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RITUAL POSITION AND "TATTOOING" TECHNIQUES IN THE FUNERAL PRACTICES OF THE "BARROW CULTURES" OF THE PONTIC-CASPIAN STEPPE/ FOREST STEPPE AREA. POROHY 3A, YAMPIL REGION, VINNYTSIA OBLAST: SPECIALIST ANALYSIS RESEARCH PERSPECTIVES

ABSTRACT

The present paper discusses the results of an interdisciplinary study of human remains in the form of two ulnae from a female skeleton found in grave 10, Porohy 3A site (Middle Dniester Area), dated to Early Bronze Age: 2650-2500 BC. The paper describes the technical aspects of applying the decorations revealed in the examination of the aforementioned bones.

Key words: Yamnaya culture, funeral rites, tattoo, postmortem changes

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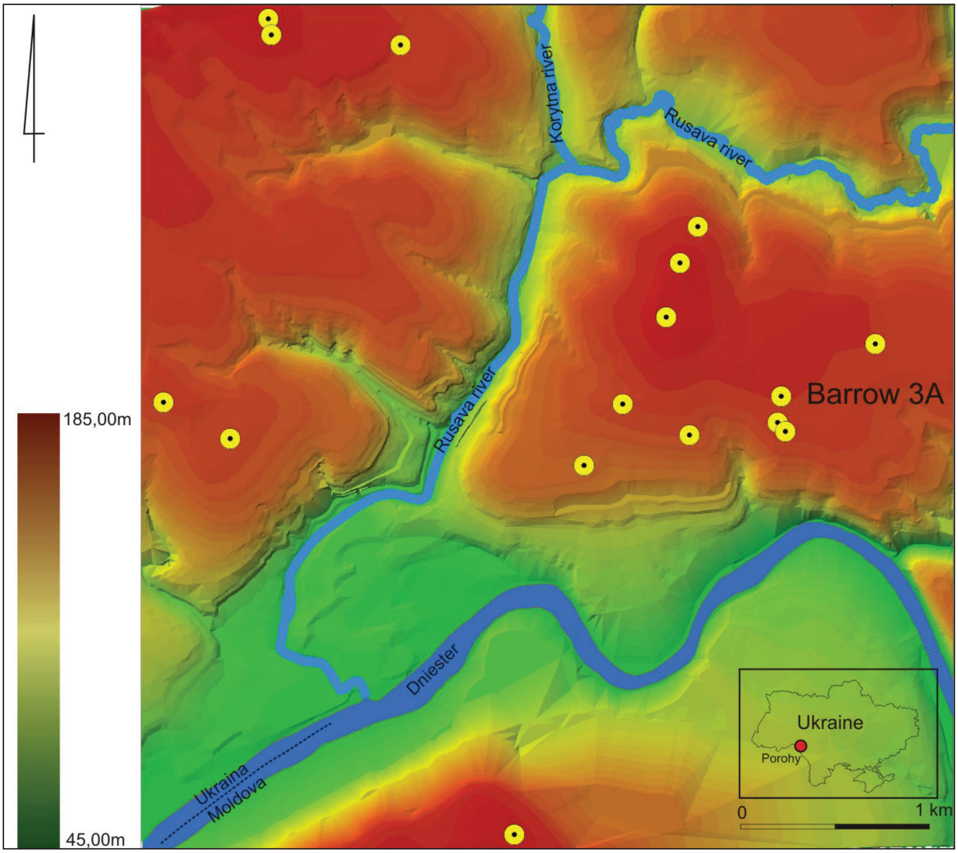


F i g . 1 . Porohy, Yampil Region, barrow 3A. Barrow location in the elevation model of the immediate surroundings of the site

An important regional diagnostic feature of the Pontic-Caspian steppe/forest steppe cultural area of the IIIrd millenium BC are "tattoos", recognized in a particularly informative version in the funereal context: on the bones in the burials related to Early Bronze Age barrow cultures: Yamnaya (YC) and Catacomb (CC). Uncommon as such phenomena are within aforementioned taxons, they inspire numerous culture-related discussions in the *barrow archaeology* research circles. The latest studies conducted by the team led by Natalia I. Shishlina focused on the objects from the Caspian steppe area CC, unambiguously indicating the connection between its prominent ritual observances and symbolic body decorations [*see* more: Shishlina *et al*. 2013].

In tomb 10, barrow 3A in Porohy, Yampil Region, Vinnytsia *Oblast* (Middle Dniester Area), the most outlying – furthest to the west – indications of the use of "tattoos" among the barrow cultures in the Pontic-Caspian area.

The above mentioned burial can be tied to the beginning of the late YC phase, with this particular site dated to around 2650-2500 BC, i.e. the prologue to the Budzhak stage [*see* Goslar *et al*. 2015 and Klochko *et al*. 2015 for the results of archaeological, anthropological and archaeometrical studies].

The subject of the interdisciplinary research were two ulnae from a female skeleton aged approximately 25-30 years old, subject to FT-IR spectrophotometric analysis, optical microscopic analysis, as well as SEM analysis with energy-dispersive X-ray spectroscopy (EDS). The study is complemented by medical and forensic anthropology expertise.

The article is structured around featuring three scopes of analytical view: archaeological (Chapter 1), physicochemical (Chapter 2) and anthropological, taphonomical and tanathological (Chapter 3).

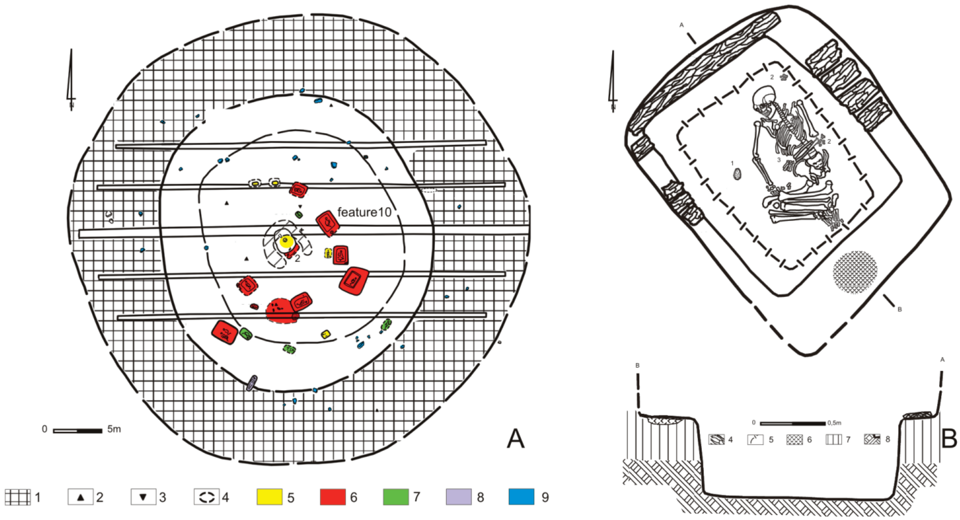
1. YAMPIL BARROW COMPLEX – ARCHAEOLOGICAL ASSESSMENT

The structure of the chapter is based upon the findings presented in previous papers concerning the outcomes of the *Yampil Barrow Complex* research [Kośko *et al*. (Eds) 2014; Klochko *et al*. 2015].

a. Porohy, barrow 3A

The barrows located in Porohy (to date, five surface evident barrows: 1, 2, 3, 3A, 4 have been examined [*see* Potupczyk, Razumow 2014:Fig. 1.2: 2] are part of a particularly prominent ceremonial and funereal centres within the *Yampil Barrow Complex* [Potupczyk, Razumow 2014: Fig. 1.2: 1]. This may be due to their positioning in the landscape zone situated directly above the Dniester River Valley, which may explain the intensity of their ritual application, both in the Late Eneolithic as well as Early and Late Bronze Ages [*see* Harat *et al*. 2014: 70n.; Klochko *et al*. 2015] (Fig. 1). They were, however, recorded in the state of widespread devastation, which hindered the inventory of archaeometric observations and implementation of interpretative efforts. The range of local "incidental ritualistic behaviours", including the hereby analysed procedure of "tattooing" the bones in the limbs of buried individuals, highly unusual, as far as the Northern Pontic scale is concerned, as well as unique amphora depositories (barrows 2, 3 and 4) [*see* Iwanowa *et al*. 2014], warrants the undertaking of further archaeometric and interpretative research initiatives.

