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USE-WEAR STUDIES OF THE FUNCTION OF PREHISTORIC WOODEN PRODUCTS, IS IT REALLY POSSIBLE? THE EXAMPLE OF PESTLES FROM SITES IN ŠVENTOJI, LITHUANIA

ABSTRACT

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The article presents the preliminary results of the traceological analysis of the collection of wooden pestles obtained during excavations of the complex of subneolithic sites in Šventoji in Lithuania. During the studies, an attempt was made to assess the possibility of interpreting the functions of the analysed tools based on the (probably) functional damage visible on them and to verify the hypotheses about the way they were used put forward by the authors of the excavations. The primary goal of the reported research was an attempt to first (preliminary) assess the nature of damage occurring on wooden tools (in this case, pestles) as a result of their use, the possibility of analysing and interpreting these traces (also in the context of post-depositional changes and modifications resulting from the conservation process), and consequently (in general) the possibility of conducting functional analyses of wooden tools dating back to the Stone Age.

Keywords: use-wear analysis, wooden artefacts, Šventoji, dendroarchaeology, pestle, hammer
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1. INTRODUCTION

The traceological (technological and functional) studies of Stone Age wooden artefacts are one of the weaker-developed branches of this method. The singular studies of this type have been discussed just in a few articles and chapters (*i.e.*, d'Errico *et al.* 2012; Caruso Fermé *et al.* 2014, 2015, 2023; Schoch *et al.* 2015; Lozovskaya and Lozovski 2016; Rios-Garaizar *et al.* 2018; Taylor *et al.* 2018; Caruso Fermé and Aschero 2020; Vidal-Matutano *et al.* 2021; Barham *et al.* 2023; Gibaja *et al.* 2023). This situation is due to many factors.

First, prehistoric wooden artefacts, especially those dating to the Stone Age, are extremely rare. For their preservation to this day, favourable soil and hydrological conditions are necessary, including, above all, the constant presence of water. Hence, most of the artefacts of this type come from "wetland" or underwater sites. Examples of this type of deposition environment include sites such as Star Carr in Great Britain (Taylor *et al.* 2018), Tybrind Vig in Denmark (Andersen 2011), Friesack IV in Germany (Gramsch and Kloss 1989), Zurich-Parkhaus Opéra in Switzerland (Bleicher and Harb 2018), Zamostje in Russia (Lozovskaya and Lozovski 2016), Šventoji in Lithuania (Rimantienė 2005), or La Marmotta in Italy (Mineo *et al.* 2023).

The second thing is that wood is a very soft organic material, which means that post-deposition processes modify its surface very fast, destroying the potential technological and functional traces as well. This very often makes traceological analysis of even reasonably well-preserved artefacts impossible.

Last but not least, prehistoric wooden artefacts must usually be subjected to the conservation process immediately after the excavation. The method of carrying out this process is crucial for preserving traces of use and the possibility of conducting traceological research.

All these factors make functional analyses of wooden artefacts extremely rare, which means every scientifically conducted study of this type can be a precious source of information about the economy or (generally) lifeways in the Stone Age (and in prehistory in general).

This article aims to present the first (test) results of traceological research of selected wooden artefacts discovered during the excavations at the complex of prehistoric sites in Šventoji in Lithuania. The primary goal was to answer the question about the possibility of conducting effective and reliable functional analyses of wooden artefacts (in general), but also about the possibility of analysing such products originating from the Šventoji sites specifically (regarding their state of preservation and the impact of the preservatives used on the potential use-wear traces). The research was also aimed at verifying (if possible) the suggestions about the functions of the analysed artefacts made by the author of the excavations in Šventoji. The final goal was to assess the possibility of conducting traceological research on prehistoric wooden products, using the equipment and methodology used to analyse this type of stone and bone products.

1.1. Sites in Šventoji, Lithuania

The archaeological complex of Šventoji in north-west Lithuania consists of about 60 sites as well as many stray finds (*e.g.*, stone and bronze axes), and several amber hoards that have so far been discovered on the swampy Littorina Sea terrace, a ribbon of land running from Palanga to the Lithuanian–Latvian border, 16 km long and up to 2.5 km wide (Fig. 1). The finds are dated generally from the Late Mesolithic to the Late Bronze Age, *i.e.*, 6000-500 cal BC. However, it is mostly famous for its Subneolithic and Neolithic wetland sites that produce astonishing everyday and ritual artefacts and are a fertile ground for interdisciplinary palaeoenvironmental studies in the same way as several other Neolithic Lake regions in the south-east Baltic, *i.e.*, Sārnate and Lubāns in Latvia and Biržulis and Kretuonas in Lithuania. From a coastal perspective, the Šventoji sites could mostly be recognized as part of the circum-Baltic Neolithic seal hunting and fishing community which lived off of the diverse and abundant coastal food resources during 4^{th} – early 3^{rd} millennium cal BC (see Rimantienė 2005; Piličiauskas *et al.* 2012; Piličiauskas 2016; Piličiauskas *et al.* 2017b; Robson *et al.* 2019).

