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3.1. Manufacturing techniques and use

Abstract: The purpose of technological and functional studies on the ornamented antler artefact from Rusinowo was to reconstruct the stages in its lifecycle. They involved identification of macro- and microtraces formed on the object during its manufacturing process and later use. The results of the use-wear analysis were supplemented by input from a series of experiments. They helped in reconstructing the history of the artefact, starting from the deliberate selection of its raw material, preparation of the necessary tools and the antler itself for working, the manufacturing process, and finally, the apparently extended use-life. Studies suggest that the use of the object definitely fitted a symbolic rather than a strictly utilitarian sphere, with some indications that the object had a relatively extended use-life within the communities involved in its manufacture and safekeeping.

Keywords: antlerworking, technology, use-wear analysis, artefact biography

Introduction

An archaeological artefact bears traces of past processes and operations, as well as of events in which it took part, passively or actively. These traces, available for examination today, are a source of knowledge about successive phases in the lifecycle of that object, mostly its final moments, but not infrequently also those that reach back to the time of its origin. Trying to reconstruct as fully as possible the history of the ornamented artefact from Rusinowo we decided to study the methods of its manufacture and manner of use. One element of the jigsaw puzzle helpful in piecing together the biography of an artefact is use-wear analysis (van Gijn 2010). Traces identified with the use of this method on the artefact from Rusinowo served as a basis when pondering the technology and uses of this object by the people living in the Central European Lowland at the close of the last Pleistocene interstadial (GI-1) and at the beginning of the later period of colder climate, the Younger Dryas (GS-1).

The artefact is a rare find because of its form, material and chronology (cf. remarks in chapter 4). From this period, from the central region of the

European Lowland we have only a small number of antler artefacts (Rust 1943; Kozłowski, Kozłowski 1977; Galiński 1990; Cziesła 2000, 2001, 2002, 2004; Beran 2001; Baales 2006; Cziesła, Masojć 2007; Gramsch, Beran 2010; Sobkowiak-Tabaka 2011; Płonka 2012) which makes the manner of working this raw material and range of uses of objects manufactured from it having a utilitarian and symbolic purpose still not fully recognized. They are based on analysis of the form of finished artefacts, artefact preforms, and manufacture waste, as well as on macroscopically identifiable traces of working.

In view of the status of studies in the technology of the working of osseous materials and their uses at the end of the Palaeolithic in our project, we set ourselves a number of objectives. First, to identify and describe in detail all the stages of shaping the object, complete with specifying the conditions in which the work took place. It was essential to recognize methods used in preparing the raw material for working and the tool types used during this work. The next objective was to recognize in the most detailed manner the stages of the process of work on the

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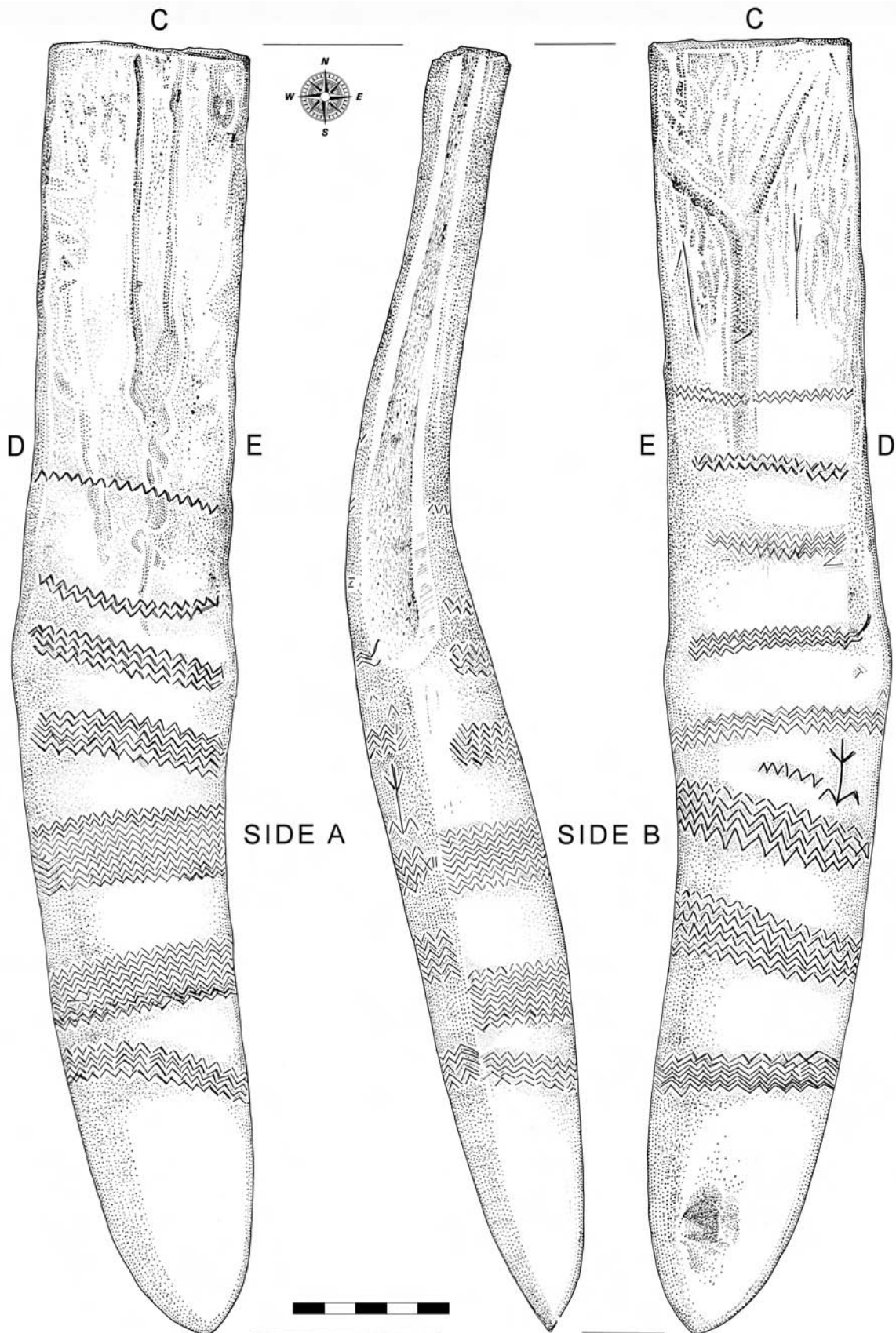


Fig. 1. Rusinowo. The antler artefact, the terminology used in the discussion. A: side with a zigzag ornament, without the anthropomorphic representation; B: side with a zigzag ornament, with the anthropomorphic representation; C: plane of truncation of the base; D: plane of truncation of the side; E: plane of truncation of the side. (Drawing T. Demidziuk)

engraved ornament, to explain matters related to the technological skills of Palaeolithic artisans, the time of manufacture of the ornament, and consequently, the meaning of this object for the people of the time. As a next step, an attempt was made to recognize the function of the object by analysing damage resulting from its use. Finally, the last objective was obtaining data supplementing the general model of antlerworking in the period of interest. In view of the character of research methods used in this task, we needed to assess the state of preservation of the artefact's surface.

Another question originally to be confirmed in the course of the technological studies was the provenance of the artefact. These studies were run independently of the results from the radiocarbon dating of the artefact, as it was thought feasible that the ornament had been executed on an older antler. A small number of similar studies which brought in technological data confirming the chronology of

artefacts made of antler have been made for younger periods – the Mesolithic and the Bronze Age (cf. Diakowski, Płonka 2010; Diakowski 2011). In the case of the object from Rusinowo, chronological determinations would open up the way for various ideas about the function of this object, depending on its dating. The radiocarbon age of the artefact measured using the accelerator method has been determined as $10\,700 \pm 60$ BP (10 780-10 610 BC) (Poz-14541), that is, the transition from the Allerød interstadial (GI-1c-a) to the Younger Dryas (GS-1).