Barrow 3A in Porohy is situated 4 km to the east of Yampil, Vinnytsia *Oblast*, where a group of minimum five barrows, locally known as *Tsari* (= royal burials), was found in the fields of the Porohy farmstead (Fig. 1). The group is located in the vicinity of the road from Yampil to Kryzhopil, in the southern part of the culmina-



F i g . 2 . Porohy, Yampil Region, barrow 3A: A – barrow plan: 1 – surrounding ditch; 2 – animal bones; 3 – pottery shards; 4 – vessel fragments; 5 – features associated with the Eneolithic; 6 – features associated with the Yamnaya culture; 7 – features linked with Noua culture; 8 – features linked with Iron Age; 9 – elements of barrow kromlech; B – plan and profile of feature 3 A/10: 1 – lump of ochre; 2 – phalanges and hoofs of small horned cattle; 3 – cattle bone tool; 4 – wood remains; 5 – outline of mat; 6 – hearth; 7 – layer under the barrow mound; 8 – sterile soil

tion of the watershed between the valleys of Dniester and its left bank tributary, Rusava. Apart from barrow 3A, two other barrows were examined as well.

The examination of barrow 3A revealed 20 features: 4 Eneolithic/from the beginning of Early Bronze Age (?), 10 YC, 5 Noua culture and 1 from the Middle Sarmatian period (Fig. 2: A). Due to considerable damage to the mound resulting from farming activities in the area, determining the relation of particular graves to the stages of raising the barrow is problematic. Two main phases have been determined, as well as local mound's enlarging. During the oldest (Eneolithic?) phase, the barrow was encircled with a stone cromlech, though the construction was significantly damaged in the process of expanding the mound in later phases. In part N, on the border of the older mound, an overturned *stele* was uncovered.

b. Porohy, barrow 3A: stage II (Early Bronze Age)

The planigraphic and stratigraphic analysis of kurgan 3A in Porohy justifies the distinction of the sequence of two barrow cemetery complexes and that of level ones dug within the rim and culmination, tied in cultural terms to the communities of the Eneolithic /?/ (stage 1) and Early – (stage 2) as well as the Late Bronze Age (stage 3).

The oldest one in stage 2 necropolis, grave 2, located in the central part of the barrow, was damaged by the other object. For this reason, it is difficult to establish the details of its construction and the position of the burial. The graves dug into the mentioned "younger mound" of barrow 3A in Porohy constitute the biggest complex of YC burials in the mound – so called "users" (9 graves) – in the scale of the *Yampil Barrow Complex*. Instead of being oriented according to the cardinal points, the graves were aligned with their longer axis towards the centre of the barrow, creating arcs around the centre of the mound, which is characteristic of the Dniester-Danube YC. At the same time, the sometime-characteristic rule of orienting the dead along or against the arrow of time, depending on their position in the kurgan [Dergachev 1986: 40], was not applied. The concentration of the Porohy graves in the eastern part of the mound is not frequently noted in the region in question.

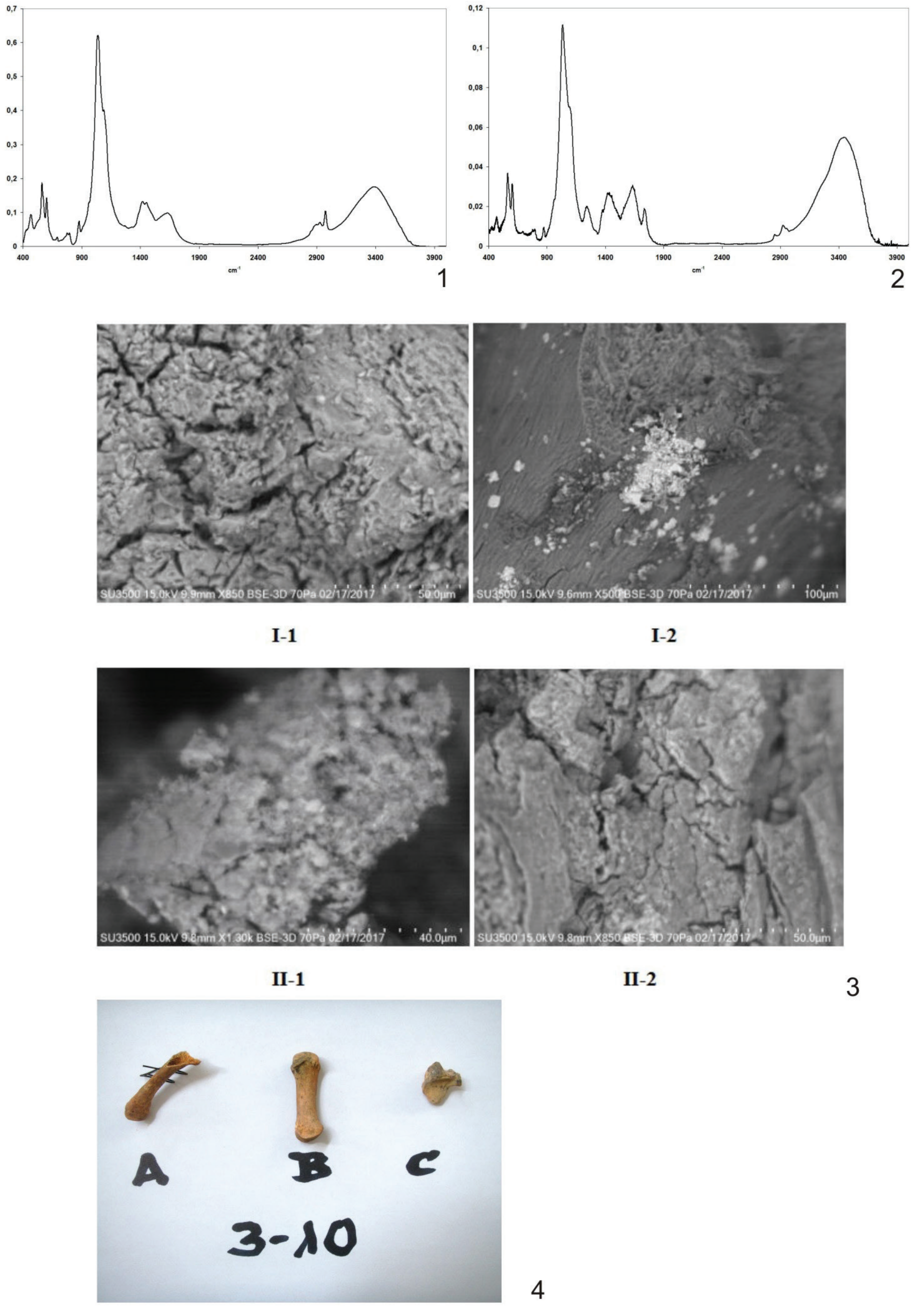
c. Porohy, barrow 3A, grave 10: archeometric and taphonomical specification

Grave 10 was dug into the north-eastern part of the mound. The rectangular outline of the grave pit was caught at the depth of 45 cm, with the step leading to the burial chamber located at the depth of 75 cm. Traces of a circular hearth were recorded in its south-eastern part, 30 cm in diameter with the fill of approximately 10 cm in depth, consisted of burnt soil, ash and charcoal. Traces of wooden elements of a transverse roofing, up to 20 cm wide and 5 cm thick, were found on the step. At the discovery level, the pit was 2.35 x 1.9 m and oriented along the NW-SE axis (Fig. 2: B).