The Šventoji sites are situated on the banks, littoral zones, and beds of former lagoons, delta channels, and rivers. The sites were interpreted as habitation areas, refuse layers, fishing stations, and amber workshops. Large quantities of pottery, as well as wooden and bone fishing gear, were unearthed during the excavations at the wetland sites. Large-scale seal hunting and freshwater fishing was inferred alongside the very sparse and dubious signs of a Neolithic farming economy in the Šventoji region (Piličiauskas *et al.* 2017a). Today the cultural layer has greatly deteriorated owing to ploughing and the drop in groundwater level at most of the habitation sites. However, the bone and wooden artefacts in the waterlogged gyttja of former bodies of water are still in good condition.

Today Šventoji might be considered one of the best archaeologically investigated areas in Lithuania. In addition to extensive test-pitting (c. 5000 m^2), many trenches (>10 000 m^2) have been excavated at the sites with the best preserved artefacts. We will discuss the three Šventoji sites (1, 3 and 23) in more detail below, as the wooden artefacts we have studied were found there.

Šventoji 1 was investigated in 1967-1969, 2010 and 2022 (Rimantienė 2005). Then an area of c. 1900 m^2 was excavated excluding test-pits, mostly at the wetland part of the site. Excavated finds were found in lake gyttja – from 0.5 to 1.7 m deep. However, it is important to note that close to it there was a low sandy hill with plenty of amber and flint artefacts within a ploughed layer (Rimantienė 2005). In places, two horizons were distinguished. The organic materials are well preserved. In the upper horizon (1A), wooden stakes, poles, pine laths, stones, and Neolithic and Subneolithic ceramics were concentrated in a strip only 1-2 m wide and more than 150 m long. Firstly it was assumed that this was a ceremonial enclosure, built on the site of an overgrown lake (Rimantienė 2005). However, today more likely is an alternative interpretation that the shallow water was still

