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A Functional Analysis of Lithics of the Early Iron Age Yankovsky Culture: New Findings

We present the results of a functional analysis of lithics of the Yankovsky culture (800 BC to the turn of the millennium) from two sites—Cherepakha-7 and Solontsovaya-2, excavated over large areas during salvage works in 2015 and 2017, respectively. Such tools are traditionally described as axes, adzes, chisels, knives, spearheads, and projectile points. Certain findings of the functional analysis disagree with this classification. The question arises of the correspondence between formal typological and traceological criteria. For functional analysis, the so-called Keeley method, or High Power Approach, was used, along with the classification of polishing types, elaborated at Tohoku University (Japan). Functions of 28 of the 62 tools selected for high-precision functional analysis were assessed. The existing nomenclature of woodworking tool types is clarified, information on the technique of harvesting herbaceous plants and on leatherworking tools is significantly specified. More details are provided on tools involved in bone carving, as well as those used to open shells of bivalve mollusks. The High Power Approach has enhanced our understanding of the functions of stone tools, which, despite the use of metals, were basic in Yankovsky technologies. Further directions of traceological studies are suggested.

Keywords: *Primorye Territory, Early Iron Age, Yankovsky culture, functional analysis, lithics.*

Introduction

From 800 BC to the turn of the millennium, the Yankovsky archaeological culture was widespread over the southern part of Meritime Region (Primorye Territory). Over the almost 140-year history of studies (the first site was discovered in the last quarter of the 19th century), local historians and archaeologists have identified more than 200 settlements and other sites; determined the chronological period of this culture; recorded the characteristic features of settlements, technological and typological characteristics of artifacts; reconstructed the main components of the subsistence system; and identified cultural and economic characteristics of the Yankovsky population (Okladnikov, Derevianko, 1973; Andreeva, Zhushchikhovskaya, Kononenko, 1986; Brodyansky, 1987). Research is currently ongoing. Today, the main task is to supplement information about certain aspects of the culture

(Rowley-Conwy, Vostretsov, 2009; Lutaenko, Artemyeva, 2017; Zhushchikovskaya, Nikitin, 2019; Popov et al., 2021). A significant advantage of modern research is based on an integrated approach, involving a wide range of natural science methods in the study of archaeological materials (Zhushchikhovskaya, 2014, 2017; Popov et al., 2021), and the recent excavations over large areas of Yankovsky settlements (Lazin, Popov, 2019). The results of these studies provide more detailed information concerning controversial or problematic issues.

The functional analysis of lithics is one of the key topics in the study of the Yankovsky culture. Ancient sites produced abundant collections of typologically diverse stone tools. This means that stone products were regularly used and, accordingly, the activities with stone tools were significant. Hence, an accurate functional determination of lithic artifacts makes it possible to establish most reliably the nature and structure of the economy and productive activities of the Yankovsky population. Over the long history of study, researchers have published a whole series of works with undeniable significance and informational potential (Okladnikov, 1963; Okladnikov, Derevianko, 1973; Andreeva, Zhushchikhovskaya, Kononenko, 1986; Brodyansky, 2013).

The functional definitions of Yankovsky tools provided in various publications are based mainly on the method of direct parallels; on interpretations of morphological features based on the professional experience of the researcher; and on the context of artifacts' discovery (Andreeva, Zhushchikhovskaya, Kononenko, 1986; Popov, Rudenko, Nikitin, 2020). These methods have some disadvantages. There is no guaranteed coincidence of ancient and modern ideas about the rationality and usability of individual tools. The shapes of tools do not always help to understand their function, especially when it comes to knapping-products. In addition, products can be multifunctional. The use of the constantly developing experimental traceological method seems to be more effective (Semenov, 1957: 15–43; Keeley, 1980: 1–10; Korobkova, Shchelinsky, 1996: 3–25; Volkov, 2013: 94–149). The effectiveness of its application to Yankovsky artifacts, produced mainly from soft rocks easily subjected to polishing, is well illustrated in the publications of N.A. Kononenko (1978, 1982, 1986). Functional analysis of a series of tools made of chert and sandstone allowed the author to reveal "the functions of a number of items about which, until recently, there was no consensus among researchers (reaper knives and grinders)" (Kononenko, 1986: 130). In addition, the results of traceological studies shed light on the economic and productive activities of the Yankovsky people, namely, "to determine the economic variability of settlements… the share and level of development of domestic crafts and branches of producing and foraging economies" (Ibid.: 130–131). To date, these are the only published materials describing the experience of applying the use-wear method to Yankovsky artifacts.

The purpose of this study is to establish the functions of the Yankovsky polished stone tools by traceological analysis, and to correlate the findings with typological definitions.