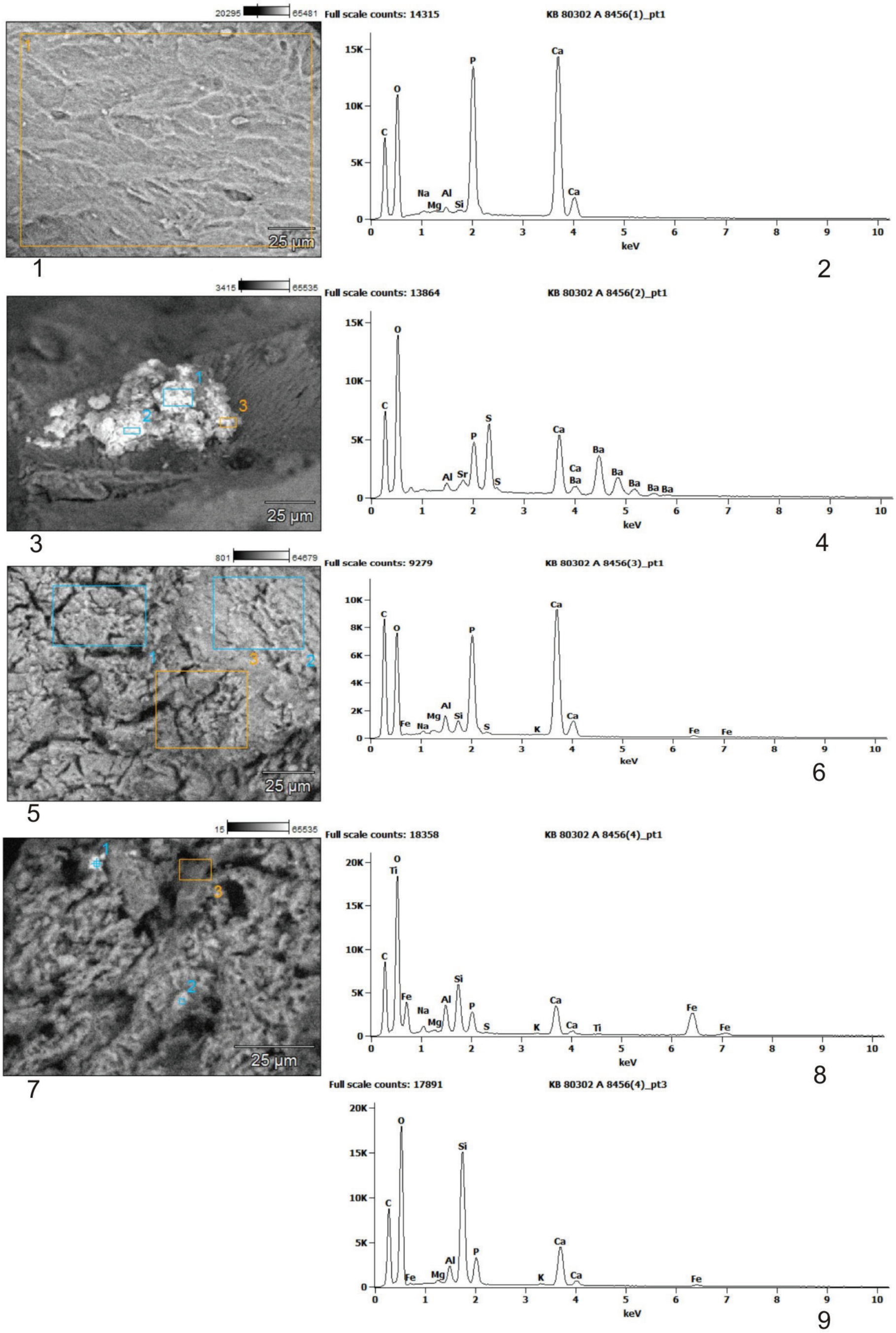
The burial chamber was of rectangular shape (1.7 x 1.4 m at the level of its bottom), 60 cm deep. Lying at the bottom of the chamber there was a skeleton of a female *Adultus* (25-30 years), preserved in the anatomical order. The body was placed in a crouched position on the back, with the lower limbs bent at the hip and knee joints. Originally placed with the knees pointing upwards, which later fell to the right side. The bones bore traces of ochre pigmentation. The upper limbs were arranged in a way characteristic of Porohy burials, with one of the limbs bent and turned towards the pelvis. The upper right limb was abducted and bent slightly at the elbow. The upper left limb was bent at the elbow at a slightly obtuse angle. Its humerus was placed parallel to the long axis of the body, and the distal ends of the forearm bone rested on the right wing of ilium. On both ulnae, regular patterns in the shape of arches and chainlets were recorded.

The deceased was placed on a mat lining the bottom of the pit, presumably made of a type of aquatic grass (reed or acorus?). Moreover, chemical compounds characteristic of the propolis lipid profile were found in the examination of the lining of the grave. Imprints of plain-weaved fabric were preserved within the precinct of the bottom of the pit – possibly remnants of a shroud [*see* Kałużna *et al*. 2017].

Metacarpal bones and finger bone segments of a goat/sheep were found under the left elbow and next to the scull of the buried individual. 20 cm to the east of the lower left limb there was a lump of ochre. A "bone awl" was found under the bones of the rib cage. When categorizing YC grave site inventories, artifacts such as these are qualified as "everyday objects", identified functionally as perforators



F i g . 3 . Porohy, Yampil Region, barrow 3A, feature 10. Chemical analysis: 1 – FT-IR absorption spectra of black dye samples (I) 80302 A-8456; 2 – FT-IR absorption spectra of black dye samples (II) 80303 A-8457; 3 – results of SEM observation of dye materials I and II; 4 – samples without a dye: 3-10A, 3-10B and 3-10C



F i g . 4 . Porohy, Yampil Region, barrow 3A, feature 10. Chemical analysis: 1-9 EDS analysis of samples of dye material I

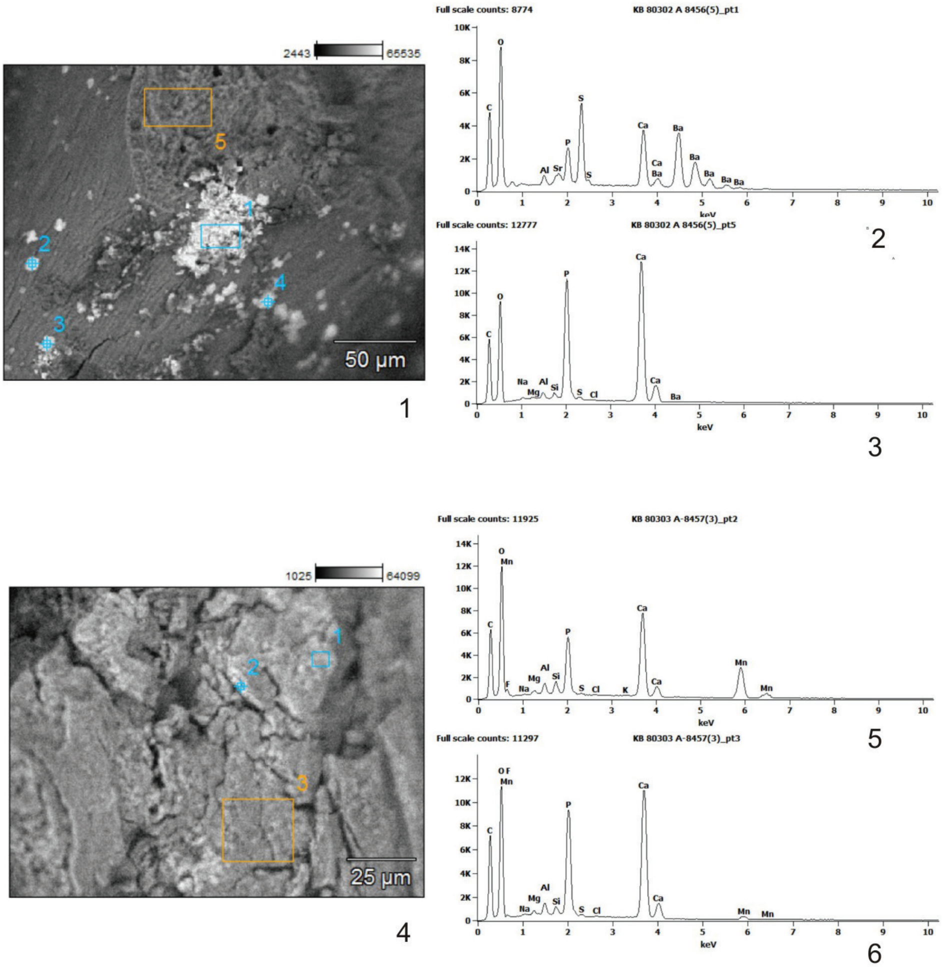


Fig. 5. Porohy, Yampil Region, barrow 3A, feature 10. Chemical analysis: 1 – EDS analysis of samples of dye material I; 2 – EDS analysis of samples of dye material II

or pins [*see* Melnik, Steblina 2013: 47-48; Subbotin 2003: 98-100]. In this case, however, the possibility that we are dealing with a “ritual object”: a fragment of a unilateral point – with reference to the ritual recorded in several graves of the eastern Globular Amphora culture (GAC) group [Wiślański 1966: 42; Szmyt 1999: 48, Fig. 10: 10].

