of the vessels may simply indicate the use of standard moulds during their manufacture. Moreover, it is known that ceramic vessels were frequently drilled for repairs (Fig. 4: 5).

Drilled holes with the diameter of 0.5-0.7 cm were found on the pottery of the Tripolye, Malice and Lublin-Volhynian cultures (Fig. 3) (Zakościelna 1986, figs. 10, 1; 12, 4). Double holes that were 0.4-0.5 cm in diameter were drilled through the flat horizontal handles of some of the Malice culture vessels (Fig. 4: 6). Those were also perhaps used for the suspension of the pottery or for fixing the lids.

Single drilled channels were also found in the walls of the late Malice pottery (Komorowski 1958, tab. CVI, 6; CVII, 23). They were located on the body or a few centimetres below the rim; therefore, also they may have fulfilled one of the above mentioned functions.

In the pottery of the Tripolye culture, small sized handles were either stretched out of the vessel's body or applied on its surface. The massive handles of large vessels were made

from twisted strips of clay, inserted into holes specially prepared in the walls. After they had been inserted, the thickness of the handles was increased by adding more clay onto the strip (Fig. 4, 7). A similar technique was employed for manufacturing the Tripolye "binoculars", where the central bridge was fixed to the body with a pin (Palaguta 2007, 116).

In the ceramic collection of the Lublin-Volhynian culture, larger handles were also attached with pins (Fig. 4: 8). This technique was fairly widespread in the cultures of the Balkan-Carpathian Eneolithic.

METHODS OF SURFACE TREATMENT

The surfaces of the Tripolye culture vessels were treated by trimming off the excessive clay from the raw surface with wooden or bone tools, with a broad (3-5 cm) working edge (Fig. 5: 1, 2). Spatulas used for working of the pottery surfaces were discovered at Tripolye settlement sites of different periods (Korobkova 1987, fig. 37: 4). *Unio* shells may have also been used as tools for this purpose. Parallel furrows left by the spatulas or valves of the shells are visible on the internal surfaces of some of the vessels (Fig. 5: 3). Imprints of fingers on some of the vessels (Fig. 5: 4) suggest that the surfaces (especially the inner ones) may have also been finished by the potters using their hands. One of the pottery fragments found at the settlement of Cucuteni-Cetăţuia allows us to reconstruct the process of trimming off the clay: fingerprints are easily discernible on the internal edge of the bowl – the potter held the vessel by the rim, and fixed the joints between the strips from the inside with a wooden spatula.

Some of the cooking pots with crushed shells added to the clay were produced differently. After building-up the initial blank from clay coils, those vessels were shaped by embossing – the 'paddle-and-anvil' technique (Palaguta 1998). During the Tripolye BII period, as opposed to the preceding BI period, this technique of shaping was often combined with trimming.

No distinct traces of surface treatment were identified on the pottery of either the Malice or Lublin-Volhynian cultures. The external surfaces of the vessels are generally smoother and less porous than the internal ones. It is probable they were additionally coated with a thin layer of liquid clay during the final stage of modelling to eliminate the pores produced by various inclusions.

The next stage of the surface treatment of some of the Tripolye fineware involved polishing with special implements made of rounded pebbles and animal bones (Semenov 1957, 215-218; Markevich 1981, 127; Sorokin 1991, 137; Skakun 2004, 73). The burnishing of the surfaces prepared them for painting, additionally increasing the water resistance of the vessels. This was further enhanced by careful re-polishing of the vessels surfaces after they had been painted (Fig. 5: 7). In the Tripolye culture, pottery was polished at the final stage of the pottery-making process, after the firing and ornamentation, i.e. over the dry surface, since the traces left by the polishing are practically indiscernible. Additionally, the

process of double polishing cannot also be excluded: the first polishing of the dry surface was performed prior to firing, while the second – after the vessel had been fired, for the final smoothing just before the painting (Semenov and Korobkova 1983, 204).