In the description of the artefact, we used a convenient scheme, dividing the object into five sides/surfaces, A-E (Fig. 1). Particular traces were located by orienting the object according to theoretical cardinal points, assuming that its apex points south, and its base points north. Thanks to this kind of scheme the description of particular component parts of the object became much easier and more transparent.

Methods

In the studies of the technology of manufacture and function of the object from Rusinowo we employed the use-wear analysis to examine macro – and microtraces resulting from manufacture and use. This method was first developed by S.A. Semenov (1964), and was later expanded upon – in the field of analysis of artefacts made of osseous material – by G.M. LeMoine (1994), F. d'Errico (1993b, 1994) d'Errico, Villa (1997), Fritz (1999), H.J. Greenfield (1999), A. van Gijn (2005, 2007), I. Sidéra and A. Legrand (2006, 2007), Ch. Gates St-Pierre (2007), Y. Maigrot (2003, 2008), R. Christidou (2008), N. Buc (2011) and others. The microscopic examination of the ornamented artefact was supplemented by experimental work contributing to a more comprehensive and in-depth interpretation of the observed traces.

The use-wear method

The microscopic examination of the find from Rusinowo was made in reflected light using optical microscopes – Olympus ZSX9 stereomicroscope (6.3-57×) and Nikon ECLIPSE LV100 metallographic microscope (50-500×), at the Laboratory for Archaeological Conservation and Archaeometry of the University of Wrocław Institute of Archaeology. The studies included the recording and interpretation of different categories of traces. The largest group among them were linear traces of different origin – striae, furrows and longitudinal undulations. They had survived on the surface of artefact and on fracture surfaces. In some parts of the find, there were also some other forms of mechanical breakage, polish and smoothing observed.

Prior to the microscopic examination, the surface of the find had not been cleaned. Only the impurities found inside the ornament had been removed. This was done mechanically, using compressed air and dental instruments with synthetic tips, after a preliminary inspection, photographic documentation of the entire surface of the find at magnifications of 6.3×, 12.5×, 25× and 40×, and making laboratory analyses of the residue (see subchapter 3.3). During the microscopic examination we used plain cotton gloves.

The analysis of the manner of execution of the ornament consisting of engraved lines forming patterns on both sides of the artefact necessitated the use of scanning microscopy (d'Errico 1988a, 1988b, 1994; Fritz 1999). The surface of the artefact was recorded in detail at an optimal magnification and high resolution obtaining its image in 3D. This was done with Zeiss Evo LS15 scanning microscope at the Laboratory of Electron Microscopy, Wrocław University of Environmental and Life Sciences. To obtain samples of a size required by this apparatus an exact copy of the find was made and also some casts of its surface and of its small fragments covered by the ornament. Epoxy resin casts were made by Jolanta Kosińska. The technology used in making the copy not only enabled the faithful reproduction of the artefact's form but also of traces surviving on its surface. The moulding material used when making the artefact casts was two-component silicone RECKLI Si-Compound translucent. The resin casts were made from epoxy resin RECKLI Epoxy

LB. Samples were coated with gold using ScanCoat6 (Edwards) and viewed with a SE1 detector, at 10 kV filament tension. Examination with the scanning microscope included the analysis of cross-sections of the engravings of the ornament, especially at the starting and ending point of the stroke and in the medial part of the line, checking the intersections and studying the angles of inclination of the walls of the engravings in relation to the surface of the artefact.

The traces observed on the artefact provided a basis for identifying individual technological and utilitarian actions associated with different stages of manufacture and use of the object. Interpretation of the results of the use-wear studies was made primarily on the basis of these available reference materials:

1. models of technological breakage and use-damage developed by the authors of the present chapter over a course of experimental studies involving the working of the antler of red deer and reindeer and use-wear studies of bone artefacts from the Stone Age (Diakowski, Płonka 2010; Diakowski 2011; Kufel-Diakowska 2011),
2. results of experiments and analysis of use-wear on bone artefacts worked with tools made from silicate rock published by other authors (Averbouh, Provenzano 1999; David 1999; Lindemann 2000; d'Errico *et al.* 2003; Ramseyer 2004; Sidéra, Legrand 2006), including incisions and the engravings (Greenfield 1999; d'Errico 1993b; 1994; d'Errico, Villa 1997; Fritz 1999; Bello, Soligo 2008).

Problems related to the technology and use which came to light after the preliminary macro- and microscopic examination of the Rusinowo find turned out to be more complex than expected. Not all the features of the traces observed on the surface of the artefact could be identified by correlating them with existing models and descriptions. Moreover, previously no experimental work had focused on elk antler (*Alces alces*), or at least, their results were not known to us. The interpretation of some of the optic images necessitated additional experimental studies designed to assist the identification of the origin of traces visible in these images. Observations made during the experiments became a vital part of the collection of comparative materials in the studies of the ornamented object from Rusinowo.

Experiments

The purpose of the experimental programme addressed on the working and use of antler of elk (*Alces*

alces) was verification of assumptions made during the preliminary macroscopic and microscopic examination of the find. They were related to variously detailed conclusions made with regard to the raw material and technology. The experimental process was divided into three stages. The first of them involved an attempt to obtain antler replicas similar in their shape to the Rusinowo find, not so much in their dimensions as in the technological traces. The replicas of the artefact were manufactured with care taken to have a complete operation chain. In this way, we identified the sequence of actions leading to obtaining the preform of the analysed artefact. Furthermore, an attempt was made to identify the type of lithic tools which had been employed during these actions. A significant element in these experiments proved to be the method of raw material preparation for working. The experiments were made on variously prepared surfaces: dry antler, without soaking, antler briefly soaked in water (two minutes), and antler soaked for a longer time (a few hours). Next to immersing the shed antler in clean water, which causes a softening of the surface parts of this material, the raw material was soaked in water with an admixture of wood ash mixed with grease. Some of these methods had been tested earlier on red deer antler. The most effective method proved to be the brief but repeated soaking in water (Osipowicz 2007). The working of fresh antler was not tested because no suitable raw material was available.

The second part of the experimental programme was devoted to making the engraved ornament, in which process less care was taken to exactly replicate the patterns visible on the artefact, only to resolve technical issues, possibly also related to the symbolism of some actions. We tested whether it is possible to detect differences in the engravings depending on the direction of the work, continuity of motion and breaks made between the consecutive engravings, the divergence between single – and multiple-episode engraving. We also tested the impact of the type and condition of the antler surface (dehydration, resoaking), on the quality and technique of the executed ornament. This is why the ornaments were engraved at different time intervals, rather than at a single sitting, on the dehydrated and soaked antler. The engraving was done with flint tools – burins on truncation and snapped flakes held directly in the hand. Bone and antler working tools rarely have traces of hafting, presumably because they rapidly became damaged. The burin was worked in two ways: engraving with its burin edge, or using the lateral edge of the burin facet (similar to a snapped

flake or blade). In this way we tested how the type of the working edge of a flint tool and microchippings affect the quality of the engravings.

Testing the function of the elk antler artefact using the finished replicas was the third, last part of the planned experiment. This was the hardest part given that the ornamented object unearthed at Rusinowo could have remained in circulation for a long time, or could have been used in a way which did not leave evident traces of use on its surface. Several tests were carried out, designed on the basis of the use-wear observed on the artefact. The mechanical action involved ramming the replica into the sand and hitting with its flat surface against the ground. We also studied the effect of dying embers of a fire on the surface of the antler. Experiments were also carried out to see what traces could be obtained by extended action addressed at the surface of the object. In order to do this, one of the replicas, wrapped in deerskin, was carried with some pauses, for 48 hours, with the deerskin being wrapped and unwrapped repeatedly. Moreover, the zigzag ornament on the surface of the replica was rubbed repeatedly with a finger.