Five ^{14}C markings were made on human bones (rib fragments): Ki-17383: 3860 ± 160 BP; Ki-17438: 4370 ± 70 BP; Ki-18928: 4070 ± 50 BP; Poz-74393: 4105 ± 35 BP; Poz-81824: 4040 ± 35 BP, situating the burial in the time 2572-2532 BC [*see* Goslar *et al*. 2015: 271].

Inventory

1. An oval lump of ochre, dimensions: 8 x 5 cm.

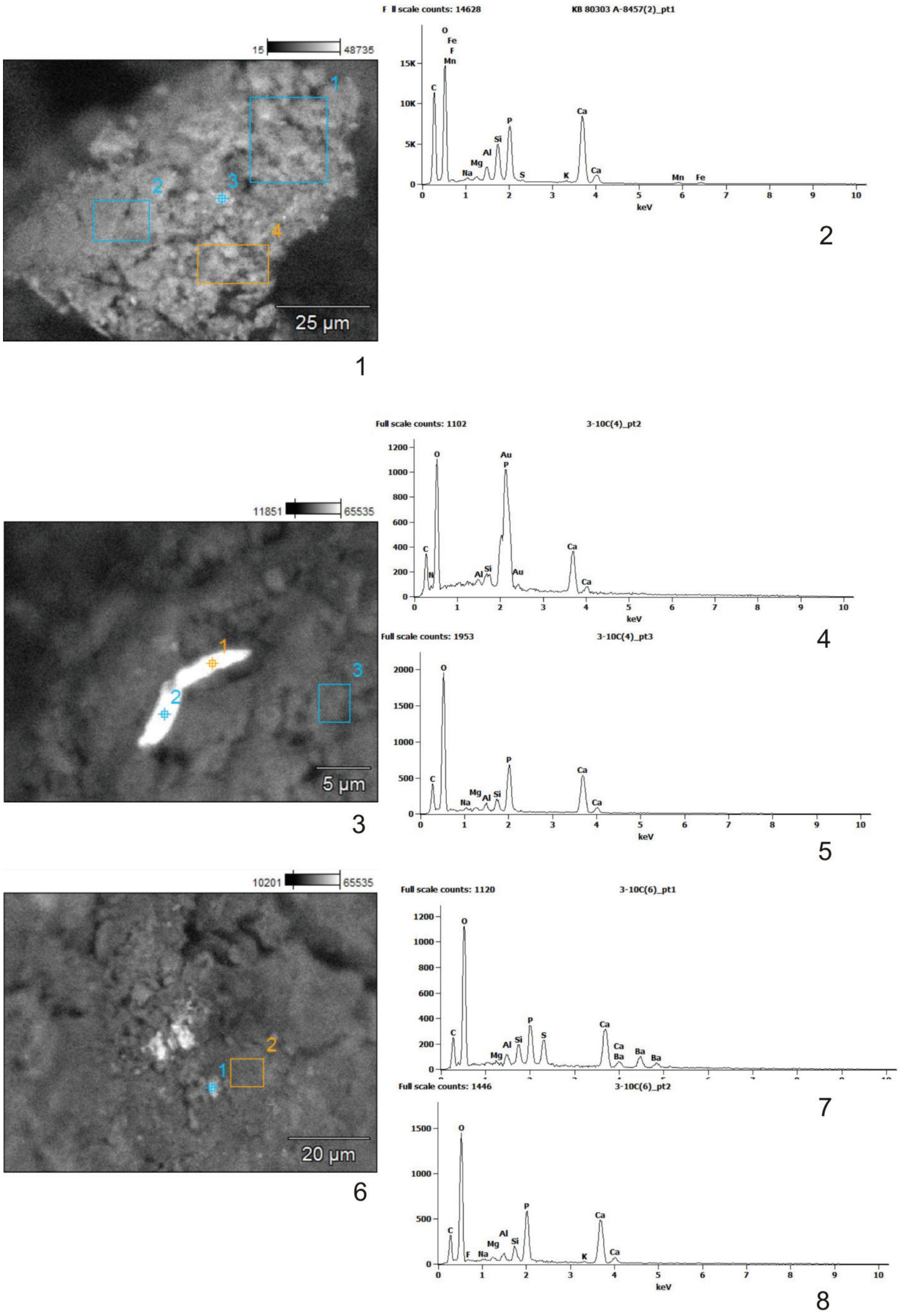
2. A „awl"/pin/damaged blade, C-shaped in cross-section, made from a fragment of a sheep's (goat's) shinbone. Dimensions: 7 x 1,5 x 0,5 cm.

d. Porohy 3A cemeteries: grave 10; ritual context: interdependent feature context

The majority of YC graves dug in the layers of the younger mound created an arc, starting at post-holes 6 and 13 on the northern side, dug before the construction of the second mound. It consists of graves nos. 12 (female, 22-25 years old), 10 (*see* pp. c), 11 (male, 25-30 years old), 1 (male, 30-35 years old), 19 (?, under 18 months old) and 17 (male, 30-35 years old). Grave 20 was found outside of this sequence – placed separately at the fringe of the kurgan. The possibility cannot be excluded that the formation of this grave site was accompanied by the extension of the kurgan, this, however, could not be confirmed due to the fact that the mound had been ravaged. The layout of secondary burial graves on an arc is a feature characteristic to the entire Dniester-Danube area [Shmagliy, Chernyakov 1970: 96; Yarovoy 1985: 57-61; Dergachev 1986: 32]. Burials in such an establishment display common features. It is noteworthy that in most cases, the documented positioning of the deceased person's body was: crouched position, with noticeable turn to the side and one of the upper limbs bent and turned towards the pelvis. This arrangement is typical for late phases of the YC. The repetitive character of ritualistic features indicates cultural proximity of the hereby specified YC burials. Therefore, burials found in the system of objects located on the *circumferencial arc* around the centre of the "younger mound" share a presumed ritual bond with grave 10, which inspired the present chapter.

2. THE "TATTOO" BURIAL: AN INTERDISCIPLINARY ANALYSIS OF THE INVESTIGATED RITUAL

Feature 10 of barrow 3A in Porohy documents the furthermost western – "frontier" – confirmation of "tattoo" application in the Pontic-Caspian area of use of this ritual procedure. Taking into account the previously motivated interpretative experiences from within local *barrow culture* rituals [Shishlina *et al*. 2013], specialist analyses were undertaken in order to – according to the baseline research plan – gain more specific expertise, the results of which deserve to be considered highly innovative (!), and thus deserve to be more broadly discussed. To substantiate, the analysed ulnae reveal decorations being applied directly to the bone of the deceased and as such, the ritual diverges from the defining framework of a tat-



F i g. 6. Porohy, Yampil Region, barrow 3A, feature 10. Chemical analysis: 1, 2 – EDS analysis of samples of dye material II; 3, 4, 5 – EDS analysis of samples 10; 6, 7, 8 – EDS analysis of the surrounding soil too as *a permanent decoration of the body surface (in said case one can speak of a quasitattoo – a "tattoo")*. The undertaken research concerned (2.1) the analysis of the chemical composition and application of the pigment, and (2.2) the analysis of observing said ritual cycle in terms of forensic medicine.