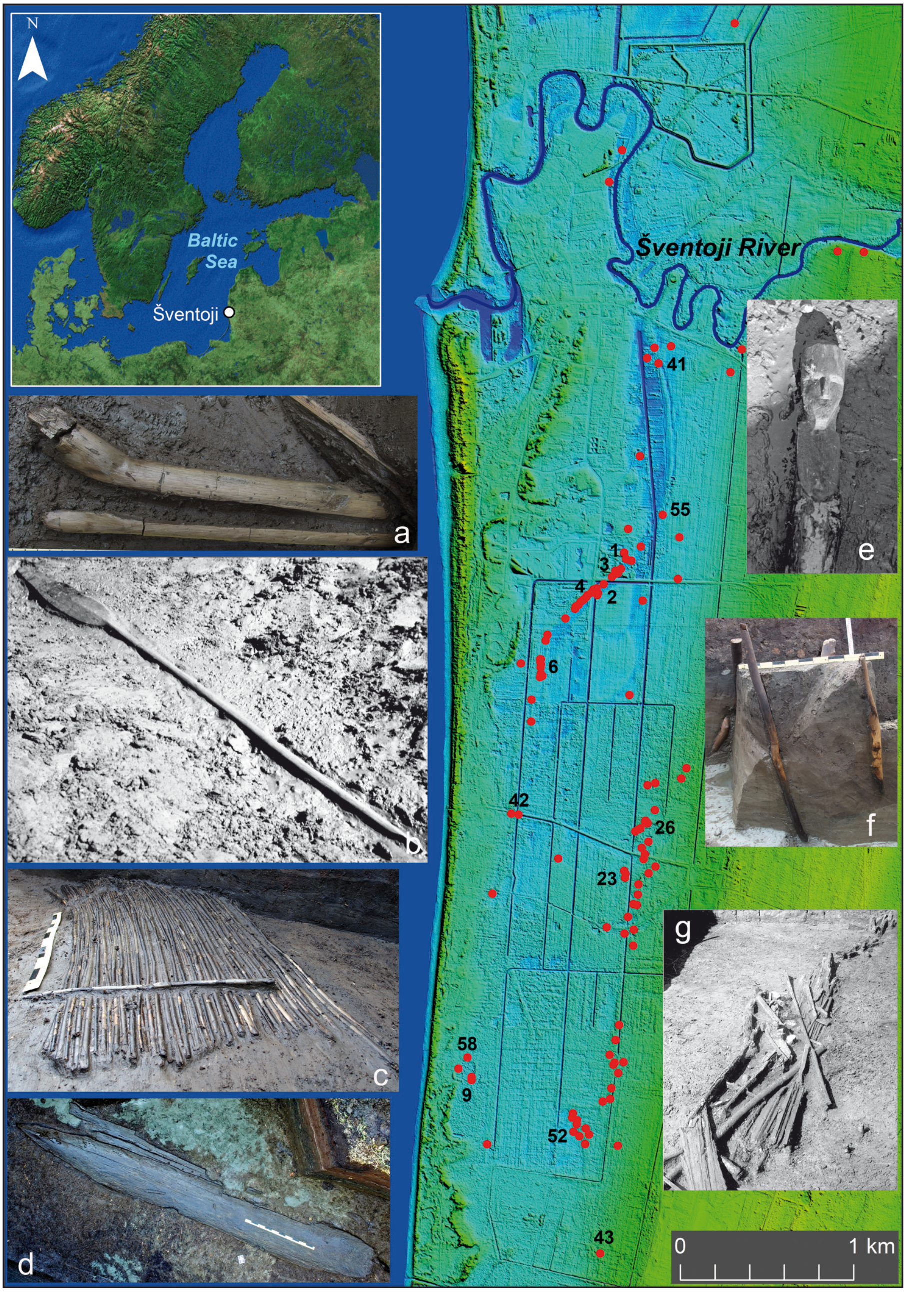

Fig. 1. Location of the Šventoji sites with photos of some wooden artefacts *in situ*: a – leister prongs at Šventoji 4, b – paddle at Šventoji 2, c – a rollable fishing fence at Šventoji 58, d – a dugout at Šventoji 58, e – an idol figure at Šventoji 2, f – piles at Šventoji 55, g – remains of fish weir at Šventoji 1 (Illustration by G. Piličiauskas)

Fig. 2. A selection of wooden artefacts from Šventoji sites: 1, 2 – paddles; 3, 4 – net floats; 5, 6 – sleeves; 7 – shaft; 8, 9 – fragments of wooden vessels/containers; 10, 11 – eel leister prongs; 12 – arrow fragment; 13 – wooden spatula (Illustration by G. Osipowicz and J. Orłowska)

present during the construction of the wooden fence and that it represents a fish weir (Piličiauskas 2016). The site is dated to c. 3500-2500 cal BC.

Šventoji 3 is located 150 m to the SW of Šventoji 1, on the shore and littoral of the erosional channel approximately 50 m wide. It was investigated 1971-1972, 2005, 2007 and 2022 (Rimantienė 2005). The excavations covered an area of 784 m^2 if not to count numerous test-pits. The finds were found in gyttja, at a depth of 0.5-1.75 m. Organic materials are well preserved including thousands of fish bones. Only Subneolithic pottery was found at Šventoji 3. Typologically and stratigraphically, it corresponds to the Šventoji 4B complex and can be dated to 3100-3000 cal BC (Piličiauskas 2016). Šventoji 3 was used exclusively for fishing during the Subneolithic. A hoard of amber artefacts and pieces of raw material was once found on a higher area adjacent to the site (Rimantiene 1979), but they may have belonged to a later period, possibly 2600-2400 cal BC, when the lake water level had dropped significantly (Piličiauskas 2016).

Šventoji 23 is located on the eastern shore of the lagoonal lake. It was investigated in 1970-1971 when an area of 1268 m^2 was excavated. The finds were found in peaty gyttja, as well as peaty sand on a higher area, at a depth of 0.4-0.8 m (Rimantienė 2005). Today, unfortunately, the wood has already decayed, but 45 years ago, a large number of various wooden artefacts were found in the littoral sediments. A dwelling area was found further to the east, marked by wooden stakes 5-12 cm in diameter distributed sparsely (Rimantienė 2005). The site is dominated by Late Subneolithic Porous pottery, analogous to the Šventoji 4B and 4A2 complexes. It is of light clay mass, shell-tempered, having numerous drilled holes, decorated with knot, comb and other impressions. Šventoji 23 was initially thought to be one of the latest Šventoji sites (Rimantienė 2005), but the AMS dates of hazelnut shells and hearth charcoal obtained in 2014-2015 show that it is actually contemporaneous with many other Šventoji sites situated in the middle of the same lagoonal lake and dates to 3200-2700 cal BC (Piličiauskas 2016). The site is important for the discovery of isolated human bones belonging to at least 3 individuals – extremely valuable material for isotopic studies (see Piličiauskas *et al.* 2017b, 2022 for results).