As we were planning the experiments, the greatest problem turned out to be choosing the right raw material to be used in the experimental work. At first, we tried working fossil antler of elk. However, the antler turned out to be too weathered and fossilized to be of use in testing technological actions and methods of softening the surface. In the end, three shed antlers of elk were used in the experiments: two of “cervine” (or pole-horn) type, similar to the antlers of red deer, submitted by Jan Reklewski of the Education and Environmental Monitoring Unit of the Kampinos National Park (Fig. 2), and a pair of palmate (shovel-horn) type originating from north-eastern Poland (Fig. 3). The antlers weighed respectively 1.69 kg, 2.13 kg and 1.36 kg. The antler was worked using artefacts made from erratic flint: burins, blades and flakes. These tools were used without hafting, held directly in the hand, to guarantee precise control over the movement of the tools and to administer the right amount of pressure.

The experiments were carried out mostly in laboratory conditions, enabling direct documentation of the experiment results (documenting the use-wear traces) and precise measurement of conditions of the experiments, eg, water temperature, acidity of substances used to soak the antler, work time and morphometric traits of the flint tools. Most of the experiments were carried out at Laboratory for Archaeological Conservation and Archaeometry of the University of Wrocław Institute of Archaeology.



Fig. 2. Elk antler of cervine (or pole-horn) type used in experiments. (Photo M. Diakowski)



Fig. 3. Elk antler of palmate (shovel-horn) type used in experiments. (Photo M. Diakowski)

Furthermore, care was taken to have the scenarios the closest as possible to those known to Late Palaeolithic hunters and gatherers, taking into account techniques of working of that age, tool types and resources afforded by the natural environment. The experimental works were documented on experiment

Experiment number	Artefact no.
Raw material	
Type of tool	
Working edge angle	
Motion	Type of activity
Duration of work	
Working material	
Hafting	
Usewear on flint tool	
Technological traces on antler	

Fig. 4. Experiment recording sheet

recording sheets (Fig. 4) and traces obtained on the replicas were tested and recorded in a manner analogous to the traces observed on the artefact.

Since the experimental work was mostly in the nature of a verification, meaning that it involved testing assumptions formulated on the basis of observation of traces and engravings on the archaeological object from Rusinowo, the description of experiments is not presented in a separate chapter. The relevant experiments are presented here when discussing individual phases of manufacture (see below). It is there that the reader will find descriptions of particular forms of traces revealed within the study of the ornamented object.

Preservation state of the artefact and its appearance

The artefact is made from the beam of the antler of elk, partly cut out from its palm, with some of the natural surface still in place, with the inner spongy substance exposed on its sides (cf. sub-chapter 2.3.). The artefact weighs 0.9 kg, has a length of 40 cm, a width of 7.5 cm, and a thickness of 4.5 cm. Surfaces A and B are covered by engraved geometric patterns of zigzag lines running approximately at right angles to the longer axis of the artefact; individual groups comprise between 2 and 11 lines, only on side A, next to 6 groups of zigzags, there is additionally a solitary zigzag line. On side B there are 8 groups of zigzag lines and additionally a figural motif composed of short lines creating a geometric representation of a human figure which is accompanied by a short zigzag line. The artefact has survived in a very good condition. Evidently, one of the contributing factors were the conditions of its context of deposition (cf. Chapter 1 and sub-chapter 2.1.). Surface erosion is minor, the antler itself exhibits signs of mineralization. The ornament was filled everywhere with a calcareous sediment.

To see whether it is possible to correctly identify the methods and the sequence of engraving the patterns on the artefact from Rusinowo a blind test was conducted. First, one person executed an engraved ornament on both sides of one of the replicas, using different engraving techniques, in different directions. A total of nine rows of lines, each numbering between 19 and 22 strokes, was engraved. During this process, note was taken of all changes in the work such as the change in the direction of engraving, touching up the engravings, changing tools, the effect of the erosion of the working edge of the tool, and the entire experiment was documented in detail. After that, the other person tried to identify the method of execution of individual strokes, using an optical microscope. In 86% cases the execution mode of individual strokes was identified correctly. Without any problem, the directions of the execution of the engravings and their intersections were identified. On the other hand, we found some divergence in the determination of methods used in touching up individual strokes, and in the attribution of some engravings to one tool only when in fact they were made using two different tools. Nevertheless, it may be concluded that the blind test was successful and that its results contributed to the adoption of the models of execution of the engravings, the experiments were designed to confirm or to refute.

On side B there are some areas of black-coloured staining. They have the form of multidirectional, irregular patterns, penetrating the structure of the antler. The extent of penetration of the staining into the antler varies. Black staining, variously pronounced, was observed in the surfaces with the ornament. Where the strokes of the ornament are wider, and the factor responsible for producing the staining must have occurred nearer the ornament, the staining extends also to the sides and the floor of some strokes. On the natural, rough antler surface which survives on the base of the artefact, the black staining appears only on the raised areas of pearls. An excellent example of this feature are also engravings from group BVI of the ornament (see sub-chapter 3.2.), with varying degree of staining inside their strokes (Fig. 5). Similar dark discolouration was observed on a bone dagger from Niezabyszewo (Sulgostowska 2012, 63, Fig. 6). Most likely, traces of this kind occurred as a result of the decomposition of plant matter which adhered to the surface of the artefact. Unfortunately, the process of formation of



Fig. 5. Stained areas near group VI ornaments (Photo B. Kufel-Diakowska)

this type of alterations has not been recognized in more detail. In literature concerned with taphonomy, similar traces have been interpreted as the effect of the action of humic acids, plant roots and fungi (Binford 1981; Lyman 1994, 375–377). In contrast to the traces observed on the find from Rusinowo, they have the form of meandering grooves similar in appearance to engraved lines. According to Professor Romuald Kosina of the Institute of Environmental Biology of the University of Wrocław (consultation of April 9, 2008), this kind of discolouration could have formed as a result of chemical processes involving fragments of wood found within the deposit close to the artefact. Organic remains of this type have been recorded within the gyttja around Rusinowo.

The surface of the artefact is smooth and polished, including the interior of the engraved lines of the ornament. One factor contributing to this condition would be the extended deposition of the object within the gyttja layer. On side A, no pronounced

damage was observed. Only in the western part of the blade, where the spongiosa starts to be visible, is visible some microchipping and cracking.

Side B of the artefact is less well preserved. From side C towards the blade, and on side D the antler surface is eroded. These are microexfoliations which occur in irregular clusters. They are present both on the ornaments and between the groups of zigzag lines and are the most in evidence between groups BV–BVIII. Between groups BVII and BVIII they run parallel to the pattern of the compact structure of the antler, which had been exposed by earlier working. There is everything to indicate that the microexfoliations occurred as a result of weathering. In this area, the ornament is less distinct, shallower, its edges are eroded and chipped, which makes it harder to detect the intersections and the correlation between individual strokes. There are marks of erosion also on some of the dark discolourations on the artefact surface. The microexfoliations observed here are either the natural colour of the antler or pale grey. The raised areas between the microexfoliations are deep black. These traces suggest that the erosion of the antler surface occurred after the artefact was discarded. Before passing into the palaeolake it must have lain on the ground, with its sides B and D exposed and this caused their partial erosion. The absence of staining of the microexfoliations may be due to several different causes. One of these has been described earlier – the more recessed areas were not affected when the agent responsible for staining was at a greater distance from the antler and the microexfoliations were not too extensive. Alternately, some of the microexfoliations could have developed when the antler rested inside the deposit, already stained, as a result of the pressure of the overlying deposit on the eroded areas.