2.1. CHEMICAL ANALYSIS OF THE DYE IDENTIFIED ON THE BONES

A chemical analysis of the dye was performed by means of the electron scanning microscope Hitachi SEM equiped with the EDS facility and the infrared FTIR spectrometry (KBr) using Bruker spectrometer FT-IR IFS 66/s. Two samples of dried materials were analysed: (I) taken from bone 80302 A-8456 and (II) taken from bone 80303 A-8457. FT-IR spectra samples I and II demonstrated a significant similarity (Fig. 3: 1, 2), especially with regard to organic components. The differences that are visible are products of secondary chemical processes (transformations of organic acids salt) and the presence of various mineral admixtures, which are present in bones, soils and random contaminations. An important observation is a well-defined spectrum, clearly differing from that of a charcoal with a thermally destroyed molecular structure. This demonstrates that the black dye used was not charcoal and was not exposed to such high temperatures (i.e. 900 ^{o}C), as applied in the production of charcoal. At the same time, it should be noted that there is a high probability of the wood tar having been used.

FT-IR spectra analysis suggests that the base for the production of material I and II was the bark and the wood of birch (absorption approx. 884 cm^{-1} and 730 cm^{-1}). In the case of material II the results demonstrates it was a bark covered wood (we found the absorption of esters at approx. 1730 cm^{-1}). The spectrum of material I is testifying to the lack of esters and the predominance of organic acids (the absorption at approx. 1650 cm^{-1}), which clearly leads to the conclusion that the basic raw material was bark and not wood.

The specific environment, however, could have led to the hydrolysis of esters and therefore one should take into consideration that in both cases the same material as material type II was used (if other circumstances do not indicate otherwise), while material I arose through hydrolysis and neutralisation of acids under the influence of environmental components, which is manifested in occurrence the strong broad absorption line, typical for carboxylic acids salt (1640-1650 cm^{-1}) and lack of absorption of free acids (1700-1720 cm^{-1}) as well as esters (1730 cm^{-1}). This may be related to the dye position, enabling the environment to chemically impact in the case of material I and creating difficulties in the case of material II.

Analysis of inorganic components with the use of SEM and EDS excludes the use of iron and manganese oxides as fundamental components of the dye in materi-

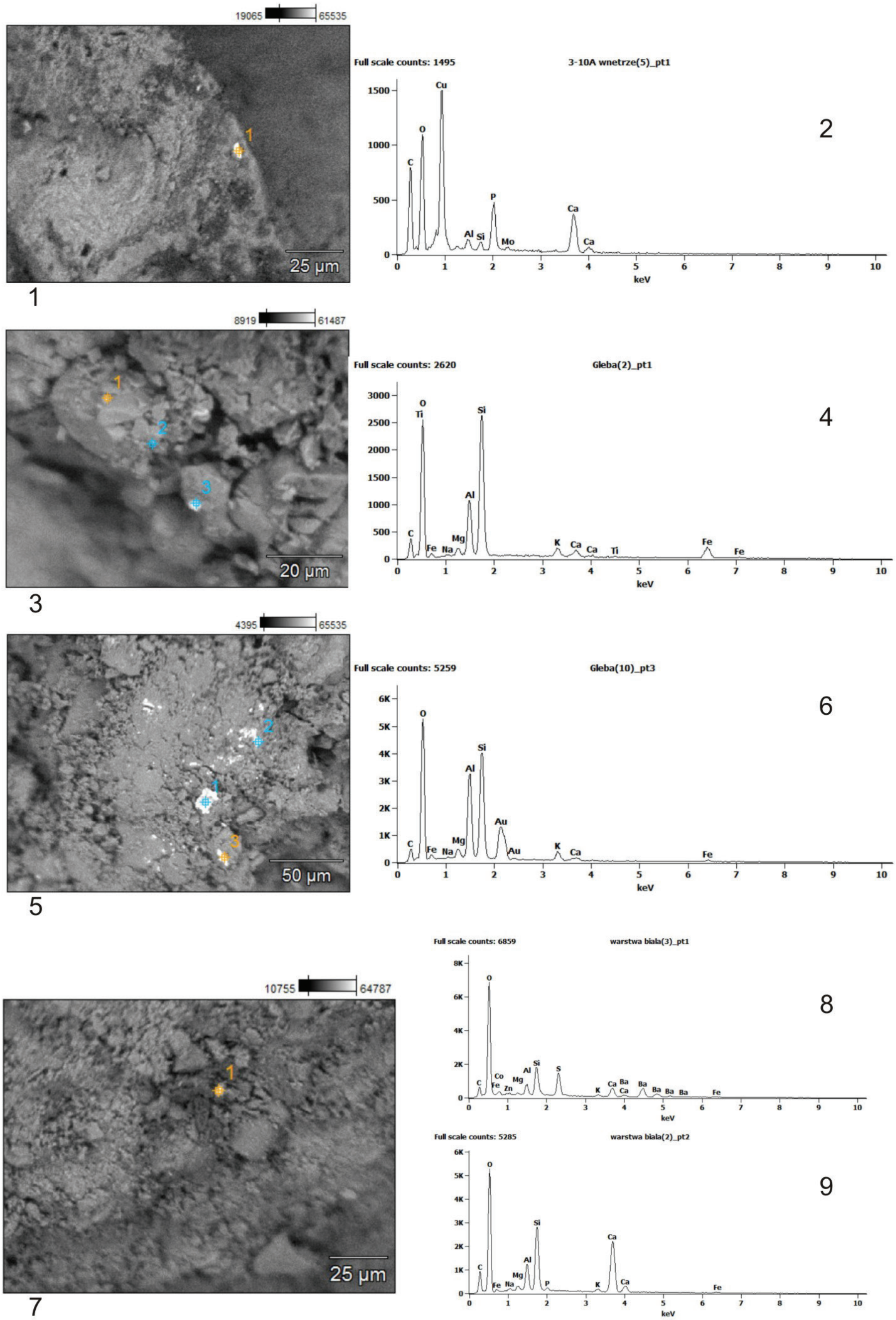
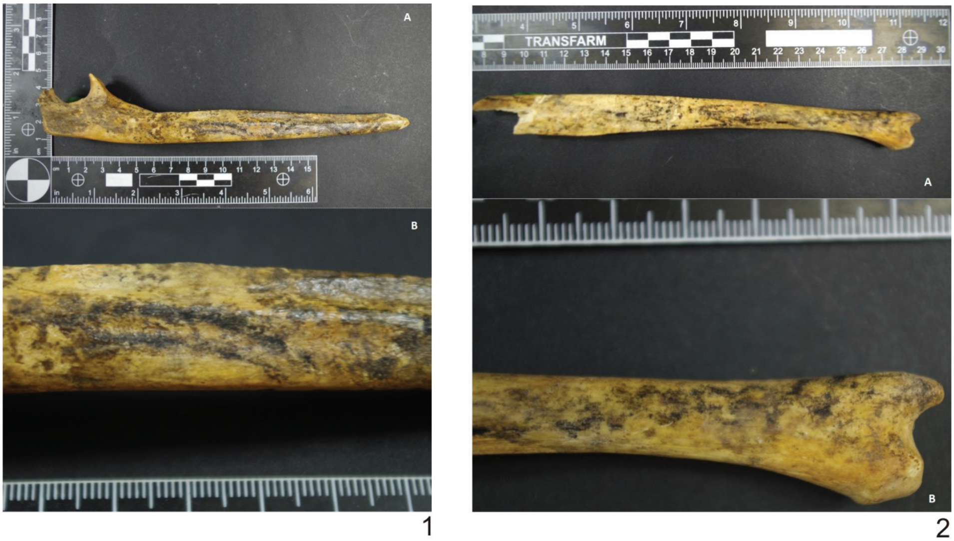


Fig. 7. Porohy, Yampil Region, barrow 3A, feature 10. Chemical analysis: 1, 2 – EDS analysis of samples 3-10; 3, 4, 5, 6 – EDS analysis of the surrounding soil; 7, 8, 9 – EDS analysis of “white layer” under burial – sample from around the head

Fig. 8. Porohy, Yampil Region, barrow 3A, feature 10: 1 – plan of feature; 2 – reconstruction of the burial by Michał Podsiadło; 3 – bones contain regular black patterns in situ; 4 – drawing of a ‘tattoo’

als I and II. In the analysis of samples there mainly occur elements of bone and clay (Na, Al, Mg, Ca, P, S, Si), at times also Fe and Mn, at the same time a lack of significant concentrations derived from iron and manganese, which occur only sporadically in the form of micro-particles (Fig. 3: 3, Fig. 4: 1-4). Phosphates dominate in the majority of samples, while some contain aluminosilicates. One should note that the presence of barium compounds has been confirmed (sulphate, carbonate) in the form of particles of about 10 micrometres in size (Fig. 4: 3, 4; Fig. 5: 1-3).