Materials and methods

Functional analysis was carried out in the Laboratory for Integrated Archaeological Research and Examination of Cultural Heritage Objects of the Far Eastern Federal University (Vladivostok) in May 2019. It included the microanalysis of surfaces and the identification of reflective characteristics of polished areas on the tools' edges at high magnification, using the Keeley method, or High Power Approach (Keeley, 1980: 10–15). An Olympus BHM metallographic microscope was used to detect use-wear traces. The observation was carried out at magnifications from ×100 to ×400. The identified traces were determined according to classification of types of wear polishing (Fig. 1) developed by specialists of Tohoku University (Japan) (Akoshima, 1989; Kanomata, 2012; Serizawa, Kajiwara, Akoshima, 1982).

A series of lithic artifacts from the two sites excavated over large areas during archaeological salvage works was selected as material for research. The Cherepakha-7 settlement is located on the western coast of Muravyinaya Bay, in the northern part of Ussuri Bay (Fig. 2). Available radiocarbon dates in the range of 2830 ± 90 to 2150 ± 80 BP determine the period of existence of the Yankovsky culture in this region. The site also yielded redeposited artifacts from the Late Neolithic

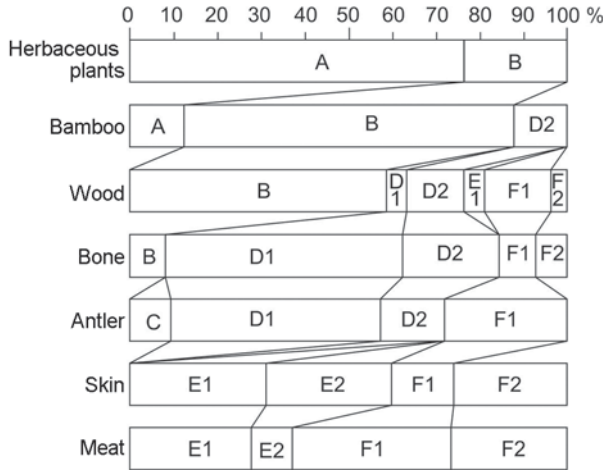

Fig. 1. Classification of polishing types (after (Akoshima, 1989)).

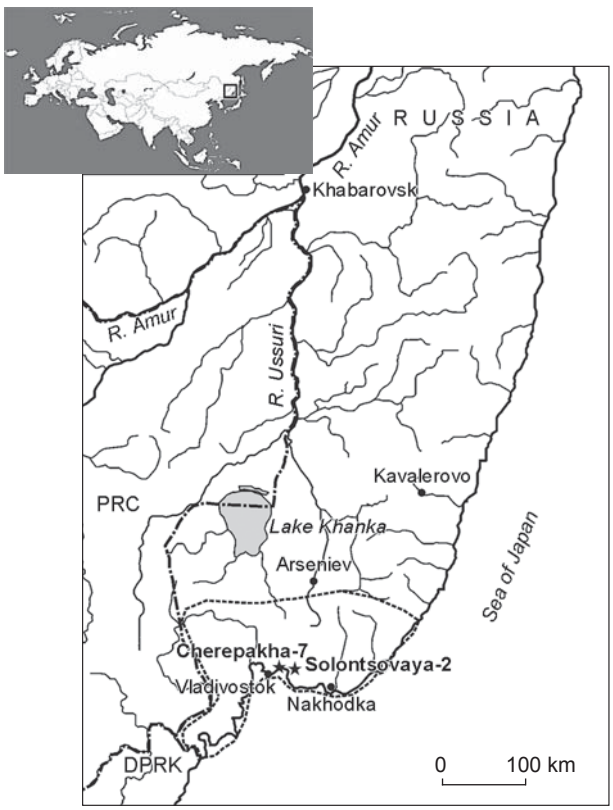

Fig. 2. Yankovsky distribution area (designated with dotted line) and locations of Cherepakha-7 and Solontsovaya-2.

Zaisanovka culture (Zhushchikhovskaya, Nikitin, 2019). The Solontsovaya-2 settlement is located on the right bank of the Solontsovaya River, in the Shkotovsky District (Fig. 2). Excavations at the site revealed layers bearing remains of the Early Iron Age Yankovsky and Krounovka cultures; solitary artifacts attributable to the Late Neolithic, Early Iron Age, and Medieval periods were also found. Radiocarbon dates in the range from 2670 ± 70 to 2510 ± 90 BP were obtained for the Yankovsky layer (Lazin, Popov, 2019).

The collections of Yankovsky lithics from the settlements under consideration are quite numerous: Cherepakha-7 yielded 853 artifacts (Popov, Rudenko, Nikitin, 2020), Solontsovaya-2 produced 2471 artifacts. A representative series of 120 specimens was selected for functional analysis, of which 62 tools suitable for microanalysis were taken through primary microscopic examination. According to morphological features, the sample included the following types: axes, adzes, chisels (37 spec., including fragments); reaping knives (10 spec., including fragments); knives (10 spec.); and spearheads and projectile points (5 spec., including fragments).

The raw material types have been conventionally determined through visual analysis, without the use of special geological methods.