The collection of wooden artefacts found at Šventoji sites includes thousands of artefacts and their fragments. Next to the remains of fishing fences (Šventoji 1, 9, 55, 58; Rimantienė 1980; Piličiauskas 2016; Piličiauskas *et al.* 2020a), a dugout boat (Šventoji 58; Piličiauskas *et al.* 2020b), and the most famous artefact from Šventoji, *i.e.*, a statue of a wooden idol (Šventoji 2; Rimantienė 1979), many small objects were discovered here that accompanied the hunter-gatherer-fishermen who used this place on a daily basis. Rimutė Rimantienė, in her book from 2005, mentions at least 530 of them, including: paddles, bark floats, eel leister prongs, bows, arrows, wooden containers, sleeves, hammers, shafts and others (Fig. 1: a-g; Fig. 2).

2. MATERIALS AND METHODS

2.1. Materials

The subject of the analysis reported in this article were five wooden artefacts which, due to their morphological features, can be classified as pestles.

The first one was found at the site Šventoji 1 (inv. no. EM2070: 756; Fig. 3: 1). It is a relatively massive tool, oval in cross-section, with a well-defined handle and macroscopically clearly visible usage damage in the working part. Its total length is 38 cm (the length of the head is 25 cm), and the largest diameter of the working part is about 6.5 cm (diameter of the handle – about 3 cm). No sample was taken from the product for dendroarchaeological research, but the results of analyses carried out earlier for this artefact indicate that willow or alder were used (Rimantiene 2005, 244).

The second tool comes from the Šventoji 3 site (inv. no. EM2132: 384; Fig. 3: 2). It is 24.3 cm long and has a rectangular head with dimensions of 15.3 cm (length) × 6 cm (width in the part without the knot) × 3 cm (thickness). The head is clearly rounded at the top, and there is a large knot at its base. The handle of the tool is well-defined, its cross-section is oval, and the maximum diameter is approximately 2.2 cm. A sample was taken from the specimen for dendroarchaeological research, the analysis of which showed that it was made of ash tree (*Fraxinus excelsior*), which confirms previous findings in this regard (Rimantienė 2005, 346).

The remaining three artefacts were discovered at the site Šventoji 23. All were found almost in the same place (near the hearth), with three more artefacts of this type (Rimantienė 2005, 449). The first of them (inv. no. EM2110: 697; Fig. 4: 1) is a Y-shaped tool, approximately 23.3 cm long, which was most likely made from the branching point of a branch. The head of the specimen has an irregularly oval (sometimes close to rectangular) cross-section. Its length is approximately 13.7 cm, with a width ranging from 5-9.2 cm and a thickness of approximately 5 cm. The handle of the tool is well-defined, round in cross-section and has a diameter of about 3 cm. There are clear depressions visible on both sides of the head (on the wider sides) and in its central part. Dendroarchaeological examination of a sample taken from the artefact showed that it was made of hornbeam (*Carpinus betulus*). This is indicated by the characteristics of the microstructure of the tested wood (Fig. 5: 1). However, this is in contradiction with previous findings which had suggested that the artefact was made of ash (*Fraxinus excelsior*) (Rimantienė 2005, 64, 449).

The second tool from the Šventoji 23 site is similar in form to the specimen described above, but much more damaged (inv. no. EM2110: 696; Fig. 4: 2). Its length is 24.3 cm, of which 14 cm is the head, which is oval in cross-section (width: 5.5-8.6 cm; thickness max. 4.5 cm). The specimen has a well-defined oval handle with a diameter of up to 3.7 cm. As a result of dendroarchaeological analysis of the sample taken from the artefact, it was found that poplar wood (*Populus* sp.) was used for its production. This is confirmed by the