F i g . 9 . Porohy, Yampil Region, barrow 3A, feature 10. Macro- and microscopic examination results: 1 – right ulna with visible decorations and close-up of the decoration; 2 – left ulna with visible decorations and close-up of the decoration. Photo by D. Lorkiewicz-Muszyńska

To clarify the presence of barium, three bone samples without a dye (3-10A, 3-10B and 3-10C; Fig. 3: 4) were subject to analysis. It was confirmed that these contained particles of barium compounds on the surface and in part in the internal sections of the bones analysed (Fig. 6: 3-8; Fig. 7: 1, 2). Such particles do not occur in the surrounding soil (Fig. 7: 3-6) but are however, present in the mat under burial – a "white layer"; sample from around the head (Fig. 7: 7-9).

On the bones (i.e. sample 3-10 A, internal), some isolated particles were also found (5-10 micrometres) containing a significant amount of copper (Fig. 7: 1, 2) as well as (separately) gold (Fig. 6: 3-5), which is in the form of a tiny flake (micrometre size). The former, means of the position would appear to point to its incidental presence. The samples of soil under analysis and mats did not contain this type of addition (in a comparative and even greater context of observation).

2.2. RESEARCH IN ANTHROPOLOGY AND FORENSIC MEDICINE

a. Material and methodology

The subject of the comprehensive interdisciplinary research were human remains in the form of two ulnae from a female skeleton from grave 10 in Porohy 3A site, dated to Early Bronze Age: 2650-2500 BC (Fig. 8: 1, 2).

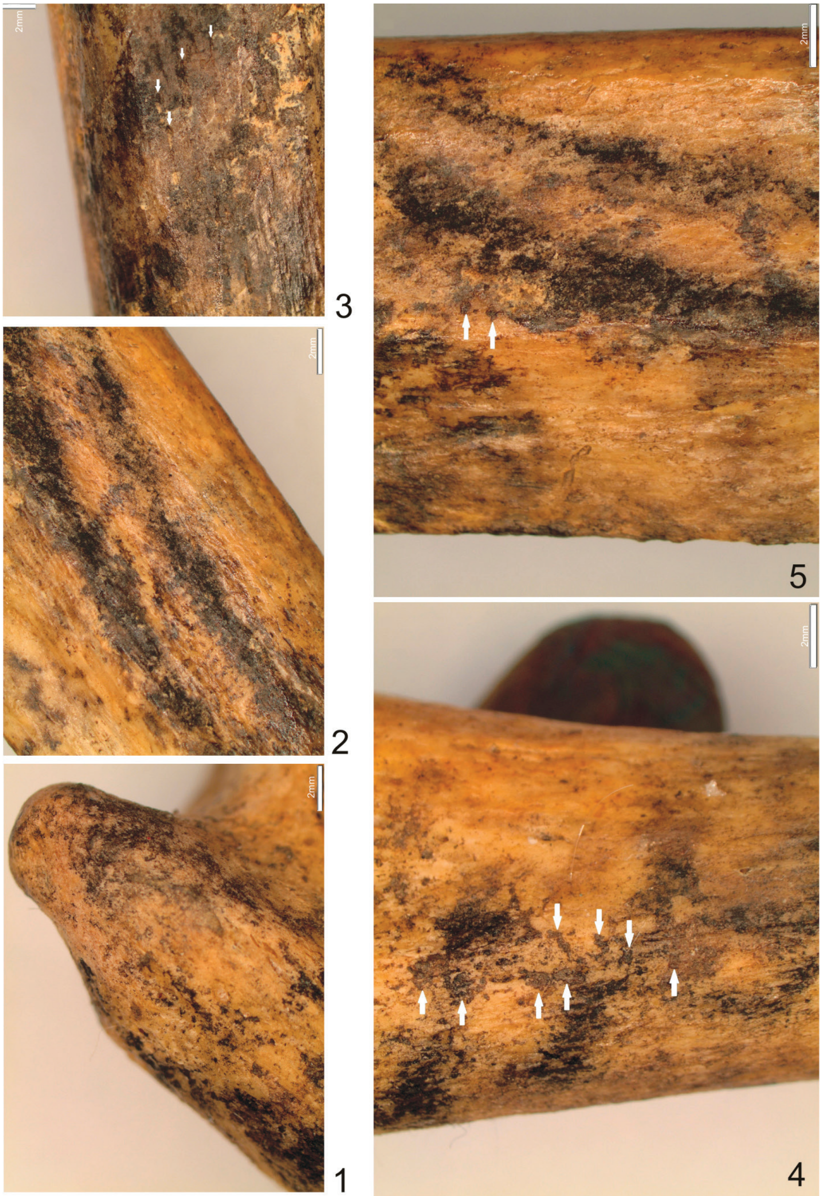
The ulnae were found to contain regular black patterns (Fig. 8: 3, 4), initially described as "tattoos" [Klochko *et al*. 2015: 104]. The detailed research was supposed to explain the mechanism used for their creation. Analyses were conducted as to the character of the decorations, their form, location, degree in which they cover the bone and the anatomic structure of the bones, anatomical attachments in particular segments of bone surface, as well as accounting for histological structure of skin unaffected by postmortem changes, and localization of the tattooing pigment as well as the processes occurring in human skin after death at different stages of postmortem changes.

The patterns on both ulnae were subjected to macro- and microscopic, and physicochemical examination. Observations were made using a stereoscopic microscope Olympus SZ61 to make a series of photographs. Additionally, photographic documentation was created using a digital reflex camera Pentax K30.

b. Macro- and microscopic examination results

Decorations on both ulnae are characterized by a high degree of regularity, maintaining continuity on the right ulna. In the case of the left ulna, the pattern is continuous over a considerable part of the bone, with signs of fading on approximately 1/3 of the shaft. The patterns on the right ulna are arranged into alternating longer parallel stripes in the shape of arches, with single, shorter stripes interlaced between them, similarly in the shape of arches (Fig. 9: 1). The patterns are located on the posterior bone shaft surface, between the posterior and exterior edge (interosseous crest). In some places, the patterns extend to the interosseous crest. The patterns stretch regularly over the interior and exterior part of the posterior surface of the bone shaft and the line formed between them, including the areas of attachment of the following muscles: the externsor carpi ulnaris muscle, the abductor pollicis longus muscle, the extensor pollicis longus muscle, the extensor indicis muscle [Senelnikov, Senelnikov 1996]. The decorations on the left ulna assume the shape of interlacing alternating lines forming a chain pattern (Fig. 9: 2). In the mid-section, they are shaped to resemble diamonds or triangles. Towards the top, they reassume the shape of a chain. Approaching the proximal end of the bone, the pattern is faded and hardly visible. Moreover, the damage suffered by the bone narrows the possibilities to assess the shape. The decorations cover a significant portion of the styloid process surface (Fig. 10: 1), which is the place of attachment of three ligaments, including its apex, to which the ulnar collateral ligament of the wrist is attached. Subsequently, the patterns run slightly upwards in a spiral fashion, and laterally along the bone shaft, covering, as in the case of the right bone, the posterior surface of the shaft. The pigment covers both the interior and exterior surface, as well as the linea between them.