In the ceramic collection of the Lublin-Volhynian culture, the pottery surface is usually matt, irregular orange, grey-orange or grey-black in colour, which suggests inhomogeneous or secondary firing. Traces of smoothing were frequently found on both the internal and external sides. Some of the vessels were polished to lustre (Zakościelna 1986, 48; 2006, 80-84). The polishing of the pottery was performed before the firing, on slightly dried-up surfaces, which retained the pattern of recessed furrows left by the polisher (Fig. 5: 5, 6).

Polishing implements were found at sites of the Tripolye and Lublin-Volhynian cultures (Fig. 5: 8). The pottery of the Lublin-Volhynian culture was polished both on the inside and outside, although exceptions also exist, with polishing found on only one side, either internal or external. Noteworthy is the find of an upper body of a pot, carefully polished on the inside. Rare traces of polishing were identified only in a few places on its external surface. Apparently, the vessel was broken back in prehistory and some of its fragments had been subjected to secondary oxidative firing, after which their surface was corroded, thus removing most of the evidence of polishing (Fig. 5: 5). Phenomena of this kind should be taken into consideration when describing the type of collection in detail.

During the Tripolye BII period, the application of a slip used as undercoating became the most common way of preparing vessel surfaces for painting. Engobe was made by thinly diluting light-coloured, fine-grained clay in water. After dipping the vessel in a clay solution or applying the slip with a brush, the vessel acquired a smooth, even surface which served not only as a background for monochromatic or polychromatic painting, but also added water receptivity to the surface (Semenov and Korobkova 1983, 230). Pottery engobing was not practised anywhere in the Cucuteni-Tripolye culture. Visually, an engobe can be identified only in cases where it has been locally separated from the vessel surface (Fig. 6: 3). Among the most common techniques was the application with a brush of a thinly diluted mineral dye undercoating, most often of light-brown or reddish colour, onto the surface of the vessel. Traces of hair from a broad brush were identified on pottery from the site of Nezvisko, where undercoating was widely employed (Fig. 6: 1). Occasionally, the undercoating was applied rather carelessly, or was intended for functions other than decorative. Thus, in Cucuteni-Tripolye culture ceramic collections, one can encounter vessels which, despite being unpainted, are still coated with weakly concentrated paint on their internal and external surfaces, a practice aimed at reducing water permeability (Fig. 6: 2).

FIRING OF THE VESSELS

Nearly all of the Tripolye painted pottery (fineware) is pinkish, orangish or yellowish coloured, a fact that indicates firing in an oxidative environment. The majority of the coarseware was fired in reducing conditions, as suggested by its dark-grey and grey colour.

However, light-brown coloured coarseware fired in oxidative conditions was also discovered.

The pottery of the late phase of the Malice culture is characterised by common careful smoothing of the surface to a slight lustre. The cross-sections are dark-grey or black on the inside, and yellowish or yellowish-pink on the outside. It may be presumed that this yellowish layer on the external surface is a slip, but it is very thin and missing in those places where the dark interior is exposed (Fig. 6: 4, 5). Such an effect is possible when the vessel was at first subjected to firing in reducing conditions and then rapidly removed from the firing pit, which allowed its surface to oxidise during the quick cooling (Glushkov 1996, 81). However, it is also possible that the vessel was fired in a pit with access to oxygen but was placed with its bottom upwards, so that its interior surface did not oxidise (Glushkov 1996, 82).

Yet another technique of surface treatment was observed in the ceramic collection of the Lublin-Volhynian culture. A number of vessels were coated with a layer of clay, which is identical in its colour and composition to the clay of the vessels themselves. This type of coating is sometimes called 'plaster-slip'. It produces a particular 'engobe casing' (Sayko 1982, 18). It must be noted that the terms 'engobe/slip' are used arbitrarily in this case, since it is widely accepted that the clay composition of a slip should differ from the clay used for modelling the vessel itself. In this particular case, the coating and the substance of the vessel are practically identical (Fig. 6: 6, 7). As demonstrated by Lyubov′ B. Kircho's studies of Bronze Age materials from Southern Turkmenistan, the flaking-off of the surface layer is also possible, if the dried vessel was wiped with a wet cloth, thereby forming the so-called false slip (Kircho 1999, 78).