Fig. 6. Rusinowo. Traces of detachment on sides C, D and E. (Photo B. Kufel-Diakowska), 6.3×

Next to the blade, there is a large cavity in the antler spongiosa exposed at the stage when shaping the blade. The surface of the cavity is not polished,

in contrast to the artefact surface. Secondary to this damage of the antler spongiosa are natural traces in the form of dark staining.

The manufacture of the artefact

The attempt at reconstructing the process of manufacturing the ornamented object from Rusinowo described below draws on technological macro- and microtraces observed on the artefact. Each trace is related to some form of technological action combining with others into individual stages of manufacturing the object. On the basis of these signs it is possible in our view to distinguish the following manufacture stages: 1) division of the raw material – obtaining the preform, 2) shaping – giving the preform its final shape, 3) incising the ornament. Microscopic examination suggests that not all actions leading to the making of the object find a reflection at present in the technological traces on its surface. It is possible to indicate actions no longer recoverable from any traces because these were eliminated by actions carried out during later stages of the manufacturing process. Some traces which are observable in some areas of the artefact were effaced to a varying extent as a result of later actions, but are still identifiable and could be described by us here.

The raw material

At the early stage of the inquiry into the manner of execution of the ornamented object from Rusinowo it proved crucial, but challenging as well, to identify the species of animal the antler belongs to. The morphology of the artefact provided no definitive answer, only the closer ultrastructural analysis of thin sections taken from the artefact revealed the similarity of features observed in them to the structure of antler of the elk (*Alces alces*) (Płonka *et al.* 2011, cf also, sub-chapter 2.3.). The artefact was made from a fragment of antler which included the beam and a portion of the palm. What had guided this choice of material? On the one hand, the shape of the antler determined the size and the form of the planned object, and also, the manner of obtaining the preform of that object. On the other hand, the large size of the elk antler offered a number of possible choices – the long tines of an intermediate diameter, the broad palm, the massive beam. The idea of the object probably was earlier than making the choice of the raw material. In confirmation, we can invoke an analogous find from Wustermark 22 in Brandenburg (Beran 2001; Gramsch, Beran 2010). Evidently, the idea was to give the artefact the largest dimensions possible, hence the choice of the beam

with a fragment of the palm rather than one of the tines. Ornamented objects made from antler tines are known from the period of the Late Glacial. However, in almost every case the antler came from reindeer. Nevertheless, in this particular case, with the planned form of the artefact to be made in mind, its maker looked about for a species of animal, and the part of its antler, which would yield a piece of possibly the largest size. Presumably, the consequences of such a choice were taken into consideration – the inferior quality of the end product. To shape the apex from the part of the antler with the burr, all the pearls had to be removed, and sizable portions of the antler compacta, which exposed the soft spongiosa. Even though in this part of the elk antler the inner porous structure is more consolidated than in the palm portion of the antler, the apex of the object made from a tine would have been more durable.

Manufacturing stages

It is unclear whether the maker of the object had outlined the contours of the future form on the palm portion of the antler. Had this contour been drawn with precision on both surfaces of the artefact (sides A and B), its lines would have become the edges of the present fracture planes on the base (side C), and on fragments of the two side faces (sides D and E). If this contour was outlined with less care, on surfaces A and B, near to the boundary of the removals, we could see fragments of engraved lines forming this contour. However, we find no signs of this sort to indicate this kind of action.

The first stage of manufacture of the object – division of the raw material – is reflected by longitudinal, parallel lines, visible on the surfaces where the compacta was removed – on the base of the artefact (side C), and on fragments of the two side faces (sides D and E) (Fig. 6). These striations originate from sawing the antler, an action which resulted in obtaining the preform. The lines are very even, there is only a small number of steps, but on the same surface, we can see individual planes. The morphology of the lines attests to precision in cutting and continuity of movement. During this process, the raw material was probably softened successively. It may be surmised that in this work the maker was using a flint tool with a long edge – a blade or a saw – not a burin. Otherwise, on the edges of

the removals, there would be visible traces left by slipping off the tip of the tool used in sawing. On side B there is a single forking striation visible right next to the edge of the removal. It originates from the initial phase of dividing the antler. At this stage it is difficult to sustain full precision of movement because the surface of the antler is uneven, riddled with vascular grooves and canals. The profile of striae formed during sawing is roughly V-shaped, with irregular, overlapping lines visible on the walls. The blade which made these lines was straight and was working towards and away from the artisan. In the first part of the experiment meant to produce the preform of the artefact, when an attempt was made to obtain a beam together with a rectangular fragment of the palm, without tines (Fig. 7), the left segment of the palm was detached using a flint burin, carving around the beam in the compacta; the right part of the palm and the fragment with the tine was detached by sawing at the hard surface on both sides with the edge of a flint blade (Fig. 8-10). Analysis of traces on the fracture surfaces showed that the traces left by carving and sawing are nearly identical and hard to tell apart. However, after using a burin, the edges of the antler displayed traces from the slipping tool tip, indicating these traces are less regular (Fig. 11). On the other hand, some parts of the artefact had to be cut off with a tool having a shorter edge, especially those with a concave contour, as in side A and the medial part of the removals on side faces D and E. However, here the traces of detachment did not survive, obliterated as they were by later work.

After sawing at the hard compact tissue on both sides of the palm, the antler fragment was detached. This is shown by the absence of linear traces from



Fig. 7. Experiment. Dividing the antler. (Photo M. Diakowski)



Fig. 8. Experiment. Dividing the antler – carving with a flint burin. (Photo M. Diakowski)



Fig. 9. Experiment. Dividing the antler – sawing with a flint blade. (Photo M. Diakowski)



Fig. 10. Experiment. Dividing the antler – sawing with a flint blade. (Photo M. Diakowski)

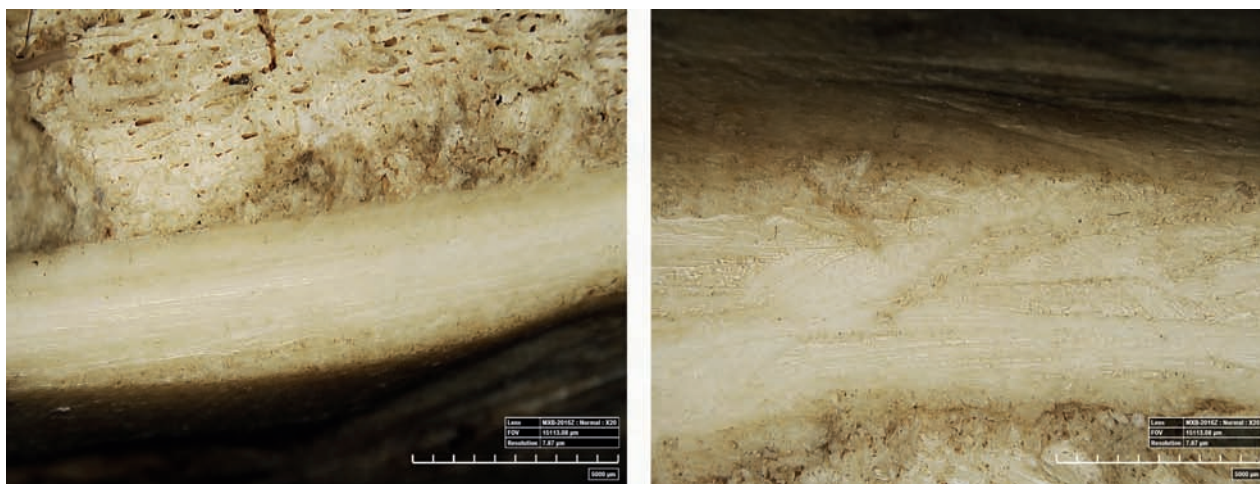


Fig. 11. Experiment. Traces of carving and sawing. (Photo M. Diakowski)