Analysis results

As a result of microanalysis, various polishing types were recognized on 11 tools from Cherepakha-7 and on 17 tools from Solontsovaya-2 (see *Table*). We designate individual artifacts by their numbers in the field records, which simplifies the identification of tools.

Axes, adzes, and chisels. This set includes 37 items (27 intact and 10 fragments) made of andesite, chert, sandstone, and green tuff. These tools show rectangular or trapezoidal shape, rectangular or similar cross section, and symmetrical or asymmetrical blade. Traditionally, artifacts with the above characteristics are classified as woodworking tools.

Despite the fact that macro- and micro-facets of retouch were noted on the edges of 24 tools (Fig. 3, *6*, *7*), traces of use polishing subject to functional diagnostics were recorded only on eleven artifacts. These traces are of two types. The polishing type B (vertical striations), attesting to woodworking, was observed on the blade edges of four tools (No. 6704, 8346, 10208, and 10234; Fig. 3, *1–4*). On the back surface of axe No. 10208, there were

Functional definitions of lithics

No. in field records*	Artifact type	Raw material	Dimensions, cm	Blade sharpening angle, degree	Polishing type	Processed material	Striations	Function
S-10524	Adze (fragment)	Green tuff	4.5 × 4.7 × 1.2	50	E2/X	Skin	Vertical	Scraping
S-10183	Adze	"	9.3 × 4.4 × 1.1	41	E2/X	"	"	"
S-10267	"	"	8.0 × 4.7 × 1.3	32	E2/X	"	"	"
S-6051	Adze (fragment)	"	5.4 × 4.0 × 1.1	41	E2/X	"	"	"
S-10140	"	"	6.3 × 5.3 × 1.8	50	E2/X	"	"	"
S-10072	"	"	10.2 × 5.1 × 1.3	40	E2/X	"	"	"
S-10208	Chisel	Chert	5.8 × 2.6 × 1.6	48	B	Wood	"	Woodworking
S-10234	Axe (fragment)	Sandstone	10.4 × 6.0 × 5.1	70	B	"	"	Chopping
C-6704	Adze	Green tuff	8.1 × 4.0 × 1.2	52	B	"	"	Woodworking
C-8346	"	"	10.6 × 4.4 × 1.4	43	B	"	"	"
C-14505	Chisel	"	9.5 × 2.0 × 1.3	34	E2/X	Skin	"	Scraping
S-10493	Reaping knife	Chert	18.1 × 6.4 × 0.7	48	B	Herbaceous plants	"	Stem breaking
S-10356	Reaping knife (fragment)	"	4.7 × 5.4 × 0.9	45	B	"	"	"
S-9231	"	"	11.6 × 4.5 × 0.9	60	B	"	"	"
S-9831	"	"	3.4 × 2.0 × 0.3	32	B	"	"	"
S-10438	"	"	4.6 × 4.7 × 0.9	52	B	"	"	"
C-6708	Reaping knife	"	13.6 × 5.3 × 0.6	24	B	"	"	"
C-8344	"	Sandstone	12.3 × 5.5 × 1.0	48	B. A	"	"	"
C-8918	Reaping knife (fragment)	"	9.8 × 4.5 × 0.7	32	B	"	"	"
C-14731	"	Chert	7.4 × 4.4 × 0.7	74	B	"	"	"
C-6787	Reaping knife	"	3.7 × 5.6 × 0.4	26	B	"	"	"
S-10370	Knife	"	11.2 × 5.3 × 1.0	33	D2	Bone, horn	Parallel	Sawing, cutting
S-10474	"	"	9.4 × 6.9 × 1.2	43	B	Herbaceous plants	Vertical	Stem breaking
S-24194	"	Green tuff	7.5 × 4.5 × 1.1	32	?	?	Parallel	Cutting
C-14736	"	Chert	10.1 × 4.6 × 0.7	36	B	Herbaceous plants	"	"
C-15946	"	"	5.2 × 7.7 × 0.7	27	D2	Bone, horn	Vertical	Sawing, cutting
C-4509	"	Green tuff	7.2 × 3.0 × 1.6	37	D2	Mollusk shell	"	Opening
S-10104	Spearhead (fragment)	Chert	10.7 × 4.9 × 1.2	25	B	Herbaceous plants	?	?

*S – Solontsovaya-2, C – Cherepakha-7.