In some cases, pottery was coated both on the internal and external surfaces. The thickness of the coating reached 2 mm. Practically in all of those cases the thick coating is flaked-off from the surface (Fig. 6: 6, 7). This is probably due to inappropriate technology, when the coating was applied to an excessively dried surface of the vessel.

A coating of this type was identified on a conical-shaped clay object which was uncovered at the Lublin-Volhynian culture settlement in Wąwolnica (Fig. 6: 7). In its shape, this object resembled a conical vase with a flat bottom pedestal. The ornament was applied in white paint over a thick layer of plaster, and has barely been preserved to the present (the design was reconstructed on the basis of a drawing made directly after the excavation). The layer of paint was fairly thin. The decorative pattern was composed of rows of horizontal and vertical lines, alternating with rows of triangles filled with paint. The object was made using the coil technique and the width of the strips was 2-2.5 cm. In its 'base', there were two holes, 0.4 cm in diameter, placed symmetrically 2 cm below the edge. It seems that this object served as a support platform for some time. However, it cannot be ruled out that from the very beginning the vessel had a pedestal, which at some point was broken in two (as suggested by a substantial fissure in the bottom which ran precisely through its middle and passed to the body). Following the breakage, holes were made to enable the fastening of the split parts of the vessel. After the repair, it may have been used

as a support or as a container for dry contents. A similar vessel, although without the holes, was discovered at the Lublin-Volhynian cemetery in Ornatowice (Gurba and Jasiński 1963, fig. 1, n).

DECORATIVE AND TECHNOLOGICAL ELEMENTS

In the ceramic collections of the three cultures considered in this paper, there are certain decorative elements which simultaneously may have also fulfilled purely technological functions. For example, among the pottery of the Lublin-Volhynian culture, there is a series of gently profiled S-shaped vessels. They are characterised by a slightly out-turned rim, covered by a set of punctuations located around the internal edge (Figs. 2: 3; 5: 5; 7: 1). These depressions were made with finger-cushions, fingernails or tools with a rounded section. The uppermost edge of the rims was in every case thickened by an addition of a narrow strip of clay, about 1.5 cm wide. It is possible that apart from a decorative function, the depressions on the internal surface of the rim also served as its additional strengthening.

This particular feature of the Lublin-Volhynian pottery may be compared with the so-called 'pearls' – an element recognised on pottery, which is widely distributed spatially and temporarily, from the Neolithic up to the steppe cultures of the Bronze Age. In the ceramic collection of the Tripolye culture, 'pearls' were identified on 'shell-tempered' pottery, dated exclusively to the BII period (Fig. 7: 2, 3). Apparently, in general terms, this feature was not solely characteristic of any specific cultural entity but served as a technological measure used in the earlier stages of pottery production. Possibly, potters strengthened the junctures between clay coils by compacting them with a special implement which left pearl-shaped imprints. With time, the meaning and function of these 'pearls' became purely decorative (Kozhin 1984, 207).

Vertical combing, so common on the necks of the Tripolye culture coarseware (Fig. 7: 4), is comparable to traces of vertical scratches identified on a vessel of the Lublin-Volhynian culture (Fig. 7: 1), discovered at the settlement site in Las Stocki. Those traces were made with a tool that had a 2.5 cm wide working edge. That implement left a pattern of shallow furrows with equal spacing between them. As it seems, they were not ornamental in nature but were the remains of an additional strengthening of the joints between clay strips. The vertical combing located on the necks of Tripolye culture coarseware may have also been a technological measure at first and which became a decorative feature with time. A similar tool was used to fix the upper part of the rim onto a semi-spherical bowl – in this case, two parallel furrows on the inner edge are clearly visible (Fig. 7: 5). An additional horizontal appliqué on the top of the vessels, along the diameter of a deep conical bowl of the Lublin-Volhynian culture, can also possibly be considered as a specific technique for rim modelling (Fig. 7: 6). In this instance, the rim may have been smoothed in order to tightly accommodate a flat lid.