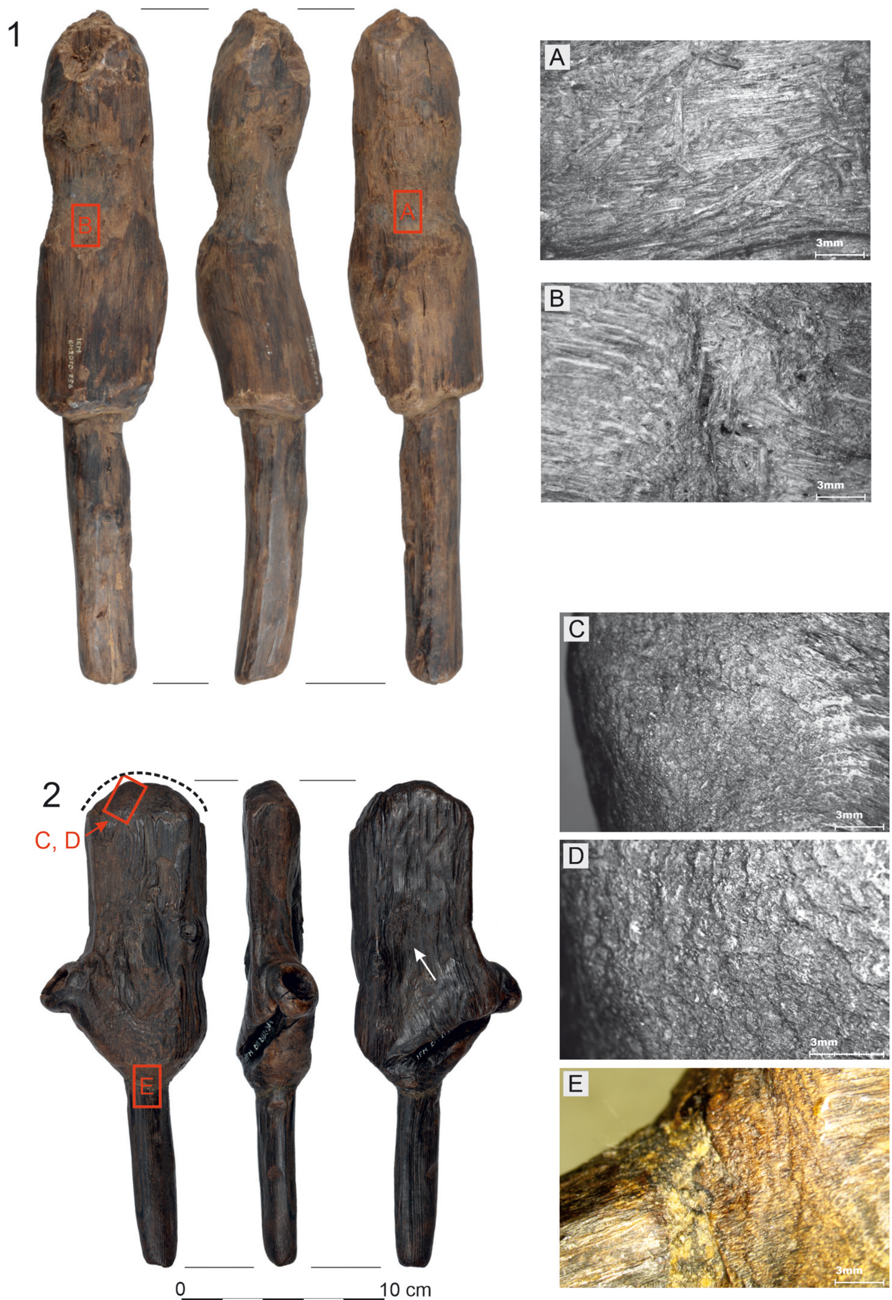

Fig. 3. Pestles that were the subject of the traceological analysis and the examples of technological and possibly usage traces observed on their surface: 1 – Šventoji 1; artefact inv. no. EM2070: 756; 2 – Šventoji 3 artefact inv. no. EM2132: 384 (Illustration by G. Osipowicz)