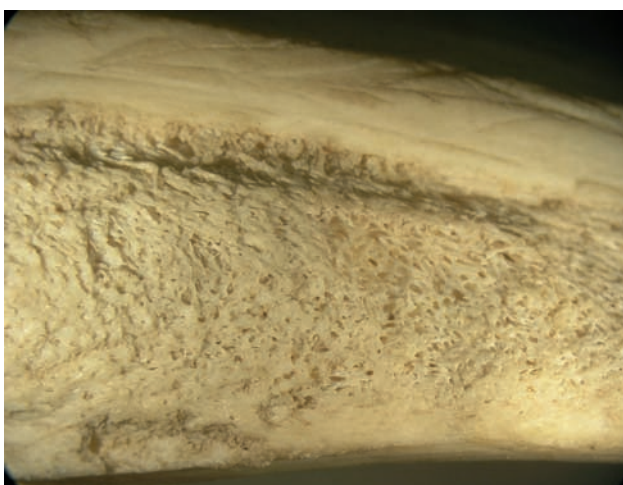


Fig. 12. Experiment. Controlled detachment over an anvil. (Photo M. Diakowski)

sawing or carving in places where the spongiosa is visible. On surface C, the spongiosa protrudes over the fracture plane with only some microchippings



Fig. 13. Experiment. Failed detachment. (Photo M. Diakowski)

visible in it. In this area, the maker of the object did not even go to the trouble of grinding or scraping the spongiosa off, unlike in the case of the two other fracture planes. Recurrent experimentation focusing on the method of dividing antler, not only from elk, but also, and especially, from red deer and fallow deer, have demonstrated that there was no need to cut the spongiosa. It was enough to carefully saw away and remove the compact tissue, and detach the redundant part in a controlled manner, eg, over an anvil (Fig. 12). The careless performance of these two actions resulted in the formation of undesirable, extensive areas of damages which could even have caused the preform to become useless (Fig. 13).

Further traces originate from the stage of the shaping of the artefact, with resulted in giving it the desired form. Much of the artefact's surface is smooth, without vascular grooves, scraped off with great care. There is no evidence of similar work done on fragments of surfaces A and B from side C, that is, on the part of the palm. They were left without the engraved ornament. Moving towards the blade, on the sides A and B and fragments of sides D and E, two kinds of traces were recorded – shallow linear traces in the form of long striae (Fig. 14) and, at roughly right angles to them, chattermarks (see Newcomer 1974, 149) in the form of ripples – so-called *carottage* (Fig. 15). On some fragments of the artefact, there are no traces from the shaping stage at all, even though the antler surface had been scraped off. The striae are the widest and the most pronounced near the blade, where the burr had to be removed. On the other hand, the ripples are best preserved on the fracture surface of sides D and E, where the traces of sawing had been removed by planing away. Both types of traces occurred when the antler surface was scraped. In the experiment targeted on shaping the

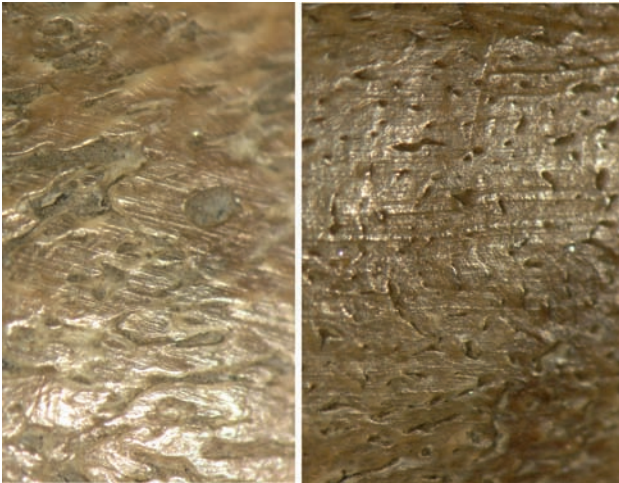


Fig. 14. Rusinowo. Traces of shaping observed next to the blade – shallow linear traces in the form of long striae. (Photo B. Kufel-Diakowska), 6,3×



Fig. 15. Rusinowo. Traces of shaping observed on the surface of truncation on sides D and E – so-called *carottage*. (Photo B. Kufel-Diakowska), 6,3×

preform to the desired form its surface was scraped, mostly to remove the vascular grooves causing irregularities, taking care all the while not to remove too much of the surplus valuable antler compacta. With this purpose in mind, flint blades were used with a small angle of their working edges, and burins with angles of approximately of 90° , which do not wear out as rapidly as the former. Traces of scraping, in the form of shallow striae, were not visible when we worked with a new, undamaged tool (Fig. 16). As the microchippings of the flint tool edge increased, the traces on the surface of the antler became visible even macroscopically (Fig. 17). Very likely, given its substantial size, the ancient object must have been worked using tools with larger angles, otherwise, the work would not have been effective, especially as it was necessary to scrape heavily the entire surface of the antler, except for the base. As the work progressed the tools suffered damage, producing deeper striae, something that is visible near to the apex of the artefact. The character of the two kinds of traces depended not so much on the type of the tool, as on the morphology of the surface being scrapped off. The ripples occurred when there was a loss of control over the tool, eg, on an uneven surface of the antler, or when there was a change in the amount of applied pressure.

As noted earlier, the striae and the ripples originating from the stage of shaping the preform appear only in some areas of the artefact and have substantially rounded edges (Fig. 18). The characteristic rounding of their edges means that as a next step the surface of the object was heavily smoothed down. This probably happened as a result of extended use of the object (see similar remarks

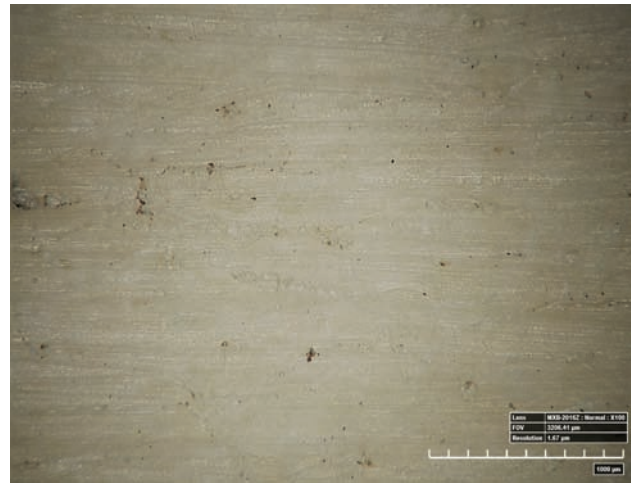


Fig. 16. Experiment. The surface scraped with a new tool edge. (Photo M. Diakowski)



Fig. 17. Experiment. The surface scraped with a worn tool edge. (Photo M. Diakowski)



Fig. 18. Rusinowo. Rounded traces of scraping. (Photo B. Kufel-Diakowska), 6,3×

concerning the preservation status of the engravings in sub-chapter 3.2.).

At this point, it is worth recalling that the traces from the shaping stage, visible on the surfaces of the antler object, originate from the final moments of working its surface. Before the antler was given its final form, the maker first had to get rid of redundant material from the part meant for the apex (blade). Found on it was a thick layer of compact substance and some large pearls of a burr. We do not know in what way they were removed because the traces of this process are not visible today. This work need not have been performed with any special care because

Antlerworking in the Late Palaeolithic

Models of antlerworking during the Late Palaeolithic and the Mesolithic are mostly addressed on the manner of sourcing and use of antler of red deer or reindeer (David 1999; Pétilion 2006; Averbouh, Pétilion 2011), and only exceptionally, of the elk (David 1999). The assumption made in them is that the use of the raw material was optimized, and different types of artefacts were made from different fragments of antler: the beam, the tines or the palm. We can distinguish three general models of operation, which are clearly dependent on the end product: 1) division of the antler by chopping (eg, Averbouh, Provenzano 1999; Averbouh, Pétilion 2011); 2) division of antler by detaching individual fragments by sawing (David 1999; Averbouh, Pétilion 2011); 3) obtaining blank by scoring grooves along the length of the antler and forcing out the intervening portions (groove and splinter technique) (Clark, Thompson 1953; Pétilion 2006).