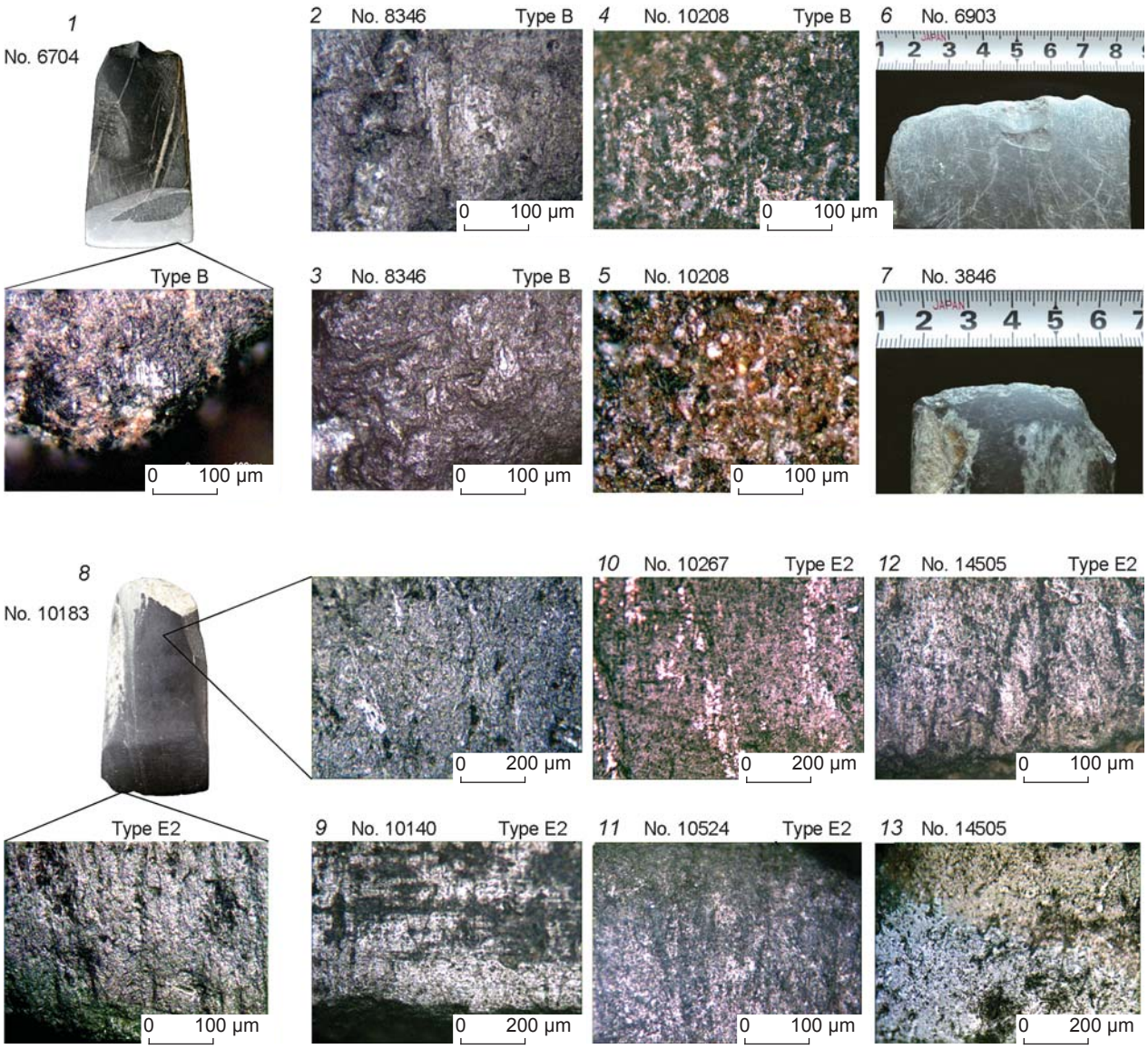

Fig. 3. Identified use-wear traces on the working elements of axes, adzes, and chisels.

typical polishing traces produced by the handle during the use of the tool (Fig. 3, *5*). The identified traces confirm the typological definitions—axes, adzes, chisels.

The polishing type E2 (vertical striations) was recognized on the blades of six adze-like artifacts (No. 6051, 10072, 10140, 10183, 10267, and 10524) and on the working surface of chisel-like tool No. 14505. The roundness and roughness of the traces suggest that the tools were used for scraping dry skin/leather (Fig. 3, *8–12*). Sometimes, soil tillage leads to a similar polishing (type X) on the edges of tools. However, the fact that the identified traces were spread over one side of the tool-edge indicates scraping. We assume that skins could have been scraped with the addition of sand, but this assumption requires further research. No other diagnostic traces of wear were noted on these artifacts. In some cases, hafting traces were recorded on three tools. The backs of artifacts No. 10267 and 10183 show polishing marks whose depth of penetration indicates the hardness of the contact material (Fig. 3, *8*). The widespread and bright polishing without linear traces noted at the base of tool No. 14505 (Fig. 3, *13*) also testifies to the handle-fastening. The obtained results allow the conclusion to be made that these tools were used as end-scrapers with handles for leatherworking.