RESEARCH ON THE COMPOSITION OF ENGOBE, PIGMENTS AND BINDER OF PAINT LAYERS

The fineware of the Tripolye culture was painted dark-brown or white over the orange or light-brown undercoating (slip). Particular patterns generally correspond to certain categories of pottery.

Chromatography-mass spectrometry of organic materials from 17 samples of the Tripolye culture pottery was conducted at the Laboratory of Scientific-Technological Expert Examination of the State Hermitage. The samples were collected at a number of settlement sites, dated to stages BI-BII, BII and BII-CI (Kalinina and Starkova 2009; 2012). The results of the analyses of particular chemical compounds of different classes lead to the conclusion that the composition of the binders included saccharose, eggs, and beeswax.

This analysis confirmed the results obtained earlier at the Laboratory of Physico-Chemical Research of the State Scientific-Research Institute of Restoration (GosNIIR), Moscow, where protein and other organic binders were discovered in the layer of painting of the Tripolye-Cucuteni pottery samples (Podvigina *et al*. 1999).

The above mentioned results cast doubt on the widely accepted view that the Tripolye-Cucuteni pottery was painted before firing (see e.g. Tsvek 1994, 70). Indeed, it has been established that the temperature of firing of the Tripolye-Cucuteni pottery possibly reached 900-1000şC, at which no organic components of the binders could have been preserved (Podvigina *et al*. 1999, 37). At the same time, it is highly probable that the surface of the vessels had been undercoated before firing, whereas the decorative pattern was applied after firing, over the undercoating.

Subsequently, using a scanning electron microscope, micro-sections of the ceramic samples originating from aforementioned sites of the Tripolye culture were examined, which allowed the differences in the technique of the surface preparation and paint composition to be determined. By the use of EDX analysis, it was established that the qualitative and semi-quantitative elemental composition of each of the three micro-section layers was different. It was also possible to reveal the differences in the engobe elemental composition on the vessels from various settlements. It was established that on the settlements of Vladimirovka and Nezvisko, clays with a high content of calcium (Ca) and aluminium (Al) were used to prepare the engobe. In the case of the Krinichki settlement, only on some of the ceramics samples an engobe that did not adhere closely were identified, with numerous bubbles and voids. Apparently, the potter could not form a homogeneous layer of the engobe (Kalinina and Starkova 2016).

In the Polivanov Yar settlement (Fig. 8: 2) a higher content of potassium (K) and aluminium (Al) was observed (Fig. 8: 2e). The relatively higher potassium content in the engobe, compared to the ceramic mass (Fig. 8: d), indicates that prior to firing a thin layer of slime with a high content of potassium aluminosilicate was applied to the surface of the

clay mass in order to obtain an engobe. In the case of white paint, kaolin was used with a small addition of burnt bones, as evidenced by the presence of phosphorus (Fig. 8: 2g). The basis of the brown dye was iron-manganese ore (presence of a large amount of manganese and iron in the composition) (Fig. 8: 2f).

Additionally, chromatography-mass spectrometry of organic materials was carried out at the Laboratory of the Scientific-Technological Expert Examination of the State Hermitage, on a sample vessel fragment uncovered at the settlement in Wąwolnica. This site is dated to the classical phase of the Lublin-Volhynian culture. The pottery sample bore traces of white painting (Fig. 8: 1 a-e).

Studies aimed at identifying organic binders previously were conducted on finds discovered at the cemetery in Ornatowice (Gurba and Jasiński 1963, 362). In this case, vegetable oils were identified as a component of the organic binders. This fact confirmed the hypothesis that painting was applied to the vessels after they had been fired.