The small number of objects crafted from elk antler prevents us from describing more fully to



Fig. 19. Experiment. Shaping the blade over a slab of sandstone. (Photo M. Diakowski)

as work progressed, the preform would have to be scraped with great care anyway, to remove all the irregularities. In our experiment, the blade was given shape so as to make its bifacially bevelled blade. This process, involving the removal of the burr and of the compact tissue by scraping, was performed using a fragment of sandstone (Fig. 19). No flint tools were needed to perform these tasks.

The final stage in manufacturing the ornamented artefact – engraving in the antler an ornament of zigzag lines and the anthropomorphic representation – is described in detail in the next sub-chapter (sub-chapter 3.2.).

what extent use was made of particular segments of this raw material. Apparently the most attractive, because of its thickest compact layer were some tines, and the short beam with the burr, possibly also, large fragments of the palm. The latter were used to make the mattocks from Star Carr and Friesack 4 (David 1999) and the axes from Hohen Viecheln and Friesack 4 (Pratsch 2006). Elk antler mattocks similar to them now held by the Lund University Historical Museum have a shaft hole and are made from the part of the palm with the beam which had been shaped into a unifacially bevelled blade. One of these finds is provenanced only generally to Scania (inv. no. 5037), the other was found at the locality Harlösa (inv. no. 29126a). On the first of these finds there are distinct marks of detachment of the blank from the antler palm in the form of a wavy line, the result of planing of the removed fragment. On both mattocks from the Lund Museum there are characteristic traces of working the surface: to remove the natural surface using the technique of whittling with

the flint blade, worked as a knife would be worked today. Additionally, identifiable on the mattock from Harlösa is an area where the natural substance was removed by means of deep grooves which were not planed to make the surface more even. In any case, this last artefact bears a much smaller number of traces from the stage of working the surface, because here much of the natural topography of the antler was left unmodified. The same fragment of elk antler, ie, a part of the palm with the beam, was used to make artefact which is currently the closest parallel to the Rusinowo find, both in its chronology and design. We mean here the object with a zigzag ornament found at Wustermark 22, in Brandenburg, dated to the period of the Younger Dryas (Beran 2001; Gramsch, Beran 2010).

The technology of manufacture of all these objects may have been similar. We can decipher it with some precision from traces surviving on the artefact from north-western Poland. First, the redundant fragments of the palm were removed with great precision. This was done with flint tools which had two different kinds of working edge – the longer side of a blade or a flake, and presumably, with a tool having a shorter working edge. After some sawing at the tough, but thin layer of the compact tissue, the rest of the antler was carefully broken off. Irregularities in the spongy substance left by the removal on side surfaces D and E were scraped off. This process was not applied to side C, where the spongiosa remained uneven, with no technological traces visible on it at present. The surface of the antler was scraped with great care, to give the object the desired shape and to remove the natural irregularities of the raw material, such as pearls and vascular grooves. This work was performed on softened antler. The surface of the artefact obtained in this manner is smooth, in

some places retaining longitudinal striae and transverse ripples from scraping with a flint tool. Roughly a third of the object in its northern portion still retains its original, unworked surface. The part with the burr had been scraped with much energy, and the blade was formed in the process, similarly as in Mesolithic mattocks and axes. On the other hand, the surface of side C of the artefact was not subjected to working at all. The last process was engraving the designs on both sides of the finished object, in the form of zigzag lines and anthropomorphic representation. As a result of subsequent use the traces from the scraping of the surface were mostly obliterated. In a similar process, the edges of the engravings became rounded and smoothed down; additionally, one of the surfaces is abraded, but this must have happened much later.

There can be no doubt that the object was manufactured using flint tools. Its context of discovery does not allow us to attribute it to any particular cultural tradition. Taking into account its dating, we may surmise that it was created and used by societies which we associate with the Arch-backed Point complex or the Tanged Point complex. Assemblages of these two complexes are marked by a high percentage of burins made on flakes or blades. The burin was the basic tool used in working hard organic materials like bone and antler, in both complexes (Cahen *et al.* 1979; Winiarska-Kabacińska 1996, 2009; De Bie, Caspar 2000; Jacquier 2014; Donahue, Fischer 2015; Kufel-Diakowska 2015). Other tools used in working bone and antler included endscrapers and blades, or even truncated blades (eg Sano 2012). Very likely, burins and various forms of retouched blades were used by the maker of the ornamented artefact from Rusinowo.

Uses of the object

Use traces

Assuming that the object could have been used as a tool, at first we looked for use traces on the blade. However, no damage produced by use was found on it. On the edge of the blade in its medial part is a chipped area with a length of 4 mm. Its edges were smoothed down and polished (Fig. 20). Most likely, this damage to the antler happened by accident.

In the apex part, on side B, where the antler spongiosa is exposed, is visible an oval cavity with an irregular interior. Its maximum external dimensions are 3.0 × 2.7 cm. The surface around the cavity is heavily polished, in contrast to the interior of this feature. Moreover, neither near the cavity nor

anywhere else on the surface of the blade are there any mechanical traces (Fig. 21).

The surface of the artefact is heavily polished, with the intensity of the polished patches dependent on their location. On side A, the heaviest polish extends from group IV (see sub-chapter 3.2.) of the ornament to the blade. The technological traces of forming the artefact were polished here so that they were shallower (Fig. 22). In the apex part, they are almost imperceptible, becoming more pronounced only next to the side edges, where the working had been much more intensive. The edges of engravings belonging to groups IV through VII of the ornament are visibly smoothed as well, their interior polished,

differently than other groups of the engravings (I-III) which exhibit no equally heavy modifications. The surface of the artefact in its northern, flat part is polished to a lesser extent. A similar degree of polishing as in the southern part of the artefact was



Fig. 20. Rusinowo. The chipped area on the edge of the blade. (Photo M. Diakowski), 6.3x.



Fig. 21. Rusinowo. Oval-shaped cavity next to the blade. (Photo M. Diakowski)

noted only in the areas near to the edges (outlying strokes in the ornament groups AI and AII), and the interior of vascular grooves was left without gloss.

Unfortunately, side B of the artefact is somewhat less well preserved. In its southern part, similarly, as on side A, it is more heavily polished. The edges of ornaments from groups III through VII are smoothed and slightly rounded. However, even despite their being shallower and wider than the engravings on side A, their interior is not as heavily polished. Technological traces had been smoothed down to the greatest extent near the apex of the artefact and on its greatest convexity. In the northern part, the traces of polish, similarly as on side A, are less pronounced – the interior of the vascular grooves and of ornaments of groups no. I and II are without polish (Fig. 23) apart from strokes next to edges of the surface.



Fig. 22. Rusinowo. Side A. Southern part. Polished surface, smoothed over shallow technological traces. (Photo M. Diakowski)



Fig. 23. Rusinowo. Side B. Northern part. Surface less markedly polished, the matted interior of vascular grooves. (Photo M. Diakowski)

Experiments

The experiments had been planned to test the origin of the traces observed on the artefact. A study was made of the possible circumstances of occurrence of the cavity on the blade, and of traces attributed to the handling of the object and its storage. Additionally, experiments were run to confirm whether the object could have been used as a digging tool.