Of particular interest is the location of the decorations on the analysed bones, i.e. their presence on the posterior shaft surface of both ulnae, oriented towards the back and laterally, on the side of the radius. Moreover, regularity and continuity



F i g . 1 0 . Porohy, Yampil Region, barrow 3A, feature 10. Stereoscopic microscope image: 1 – of a decoration fragment on the surface of the styloid process (left ulna), which is an attachment point for numerous anatomical structures; 2 – of a section of the pattern (right ulna) – visible regular patterns evenly covering the surface of the bone; 3 – of a section of the pattern (right ulna) – visible accumulation of the pigment in the natural openings in the cortical bone; 4, 5 – of pattern fragments (4 – left ulna, 5 – right ulna) – visible regular chain (4) and arc (5) patterns evenly covering the surface of the bone. Arrows indicate the presence of the pigment in openings resulting from natural erosion (4 and 5) of the patterns over the muscle, ligament, tendon and the interosseous membrane attachment points can be observed (Fig. 9).

The aspect of natural roughness and porosity of the bone and the manner in which the pigment was applied are of significance. Closer observation under the stereoscopic microscope revealed a high degree of regularity and good coverage of even surfaces of the bones. Absence of pigment was observed in some cavities where the surface of the bone was uneven (Fig. 10: 2), while on the edges of natural openings (i.a. *foramen nutricium*) a greater accumulation of the pigment was observed on one of the edges, consequently on the same side of each opening (Fig. 10: 3). Pigment accumulation on the edges was observed in the lateral part of the openings, considering the placement of the bones *in situ*. Pigment accumulation contrary to the forces of gravity may indicate the direction of pigment application and the force and pressure of the tool used to spread the pigment on the bone (Fig. 10: 3).

Considering the issue of time and technique used for applying the pigment, one must take notice of the parts of the bone affected by natural postmortem changes (decline) in the bone and the pigment it contains. During the microscopic analysis, pigment application to the cavities in the cortical bone occurring due to natural postmortem erosion of bone was observed (Fig. 10: 4, 5).

c. Skin structure

The histological structure of skin determines its ability to preserve the traces of dye used for tattooing. Skin is made up of two layers: the epidermis and dermis, with the hypodermis underneath (Fig. 11: 1). The photograph below illustrates the proper histological structure of skin unaffected by postmortem changes.

The main functions of the epidermis are isolation and protection. Over a human lifetime, the epidermis is subject to a continuous renewal process, and therefore regenerates constantly. Any damage to the epidermis does not lead to permanent changes – scars, and dye applied to the epidermis only cannot be sustained for longer than approximately one month.

The dermis contains numerous fibres of dense connective tissue which provide the skin with flexibility. They contain receptors, nerves, blood vessels, glands and hair roots [Bochenek, Reicher 2007; Senelnikov, Senelnikov 1996]. This layer performs the nutritive and protective function. Damage to the dermis, which is 1 mm to 3 mm thick, leads to scarring. In the process of tattooing, the dye is deposited in the upper layer of the dermis. The large amount of dense connective tissue present in this layer allows for maintaining the specific shape of the tattooed image for many years, while the inflammatory reaction which develops in response to insertion of needles and dye into the skin, as the dye is perceived as a foreign substance by the human body, leads to changes in the colour of the tattoo.

Under the dermis there is the hypodermis, built of loose connective tissue and numerous adipocytes, where receptors, blood vessels, lower sections of hair roots and glands lie.

F i g . 1 1 . Postmortem changes and skin structure: 1 – histological structure of skin unaffected by post-mortem changes: A – epidermis; B – dermis (x100) HE colouring; 2 – postmortem changes due to putrefaction; 3 – numerous blisters visible postmortem changes followed by exfoliation of the epidermis; 4 – post-mortem changes in the histological structure of the dermis – putrefaction (x100)1 – damaged structure of connective tissue elastic fibres; 5 – postmortem changes due to putrefaction. Numerous insect larvae visible; 6 – postmortem changes due to putrefaction and desiccation, partial skeletonisation. Further postmortem changes are those of preservative character. This indicates that late, long-term postmortem changes lead to the preservation of all or most of soft tissues along with the skeleton, for years or even centuries; 7 – a mummified corpse. Disintegration of desiccated skin visible on the back. Underneath, crumbling deeper layers of desiccated soft tissue; 8 – tattoos on corpses demonstrating late postmortem changes (putrefaction)

d. Postmortem changes

From the point of view of the broad interdisciplinary analysis of 'tattoos' (decorations) on bones, the postmortem changes occurring in the soft tissues of the body after death deserve particular attention. All the postmortem changes in the body can be divided into two groups: early and late [DiMaio *et al.*1993; Raszeja 2013]. The early changes include: pale appearance; cooling; rigor mortis; livor mortis and desiccation, with livor mortis and desiccation worthy of particular attention. As an early postmortem change, desiccation is a symptom of progressive loss of water resulting from evaporation through the skin tissue deprived of the *stratum corneum* – vermilion zone, conjunctiva, cornea and labia. As an early postmortem change, it does not lead to prolonged preservation of desiccated tissues for years after the death. Livor mortis occurs as a consequence of blood pooling in the lowest situated capillaries after circulation has stopped.

Shortly after death, the process of autolysis begins – spontaneous decomposition of tissues or cells of the body under the influence of its own enzymes, in aseptic conditions. Autolysis first begins in the organs rich in enzymes and sensitive to the lack of oxygen, such as the pancreas, the mucous membrane of the digestive system, the brain and the adrenal glands.

Late postmortem changes include putrefaction, skeletonization, adipocerous formation, peat bog transformation and mummification. Putrefaction refers to disintegration of tissues due to the activity of bacteria in the body after death. Under the influence of the enzymes produced by bacteria, complex organic compounds disintegrate into simple organic and inorganic compounds. Protein, carbohydrates and fats cleavage causes the production of gases with high concentrations of ammonia, carbon dioxide, hydrogen sulfide and methane. As a result of haemoglobin reacting with hydrogen sulfide, sulfhemoglobin and verdoglobin are formed, which explains the change of colour (green colouration) of the body.

Putrefaction spreads along the vessels as a result of the pressure of putrid gases inside the circulatory system and body cavities. Due to the pressure, displacement of tissue fluids in the skin occurs, followed by formation of liquid-filled blisters, detachment of the epidermis (Fig. 11: 2), and eventually exfoliation of the epidermis (Fig. 11: 3). As a result of putrefaction and the presence of large amounts of gases, internal organs and muscles become foam-like. The microscopic picture shows absence of the epidermis due to its complete detachment, thinning and fragmentation of dermal elastic fibres, as well as destruction of skin structure [Mills 2007]. Numerous spaces between particular bundles of elastic fibres of the dermis can be seen (Fig. 11: 4).

In periods of insect activity (spring-summer-autumn), corpses buried in relatively open conditions (similar to those discussed in the present study, such as pit graves, catacomb graves), may become the feeding grounds for insects in various stages of development (Fig. 11: 5), as well as for rodents, which significantly accelerates destruction of soft tissue.

The final result of putrefaction and decomposition of a corpse is its complete skeletonisation. One should, however, note that the postmortem changes in question do not occur equally throughout the entire body, but rather particular parts become skeletonised quickly as compared to other parts of the body (Fig. 11: 6).

Mummification occurs when a corpse is left in a very dry and airy environment, in relatively high or very low temperature (Fig. 11: 7). It should be noted that as a result of mummification all layers of soft tissue are preserved, including skin, muscles and tendons. Due to desiccation, numerous wrinkles and creases appear on the surface. These tissues, however, shrink and break with the use of even very little pressure, both on the skin surface and in the deeper layers. As a consequence of climatic changes (temperature, humidity) and the impact of insects and animals (e.g. rodents), postmortem destruction of the body may be accompanied by considerable loss of desiccated soft tissue (Fig. 11: 7), subsequently leading to complete disintegration of soft tissue and complete skeletonisation.

Adipocerous formation occurs in an extremely humid environment in the absence of oxygen. The process is based on the transformation of adipose tissue into adipocerous mass. It begins with hydrolysis and fat liquefaction, which leads to tissues soaking in and absorbing the above mentioned liquefied fatty substance. Due to the activity of anaerobic bacteria, a greater amount of saturated fatty acids are produced, together with grey-white tissue mass, initially semi-solid, which subsequently hardens because of predominance of saturated fatty acids over unsaturated ones. Soft tissues are preserved in its entirety, though they are rather fragile.