The functional purpose of the tools whose working surfaces have no polishing traces can be determined by the edge damage and the macro- and micro-facets of retouch (Fig. 3, *6*, *7*). Such marks are the results of heavy blows over hard material. Taking account of the typological definition of artifacts, these implements can be identified as chopping tools. The analyzed set also contained two blanks of axes with typical dimensions of 16.6 × 5.7 × 3.8 and 16.3 × 5.7 × 3.4 cm (No. 12674 and 9500).

Reaping knives. The set includes 10 items (three intact and seven fragments) mostly of elongated rectangular shape with rounded edges, a slightly convex blade, and a drilled hole in the center. The microanalysis of the artifacts has shown polishing of type B, indicating work with herbaceous plants or wood-processing. Because these tools were made of chert and sandstone, use wear traces were found only in limited areas of the working surfaces containing harder minerals.

The clear traces of polishing of type B (vertical striations) have been observed at the edges of the blades of tools No. 10493 (on one side) and 8344 (on both sides) (Fig. 4, *1*, *2*). Less obvious smooth and rounded traces of this type (vertical striations) were noted on limited areas near the edges of blades on one side of artifacts No. 8918, 6708, 6787, 9231, 10438, 9831, and on both sides of tools No. 14731 and 10356 (Fig. 4, *3*–*5*). In addition, item No. 14731 showed the uneven density and distribution of polishing on its sides, one of which was in stronger contact with the processed material.

In the centers of artifacts No. 8918 and 14731, close to the holes, ground grooves were identified intended for the thinning of surface before drilling. In addition, these items and tools No. 10356, 6708 showed traces of rope fastening—areas of linear polishing directed from the hole to the back (Fig. 4, *6*).

Notably, in the middle part of the blade edge of tool No. 8344, along with the above polishing marks, clear traces of polishing of type A (vertical striations) were noted (Fig. 4, *2*), which are the result of overlapping of the polishing traces of type B. Another distinctive feature of this specimen is the

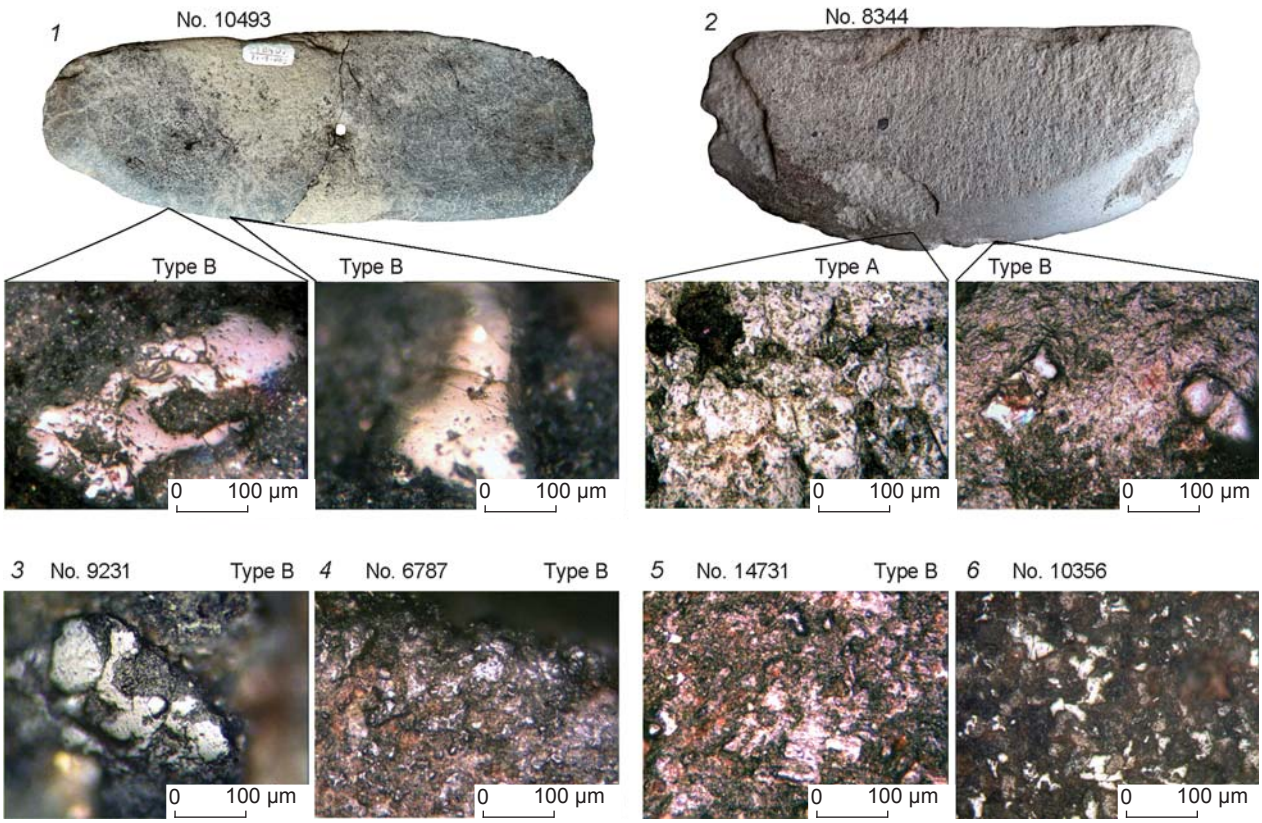

Fig. 4. Identified use-wear traces on the working elements of reaping knives.

method of rope attachment. Instead of hole, two notches were made on its lateral faces.