To test the damage on the blade in one experiment the blade of the experimental tool was rammed into the sand, in another, the flat surface struck repeatedly against a hard surface. In the first case, the artefact replica was mounted with its flat surface on a shaft using leather straps. Next, the blade was rammed into the sand, during this action its entire surface was embedded up to the part fastened to the shaft. This process was sustained for a total of two hours and resulted in the formation on the edge of the blade of several areas of chipping and fissuring perpendicular to the working edge, moreover, the blade became slightly rounded. Longitudinal linear traces were observed everywhere on the surface, varying in length, width and depth, parallel and diagonal in relation to the direction of the work. The process did not result in the formation of the cavity on the tested surface (Fig. 24).

In another experiment, the flat surface of the antler replica blade was struck against a sandy and rocky surface. This process resulted in the formation of many small indentations (1 mm in diameter) on one of the sides of the object (Fig. 25). Even a powerful blow force against a large, angular rock failed to produce a cavity similar to the one seen on the original artefact. Each blow produced new small pits between 2 and 3 mm in the area. A similar hole in the area was obtained only after 30 heavy blows. However, even then, the morphology of the cavity on the replica was different. Around the hole, there were many overlapping punctate traces from the percussion (Fig. 26). The experimentation demonstrated that this type of a cavity cannot be obtained by administering a number of blows.

Traces from hafting of the antler tool were tested in the following manner. The replica of the artefact was attached to a wooden shaft using leather straps. The antler was made fast with the shaft with one of the flat sides of its base, which prevented it from sliding. The ramming of the replica into a sandy surface for two hours and the carrying of the hafted object for several hours produced no marks on the replica.

Our experiments in which the replica was carried around wrapped in a deerskin, placed in a bag (a total of 48 hours) similarly did not result in the

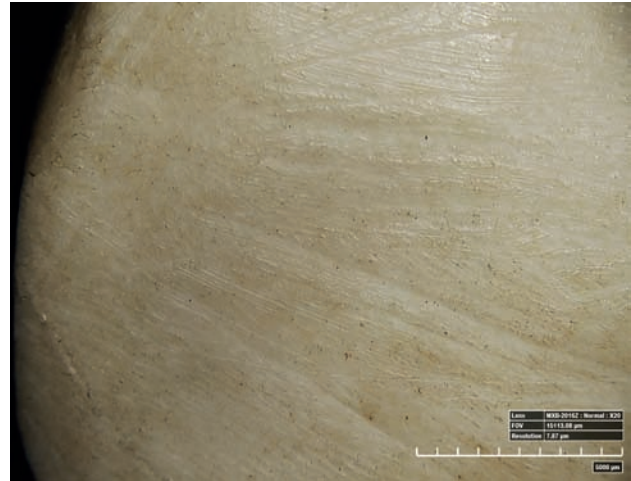


Fig. 24. Experiment. Traces from ramming the blade into sand. (Photo M. Diakowski)

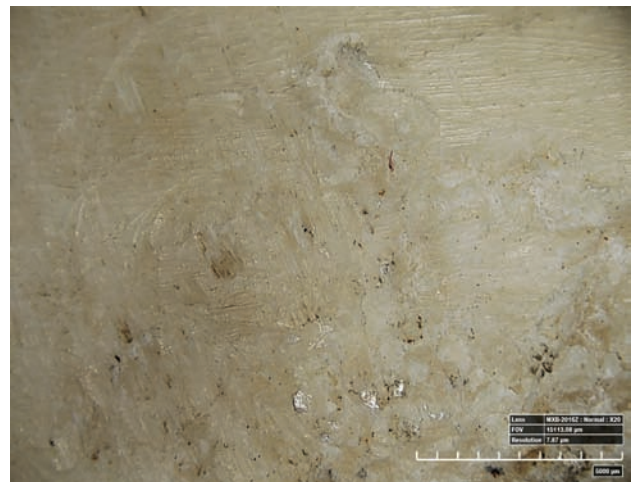


Fig. 25. Experiment. Traces from striking with the flat surface of the blade against a sandy and rocky surface. (Photo M. Diakowski).

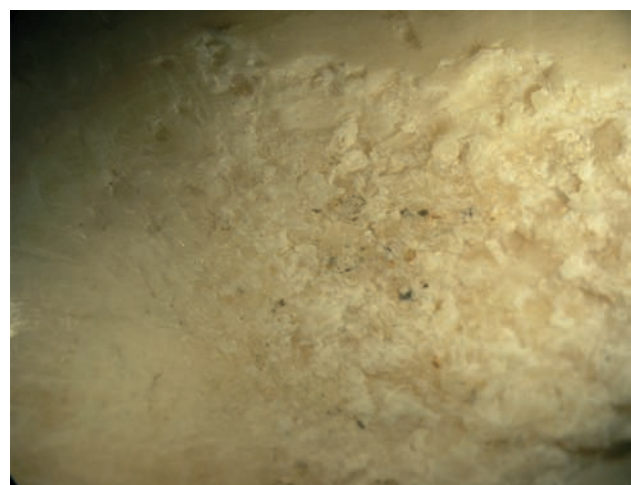


Fig. 26. Experiment. A cavity resulting from 30 heavy blows with the flat surface of the blade against a sandy and rocky surface. (Photo M. Diakowski)

formation on its surface of any apparent polish that would be visible macroscopically. Similar effects were produced by rubbing the zigzag line with a finger (1270 times). Nevertheless, when examined under the microscope the surface of the replica was found to have become slightly polished and glossy – its microphotograph is different from the image of the replica right after its completion (Figs. 27, 28). The ridges of the striae left by the scraping process (the stage of shaping the surface) became rounded. Various degrees of rounding were also observed on the engravings. These traces are more pronounced in the most protruding and exposed areas of the replica. The factor responsible for the polishing and smoothing down of the engravings on the original artefact must have acted on the surface in a uniform manner, with not too great force, such as touching, rubbing with a hand, storing and carrying about in a container made of an organic material.

On the function

The artefact displays no traces of use as a tool, but the worn condition of the ornament and of other parts of the surface indicate extended use. The non-utilitarian function of this object is evidenced mainly by the lack of traces of work on the edge of the blade. Considering the method used in shaping this object, it is legitimate to suppose that this place would display marks of damage resulting from its use. Despite this, on the edge of the blade, just a single chipped area was observed, probably the result of some accident which befell the object at an unspecified time when it was in function. There is no other damage in its neighbourhood.

Using supplementary evidence from the experiments the interpretation of the artefact as a digging tool must be rejected as well. There are several alternative explanations for the presence of the cavity near the blade. The damage could have occurred as

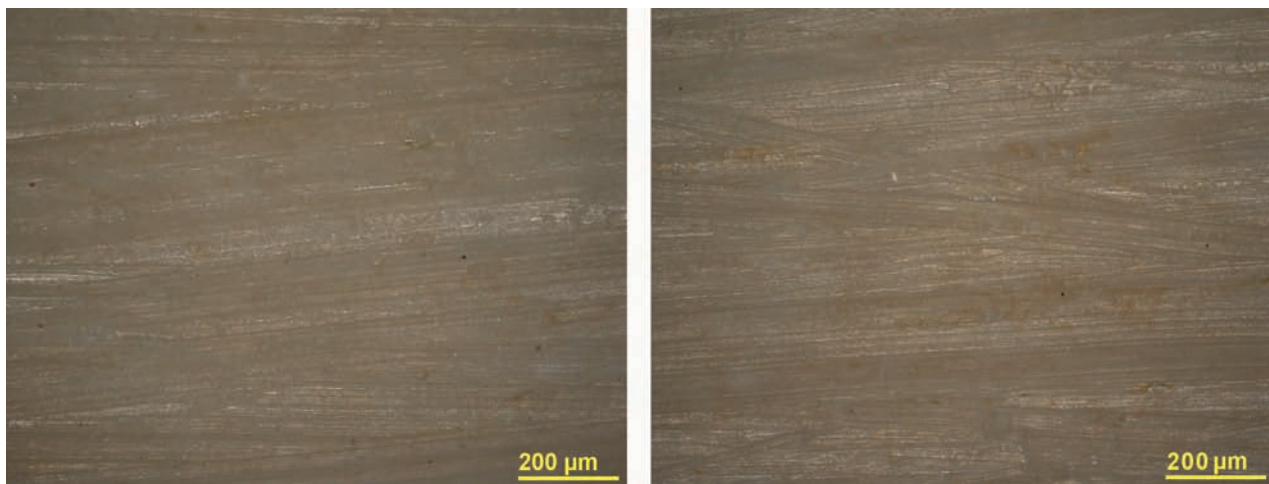


Fig. 27. Experiment. The surface of the replica shortly after its execution. (Photo M. Diakowski)