Peat bog transformation occurs when the corpse is interred in a peat bog. As a result of the presence of acids and tannin in this type of soil, the activity of bacteria is suspended and skin becomes tanned, muscles and internal organs decompose and bones decalcify. Postmortem changes of adipocerous and peat bog type should be excluded on account of the absence of conditions necessary for their occurrence, because of access to oxygen and the fact that the grave pit is not located in a highly humid environment or indeed in a peat bog.

Tattooing is based upon repeated breakage in skin continuity and contact with a needle, used to apply the dye to the surface layer of the dermis, containing a large number of elastic fibres of connective tissue. Currently, specialists use sophisticated devices allowing them to apply the dye into the skin at consistent depth, to the connective tissue in the upper layer of the dermis. In the past, when tattoos were applied manually using needles made out of a bone or wood, it was impossible to apply the dye each time to the same level of the dermis, and its application to the subcutaneous tissue resulted in complete absorption, due to the inflammation arising around it.

In the case of death and postmortem decomposition process, gradual destruction of soft tissue occurs, including the skin surface, resulting in deformation and destruction of tattoos (Fig. 11: 8), as the dye becomes homogenous with the elastic tissue of the dermis after the tattoo is made (Fig. 11: 4). The thickness of the dermis, where the ink accumulates, and the amount of ink applied to the upper layers of the dermis, need to be taken into account as well.

3. ’THE TATTOO BURIAL’: RITUAL POSITION AND EXECUTION TECHNIQUE

Discussion

The conclusions presented in chapter 2 make it impossible to qualify the *symbolic* decorations of interest, documented on the ulnae of the deceased female from grave 10 as tattoos. The complex analysis conducted on the bones indicates the application of a dye, most likely tree tar, posthumously onto the bones at the skeletonised stage, with minor damage from natural erosive changes already present.

Moving the application of symbolic decorations (‘tattoo’) to the post-skeletonisation stage of the interred creates new opportunities for cultural and thanathological interpretation: studies of the sequence and techniques of funerary rites and the attempts at placing them within the hypothetical concept of death theory, respected and observed by YC (or, more broadly speaking, YC/CC) communities.

The innovative nature of the above mentioned conclusions, resulting from the application of specialist analytical techniques, justifies, in our opinion, further discussion of the presented hypothesis in respect to the direction of future research as a means of its verification.

The deep pit grave in which the corpse had been placed (*see* Chapter 1) was situated in a steppe environment [Jankowski *et al*. 2017] and covered with oak planks [*see* Stępnik *et al*. 2017]. It is therefore likely that the ‘chamber’ remained accessible to air, insects and rodents and that postmortem changes happened rapidly in comparison to the changes in a corpse placed in an earth-filled grave. The sequence of changes in the above mentioned conditions could have happened in two possible ways:

– the most likely scenario is that the corpse was subject to progressive decomposition up to the point of complete skeletonisation within the period of approximately two years;

– mummification and further skeletonisation cannot be excluded, though the duration of such changes, from the theoretical point of view, cannot be predicted.

If one were to accept the most likely character of postmortem changes, that is putrefaction, it ought to be emphasised that penetration and multiplication of bacterial colonies took place within the skin and soft tissues, as well as between the clusters of elastic tissue of the dermis, where the decorative dye is deposited, and in the remaining layers of soft tissue. The activity of bacteria led to tissue degradation and its separation due to the production of gases and gradual liquefaction. These changes resulted in complete degradation of soft tissue structure, also visible in the histological picture of the skin (Fig. 11: 4). Such changes first lead to deformation of the decorative image and subsequently to its liquefaction along with soft tissue succumbing to the forces of gravity. It is therefore impossible for patterns applied to the skin (tattoos) to be imprinted onto bones after complete destruction of soft tissue. The tattoo dye cannot separate itself from soft tissue and remain on the bone, as it becomes homogenous with the elastic tissue of the dermis after the tattoo is made. The activity of insects (Fig. 11: 5) or rodents in this process, which can significantly accelerate postmortem changes and enhance the degradation of soft tissues along with the tattoo, cannot be ruled out.

In a variety of postmortem processes in a corpse leading in effect to its skeletonisation, the soft tissue degrades at different rates in different parts of the body. Such changes never occur in the same way throughout the entire body, as illustrated in Fig. 11: 6.

In case of mummification, however, soft tissues desiccate and wrinkle, while tattoos are deformed. It is often difficult to reconstruct precisely the design of patterns on desiccated, deformed and wrinkled hard tissue of mummified corpses. Barkova and Pankova [2005] point to the difficulties tied to discovery of tattoos on certain areas of skin surface on mummified corpses. In their research programme, infrared lamps were used in order to reveal all of the tattoos. Moreover, it was noted that the majority of the tattoos revealed were deformed due to the wrinkling of dried skin. For the purpose of revealing the complete outlines of the tattoos, it was necessary to illuminate and photograph the tattoos from various angles. Despite the application of a variety of reconstruction methods, small deficiencies were noted in specific fragments of these outlines.

In 2004 Russian scholars [Kyzlasov, Pankova 2004] published a work in which they detailed the results of research into the mummified remains of three people discovered by archaeologists in 1969. Tattoos were discovered within the skin layers of one of the mummies. Microscopic and macroscopic analysis showed that the black tattoo pigment was soot. The researchers noted that tattoo drawings were only preserved in fragments, while parts were lost along with damaged skin layers. In the photographs accompanying the publication, the shape of the pattern is clearly visible, discontinued at points of tissue damage, with parts of the skeleton and fragments of the crumbling layers of remaining soft tissue, devoid of any patterns whatsoever reminiscent of a tattoo.

Certain researchers of prehistoric graves [Shishlina *et al*. 2013] have analysed cases of decorations revealed on bones discovered in pit and catacomb graves. Shishlina *et al*. [2013] documented several cases of decorations revealed on bones made with a variety of materials (soot, coal and ochre). The researchers proposed a theory on the tattooing of skin, with transfer of dye onto bone after soft tissue disintegration, preserving clear shapes and patterns of the decorations. Their work does not suggest that detailed specialist analyses had been conducted with respect to bones with decorations, taking into account the nature of the decorated bone surface, detailed localisation of the dye with respect to the anatomical structure, nor indeed microscopic and chemical analysis.

The patterns visible in the burial from the Dniester Region, indicate that the dye was applied posthumously, directly onto the bone. These patterns cover both ulnae over a significant part of their length, with significant regularity of decorations and high level of dye coverage on the surface of both ulnae – including the attachment points of numerous anatomical structures (muscles, tendons and ligaments). A substantial amount of dye (most likely tree tar), thoroughly covering the surface of the analysed bones in the sections with visible decorations, should be noted.

Therefore, in the opinion of the authors, translocation of dye from soft tissue onto the ulna of the individual in question – grave no. 10 in Porohy 3A – is not possible, on account of a series of significant factors, such as the nature and course of postmortem processes and changes, the thickness of soft tissue in the area in question, the nature of anatomical structures, the highly regular character of the decorations and finally, the amount of dye applied.

CONCLUSIONS

Based on the anatomical properties of the structure of a human body, the histological structure of the skin and location of the dye used for tattooing, having conducted an analysis of postmortem changes occurring within the skin after death, and having taken into consideration the continuous and regular nature of the pattern on the ulnae of the individual from grave no. 10, an interdisciplinary team of researchers has concluded *that there is no possibility of a transfer of tattoo dye from the skin onto the surface of an individual's bone*.

The analysis of two ulnae documented in this article indicates that the patterns were made using tree tar, postmortem and directly onto the skeletonised human remains. The placement of the individual's ulnae in grave no. 10 (Fig. 10), and the location of patterns on the upper skin surface, that is, on surfaces accessible without changing the arrangement of the body, may suggest that the patterns were created on the skeletonised remains without the need to change their placement in the pit (= *in situ*).

The present conclusions ought to see the beginning of a wider research programme focused on the analysis of the techniques used to create *decorations on bones in "kurgan cultures" communities* in the context of the Pontic-Caspian Region.

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