The pigments were analysed by means of microchemical tests. The white pigment was chalk-based, with admixtures of silicates, as evidenced by the large amount of calcium in the paint layer (Fig. 8: 1e), and inclusions of crushed shells (Fig. 8: 1c).

In the course of the analysis, the sample was divided into two – proteinaceous and lipoid – fractions. In the lipoid fraction, the following components were identified: saturated fat acids C_{14}-C_{28}, among which the palmitic acid ($CH_3(CH_2)_{14}COOH$) was the main constituent. The study of the relative content of fat acids within the range C_{20}-C_{28} showed the highest share of C_{26}. In addition, paraffin compounds with uneven numbers of carbon in the chain were recognised. The components themselves as well as their specific ratios are typical of beeswax.

Despite the fact that the study indicated the presence of protein containing substances, their exact identification was difficult due to strong degradation of the particular components.

The presence of beeswax in the composition of the organic binders within the painting layer of the Lublin-Volhynian pottery is another indirect confirmation of the supposition that the Tripolye culture pottery was painted after it had been fired (or, perhaps, with an additional low-temperature heating to fix the painting), since beeswax was also identified as a component of its binders.

CONCLUSIONS

The comparative analysis of the pottery-making technologies of the Tripolye, Malice and Lublin-Volhynian cultures presented above has revealed considerable differences between them. Despite the fact that these cultures co-existed simultaneously on the Podolsk Upland from the first half of the 5th to the first half of the 4th millennia BC, Tripolye ceramic production was by that period at an significantly more advanced level. This is evidenced not only by the diversity of forms and categories of pottery, but also by the presence of spe-

cialised production assemblages: those were necessary to fulfil the needs of growing Tripolyan populations during the expansion of this culture, which had considerably increased its territorial range by the end of the middle period. High-temperature oxidative firing in special pottery kilns, careful working of the vessels' surfaces, and the diversity of ornamental compositions are among the main characteristics of Tripolye pottery-making.

The people of the Malice and Lublin-Volhynian cultures, who for a certain period of time occupied the same regions as the Tripolye groups, never attained such sophistication in pottery production. This is indicated by non-standard, irregular (oxidizing in some cases, reducing in others,) firing of the vessels, with the whole process apparently conducted in pits, as well as by the poor preservation of ornamental painting and the surfaces of vessels in general. Noteworthy is also the existence of numerous specific technological variations of Malice and Lublin-Volhynian pottery, which indicates incomplete development of ceramic technologies. For comparison, the Tripolye culture ceramic assemblage of the same period is characterised by a standardization of forms and unification of vessel production techniques. The explanation of these differences lies primarily in the aspect of settlement size – rather small in the Malice and Lublin-Volhyniann cultures – and the consequent absence of a demand for large-scale manufacturing complexes.

Nevertheless, at the Tripolye culture sites located on the Podolsk Upland, one can encounter imported pottery manufactured by people of the Malice and Lublin-Volhynian cultures (Skakun and Starkova 2003). At the same time, no imports of Tripolye pottery were found at Malice and Lublin-Volhynian settlements (Zakościelna 2006, 92). It seems that pottery was not a subject of inter-cultural exchange, and was brought to foreign culture sites together with the people who manufactured the vessels. Moreover, among the artefacts discovered at Tripolye culture sites, along with the imports, fairly numerous imitations of such imports were also identified. The latter retain the form and decoration of the original specimens, but were manufactured from local clay and using local Tripolye technology. This may indicate that particular representatives of the Malice and Lublin-Volhynian groups may have stayed for some time among the Tripolye communities.

A comparative, multi-aspect analysis of pottery production in the Tripolye, Lublin-Volhynian and Malice cultures is a promising method for increasing the understanding of the relations between these three cultural entities, in the regions of the Upper Dniester and Podolsk Upland.

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