The distribution, shape, and direction of the recorded traces suggest that these tools were indeed used as reaping knives, which were attached to the hand with a rope. The plant harvesting was carried out by vertical movements, with rotation of the wrist towards the body while holding the stem with the thumb.

Knives. The sample includes 10 intact artifacts with sharpened and ground edges. The artifacts have been classified into two groups by design: with an arcuate blade and the presence of a deliberately distinguished handle (3 spec.); and with a blade prepared on fragments of tools or production waste (7 spec.). In the first group, two artifacts showed diagnostic use wear traces. Uneven double-sided polishing of type B (vertical striations) were traced on the edge of knife No. 10474 (Fig. 5, *1–3*). The blade was fashioned perpendicular to the long straight handle. The features of the revealed traces suggest that this tool was used for the same operation as the reaping knives described above.

Double-sided polishing of type D2 (parallel striations) was observed on the working edge of specimen No. 10370, with a beveled blade and a short straight handle (Fig. 5, *4–6*). The recognized traces indicate that the knife was used for cutting or sawing bones or horns. A distinctive morphological feature of this tool is a drilled hole in the center of the handle.

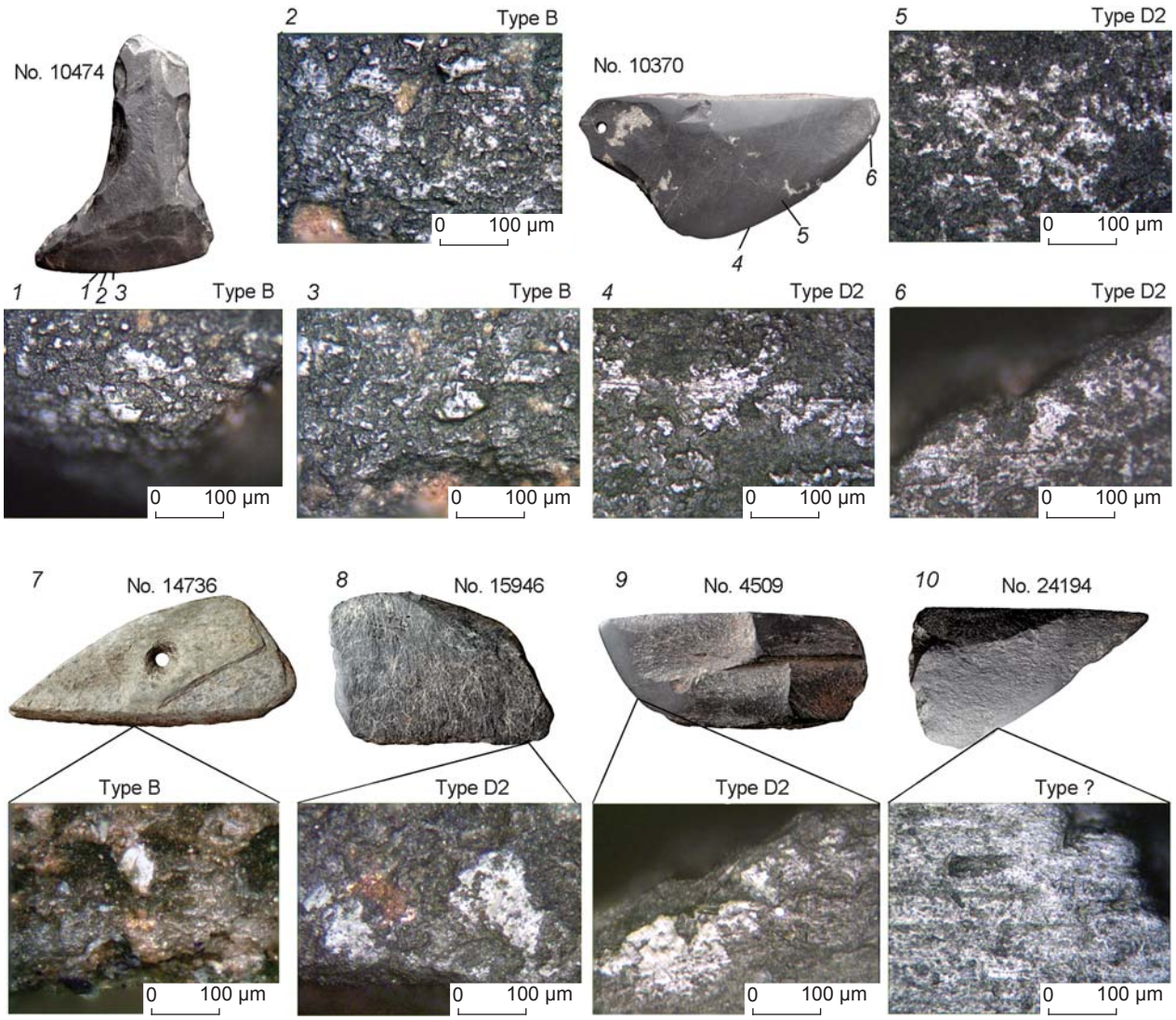

Fig. 5. Identified use-wear traces on the working elements of knives.