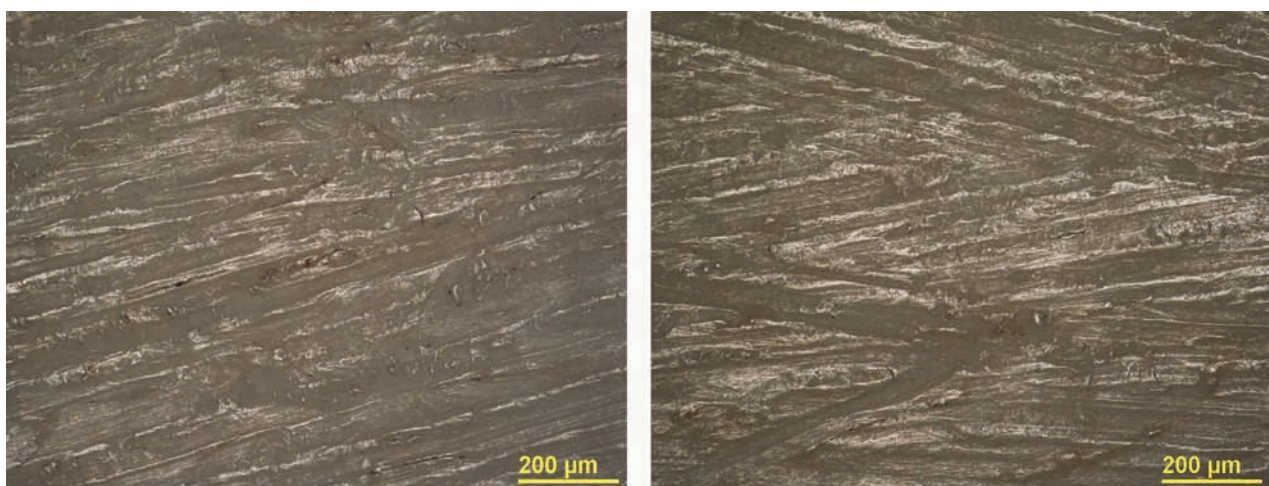


Fig. 28. Experiment. The surface of the replica after being carried about for 48 hours or rubbing the zigzag line with a finger 1270 times. (Photo M. Diakowski), $\times 16$

the object was being lifted from the gyttja deposit by heavy machinery. However, in this case, the damage would have been more serious, and there would be no reason for the cavity to retain on its inside the punctate marks from percussion. The other alternative would be damage inflicted by hitting the flat surface of the blade against a hard object, like a rock. We would have to assume that afterwards the object was discarded since the cavity had no time to become polished. However, the experimental studies have demonstrated that the number of blows and the force needed to create such a large cavity would have produced numerous punctate indentations around the edge, not observed on the artefact. We may accept as the most likely scenario the deliberate striking with the object, but only after a longer period of its circulation, which would have caused the structure of the exposed spongiosa to weaken. In this case, the cavity would be more likely to be produced by percussion, or from the removal of fragments of the spongy tissue than if the antler spongiosa was still fresh.

The variable, and at the same time considerable intensity of the polish on the artefact proves that this object continued functioning for a very long time. The worn condition of the technological traces and of the edges of ornaments, as well as the glossy

condition of the surface in the mesial area of the artefact and near the blade, must have been caused by frequent touching of these parts of the object, carrying it around wrapped in skin or fur. At this time, the opposite, unworked part of the artefact could have been covered by a haft. The rough, undulating surface was not exposed to intensive contact with the material of the handle. And indeed, the surface of this part, or rather, the bottom of the vascular grooves, are almost without polish. Considering the degree of polish and studies of the use-life of bone objects, we may assume that the artefact from Rusinowo was used over a very long period, possibly even for dozen-odd generations (cf. Choyke 2009; Choyke, Daróczy-Szabó 2010).

The artefacts from Rusinowo and Wustermark 22 are unique specimens. Tools closest to them in their raw material (elk antler) and morphology were found at Starr Carr (David 1999, Pl. 70). However, the antler palm used in making the mattocks, as interpreted by E. David, was perforated so that the tool could be set at right angles onto the handle. According to an earlier view proposed by R. Feustel, objects of this type were used in ceremonies, too fragile for chopping wood or to be used in warfare (Feustel 1973, 145-146).

Artefact biography

Through multi-dimensional technological, functional and taphonomic studies we tried to trace the biography of the object from Rusinowo. What interested us were the choices made, actions and processes to which it was subjected from the moment of the birth of its idea, through it being given shape and utilisation, until the time of its discovery by a chance finder at the beginning of the 21st century.

In the history of the artefact, the first important event was the selection of the raw material. The material sought for had to be amenable to obtaining the conceived form. The elk antler of a large size could be used in making an exceptional object, one offering much room for a larger number of the engravings. Technological traces associated with dividing the raw material and shaping the artefact suggest great precision of its manufacturing process, and simultaneously, not a small outlay of labour. The blank was manufactured, and the ornament engraved using flint tools. The manner of execution of the ornaments is described in the chapter below.

A relatively long stage in the history of the ornamented object was the period when it was in use.

That being said, we need to emphasize that its character was not utilitarian – there are no traces of work to show it was so. On the other hand, the edges of the engravings on the artefact from Rusinowo are not sharp, or distinct as they would be in a freshly executed ornament. They have been smoothed, polished and rounded, suggesting repeated handling, touching or rubbing, possibly over an extended period. The duration of this period cannot be estimated more closely. On the other hand, there is much to suggest that this object used to be hafted. The parts of the artefact found inside the handle did not develop an equally heavy and uniform polish as the rest of its surface. This applies to the interior of vascular grooves and of the engravings, groups I-III on side A, and groups I-II on side B, except for areas bordering on the margins. The absence of use-wear, taken together with the heavily polished surface and the worn condition of the technological traces and the engravings, and possible hafting, all combine to show that the role served by the Rusinowo artefact was non-utilitarian.

It may be safe to conclude that the cavity on side B took form during the final phase of the functioning

of the object, either by design or accident. It lacks polish which would have taken form if the object had continued in use. Perhaps, when after a very long period of being carried about and used in rituals, the structure of the spongiosa grew weak and the object was “killed” symbolically by striking several times against a sharp rock and next, discarded. Thus ended the history of its relationship with the Palaeolithic community. Traces of erosion visible on sides B and D suggest that for a time the object lay exposed to the elements.

The techno-functional studies of the artefact from Rusinowo have brought in much significant data concerning the method of execution and stages in the use-life of this object. Detailed biographic studies prove that it had continued in use for a long time, meaning that its significance for the community would have been considerable. Actions and processes to which it had been subjected, starting from the moment of selecting its material, its manufacture, execution of the ornament, use, and the end of its use-life, had all been well-thought and deliberate.