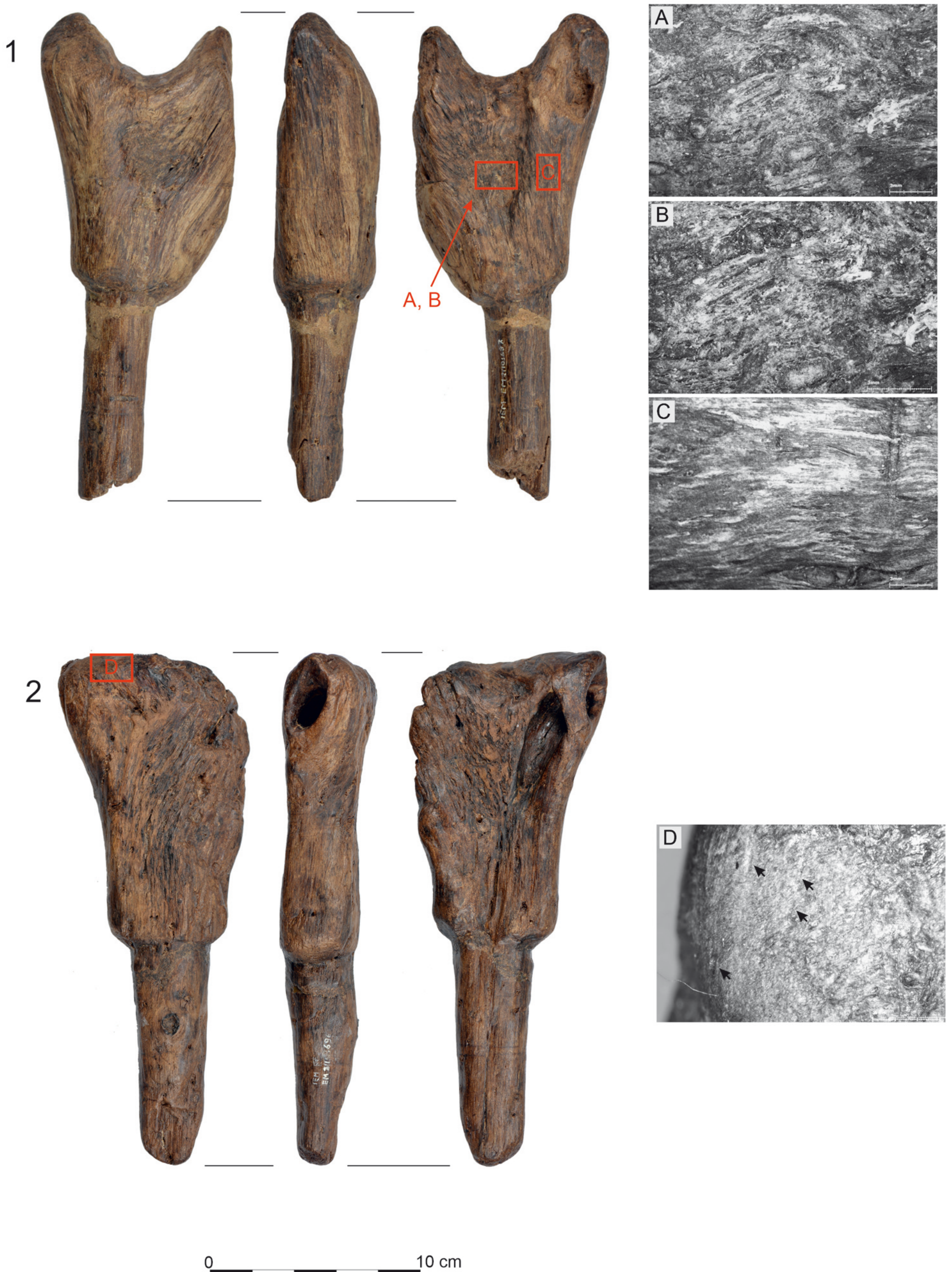

Fig. 4. Pestles from Šventoji 23 site that were the subject of the traceological analysis and the examples of possibly usage traces observed on their surface: 1 – Šventoji 1; artefact inv. no. EM2110: 697; 2 – inv. no. EM2110: 696 (Illustration by G. Osipowicz)