In the second group, diagnostic wear marks were identified on four knives. Barely noticeable polishing of type B (parallel striations) was recorded on limited areas near the edge of tool No. 14736 (Fig. 5, *7*). The noted use traces indicate that the tool was used for cutting plants. It is noteworthy that this artifact was made from a fragment of the middle part of a reaping knife.

Polishing of type D2 (clear vertical striations) was found in the separate areas of the blade formed on one of the faces of a fragment of chert tablet No. 15946 (Fig. 5, *8*). Judging by the features of the traces, the tool was used as a knife for processing bones or horns. The working blade prepared on the sharp face of a fragment of chopping tool No. 4509 shows areas of polishing of type D2 (clear vertical striations), which are brighter and smoother than on knives No. 15946 and 10370 (Fig. 5, *9*). This item was apparently used to open shells of bivalve mollusks.

The sharp face of a fragment of chopping tool No. 24194 reshaped into a working blade, shows polished areas (parallel striations), which type could not be determined. The character of abrasion and the direction of wear marks (Fig. 5, *10*) suggest that this knife was used to process soft material.

Spearheads and projectile points. There are five artifacts (two intact and three fragments). Judging by the dimensions of the artifacts and the shape of their wings, tips, blades, and nozzles, they were classified as spearheads and projectile points. Polishing subject to functional diagnostics was recorded on only one artifact. However, traces of wear indicating the use of the specimens were found on three points.

A comparatively small area of polishing was traced along the edge of an asymmetrically sharpened blade on one side of spearhead No. 10104, made of gray-green chert (Fig. 6, *1*). The isolated traces of wear do not allow us to classify its type reliably. However, their roundness and localization suggest the attribution of the polishing to type B. Probably, after disposal, the spearhead was used secondarily, as a tool for the processing of herbaceous plants. These data are of special interest for the analysis of the morphological features of the item. The leaf-like shape with a rhomboid rib, as well as the specified character of the blade-sharpening, indicate that this artifact belongs to the Lidovka culture of the Early Iron Age (Dyakov, Konkova, 1981). However, the context of discovery, and traces of reuse in the form of drilled biconical holes, as well as evidence of secondary use, suggest the use of this point also in the Yankovsky period. Notably, no traces of contact with rope were observed in the areas of the holes.

Wear marks in the form of deep long grooves running parallel to each other and forming a kind of flute in the center of the artifact (Fig. 6, *2*) were noted on projectile point No. 12843 with elongated blades. The grooves run from the stem to the tip of

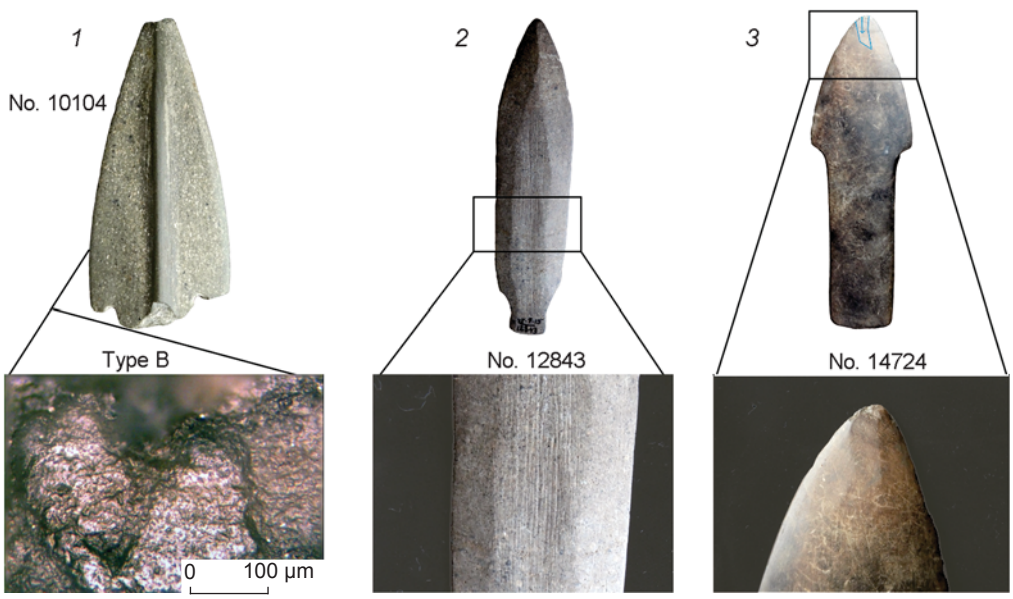

Fig. 6. Identified use-wear traces on the working elements spearheads and projectile points.

the point. The macro-traces of wear indicate that this point was fastened on the shaft, and also mark the approximate area of fastening.