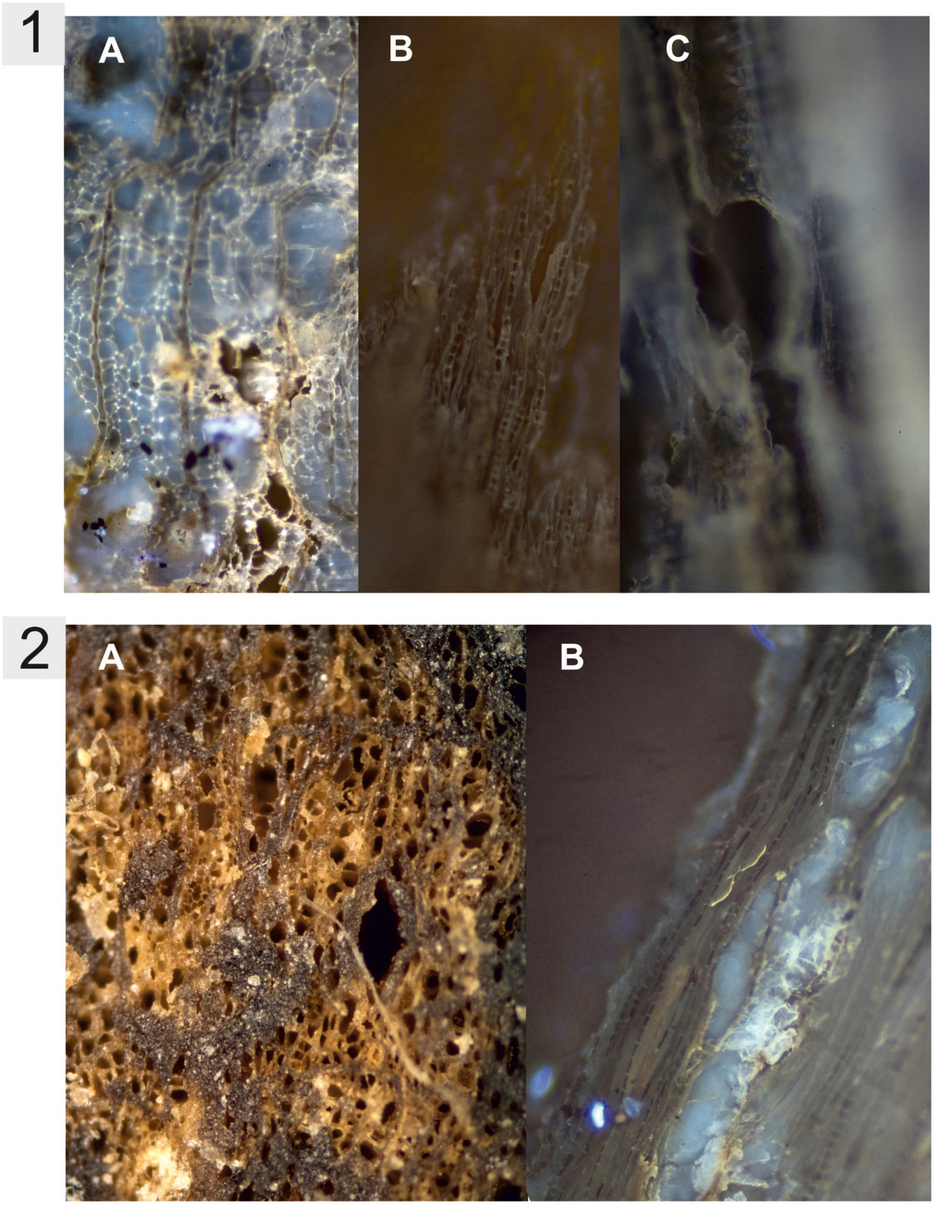

Fig. 5. Results of dendroarchaeological analysis: 1 – Characteristic features of *Carpinus betulus* wood (artefact inv. no. EM2110: 697): A. traversal section with diffuse porous tissue (100×MAG, UV light), B. tangential section with uniseriate rays forming an agregate ray (50×MAG, UV light), C. radial section with simple perforation plate and large pits in ray-vessel intersections (200×MAG, UV light); 2 – Characteristic features of *Populus* sp. wood (artefact inv. no. EM2110: 696): A. traversal section with diffuse porous tissue (50×MAG), B. tangential section with uniseriate, homogenous, long rays (100×MAG, UV light) (Illustration by G. Skrzyński)

Fig. 6. Pestle inv. no. EM 2110: 872 from Šventoji 23 site that was a subject of the traceological analysis (Illustration by G. Osipowicz)

microstructure of the analysed material (Fig. 5: 2). However, this result does not agree with previous findings, which suggested that the artefact had been made of made of ash (*Fraxinus excelsior*) (Rimantienė 2005, 449).

The last tool from the Šventoji 23 site (inv. no. EM 2110: 872; Fig. 6) is analogous to the specimen from the Šventoji 3 site. It has a head whose longitudinal and cross-sections are close to a rectangle, approximately 15 cm long and 6 cm wide. Its maximum thickness is about 2.7 cm. The total length of the product is approximately 26.6 cm. No sample was taken from the artefact for dendroarchaeological research, but previous analyses indicate that it was made from alder (*Alnus*sp.) (Rimantienė 2005, 449).

The choice of these (and not other) artefacts for the analysis reported here over other similar products found in Šventoji was determined by their relatively good state of preservation.

2.2. Methods

As mentioned in the introduction, traceological research on wooden artefacts has only very recently been begun, and a research methodology that takes into account their specificity has not yet been developed. For this reason, the reported microscopic studies used

Fig. 7. The examples of the use-wear traces observed on the working edges of the experimental tools (Illustration by G. Osipowicz)

the methodology and terminology already developed for traceological studies of stone and bone specimens (*e.g.*, Vaughan 1985; Van Gijn 1989; Sidera 1993; Juel Jensen 1994; Korobkowa 1999; Legrand, 2007; Osipowicz 2010; Buc 2011; Orłowska *et al.* 2023). Of course, they were adapted (as much as possible at this stage of research) to the specificity of the analysis of wooden products.