A trace of a crack formed as a result of a thrusting motion was noted at the tip of the asymmetrically triangular blade of spearhead No. 14724 (Fig. 6, *3*). The damaged area was almost completely destroyed in the process of re-modification, re-sharpening, and polishing of the head.

Discussion

Despite the small size of the analyzed samples (62 spec.), we managed to draw a number of interesting conclusions and to outline promising directions for further research. First, the derived results propose a new insight into the existing typological classification of the Yankovsky lithics. Among the implements traditionally considered as woodworking tools (adzes and chisels), end-scrapers for leatherworking were identified for the first time. It is noteworthy that they were found at both settlements. A rectangular or trapezoidal shape and a rectangular or similar cross-section, as well as an asymmetrically sharpened blade, are common morphological features of adzes, chisels, and the identified end-scrapers. The end-scrapers show the following features: clear polishing spread all over the tool, average dimensions in the range of 9.2 × 4.6 × 1.2 cm, blade-sharpening angle in the range of 32° to 50°, raw material green tuff, and absence of heavy edge damage. These characteristics quite conditionally distinguish the products intended for skin-scraping from woodworking tools, because they are also typical for the latter. Hence, the only way to identify adze-like and chisel-like end-scrapers reliably is functional analysis. Available publications on the Yankovsky culture do not provide information about the appearance of tools for skin-scraping. This is despite the fact that skin-processing took a significant part in the production activities of the ancient population (Andreeva, Zhushchikhovskaya, Kononenko, 1986: 149–176). It is noteworthy that the tools under discussion were fastened on the handle. There is no information about the composite structure of end-scrapers from the earlier periods in Primorye. Relying on the published functional studies of such tools of the Old Koryak culture (15th–17th centuries AD) (Takase, 2011), we can suggest two possible options for the location of the working blade in relation to the handle: perpendicular or parallel to its length axis. This issue requires further research. However, even now we can say that the identified end-scrapers with handles not only expand our knowledge about the leatherworking toolkit, but also specify information about the technique and structure of this craft.

Second, the microanalysis of the working surfaces of the reaping knives confirmed the information about their functions that was derived earlier by comparing our data with the results of traceological studies by N.A. Kononenko (1978), and also reconstructed the process of using these tools.

Third, among the analyzed knives, we were able to identify two for processing bones and horns, and one probably used to open shells of bivalve mollusks. Judging by the importance of bone carving and the great role of collecting mollusks in the subsistence system of the Yankovsky population (Andreeva, Zhushchikhovskaya, Kononenko, 1986: 149–176), we assume the existence of specialized tools for these activities. However, this issue requires the analysis of functions of a larger sample of knives.

A fairly large number of artifacts with macro-traces of use (edge damage, linear traces, grinding, etc.), but without traces of functional wear (34 spec.), in our opinion, may be a consequence of the reuse of these tools: re-modification in case of breaking or resharpening of the blade. The evidence supporting this assumption is recorded in the results of the analysis. Other options involve a short use of tools, as well as the destruction of polishing marks during archaeologization of the artifacts; but they do not disaffirm the above.

Conclusions

As a result of the traceological study, the functions of 28 stone tools from the collections of Yankovsky artifacts from the settlements of Cherepakha-7 and Solontsovaya-2 were determined. The obtained data clarify the existing type list of woodworking tools, and add significant information on the technique of collecting herbaceous plants and on the set of leatherworking tools. Tools for processing bones and, probably, for opening shells have been identified.

One of the most interesting results was the identification of function of the products that were traditionally considered chisels and adzes based on their shape and, accordingly, were attributed to woodworking tools. It turned out that the well-polished medium-sized adze- and chisel-like tools are end-scrapers for dry-skin working. At the Yankovsky sites, such tools most often occur in their intact form, without traces of strong blade damage—in contrast to chopping tools.

The derived results indicate the need to develop traceological studies of artifacts of the Primorye archaeological cultures. However, currently, there is a lack of experts in traceology engaged in macro- and microanalysis in Primorye. Implementation of this method will make it possible to specify, significantly, information about the subsistence system of the ancient population.

Promising directions for further functional research are the clarification of data on the technique of using the identified end-scrapers and their attribution to the longitudinal or transverse type; detailed analysis of a representative series of knives for identification of specialized groups; and microanalysis of tools with known functional purposes for more detailed reconstructions of the processes of their use.

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