Two microscopes were used during the research. The assessment of the state of preservation of the artefacts, as well as a preliminary analysis of technological and functional traces present on their surface, was carried out using a Nikon SMZ-745T optical microscope coupled with a Delta Pix Invenio6EIII camera. It allows for optical magnifications of up to 50×. This equipment was used to take the microphotographs shown in Figs. 3, 4 and 7. Additionally both, artefacts and experimental tools were analysed using the Zeiss Axioscope 5 Vario metallographic microscope, which allows obtaining objective magnifications up to 50× (optical magnifications up to 500 ×).

Samples for dendroarchaeological research, the results of which are presented in the article, were collected using an incremental drill, taking cores with a diameter of 5 mm and a length of approximately 10 mm. The samples were contaminated with the substance used to preserve the artefacts, *i.e.*, wax, which was removed by a 5-minute water bath at 100˚C, which was repeated three times. For anatomical analyses, an Olympus BH2 reflected light microscope was used, operating in the magnification range of 50-500×, with the possibility of conducting observations in a dark and bright field. The observations used the phenomenon of lignin fluorescence in ultraviolet light (Donaldson 2013). For this reason, a specially designed UV light source with a frequency of 365 nm was installed in the microscope. This equipment was used to take the microphotographs shown in Fig. 5. For taxonomic determinations, anatomical keys were used (Schweingruber *et al.* 2011, 2013) and a xylological comparative collection. The names of the plants are given in accordance with the botanical nomenclature applicable in Poland (Mirek *et al.* 2002).

2.2.1. Experimental program

The experimental research program carried out for the purposes of these studies was largely based on suggestions made about the functions of the analysed artefacts by the author of the excavation, R. Rimantienė (2005). In the case of the artefact from the Šventoji 1 site, she suggested that it was a stick, maul for driving, beating poles (German: *Holzbleuel*). She based this suggestion on the fact that it was found among elements of a fence, with three more similar artefacts lying nearby – all very worn, with the heads smashed and the shafts broken (Rimantienė 2005, 244). The remaining analysed artefacts were interpreted by the excavator (Rimantienė 2005, 346) as nut shellers, used to crush hazelnuts and/or water chestnuts (*Trapa natans*). The basis for this suggestion were ethnographic analogies and the fact of identifying the remains of a water chestnut on the surface of one of the artefacts (Rimantienė 2005, 449). Additionally, the planned experimental program included activities that, in the opinion of the authors of this article, could have generated traces analogous to damage of (possibly) usage origin that was observed on artefacts from Šventoji.

Experimental tools were used for the following activities (*cf. Supplementary material*):

1. Debarking of poplar and hornbeam trunks. The experiment was carried out during the first International Camp of Experimental Archaeology, Toruń 2021 (Osipowicz *et al.* 2022). In order to debark trunks intended for dugout canoes, wooden and antler wedges were beaten with two pestles made of ash wood (Fig. 7: A). They were also used in the same way to remove the rotten outer layers of the tree. The duration of the experiment is impossible to determine because the tools were used *ad hoc*, when necessary. However, it was not less than a few hours.

2. Driving wooden pegs into the ground. The experiment was carried out during the first International Camp of Experimental Archaeology, Toruń 2021, but also after its completion, at the Institute of Archaeology of the Nicolaus Copernicus University. A hammer made of pine wood was used to drive sharpened stakes made of different types of wood into the ground to various depths. Also in this case, the exact duration of the experiment is impossible to determine, but it was certainly over an hour.

3. Breaking hazelnut shells. During the experiment, dried hazelnuts placed on a processed trunk of an unspecified tree were broken with a pestle made of pine wood (Fig. 7: D). The experiment lasted approximately 60 minutes.

4. Grinding hazelnuts. The experiment involved crushing/grinding hazelnuts in a small beechwood bowl using a pinewood tool (Fig. 7: G). The duration of the experiment was 30 minutes.

5. Grinding the shells in a wooden container. The experiment was identical to the one described above, except that in this case the shells of the common mussel (*Anodonta anatina*) were crushed (Fig. 7: J).

It was impossible for us to carry out experiments with the processing of water chestnuts (*Trapa natans*) due to the fact that this plant is currently a species found very rarely in the Baltic Sea zone.

3. RESULTS OF TRACEOLOGICAL ANALYSIS

3.1. Artefacts

Traceological research carried out on the described artefacts from Šventoji was significantly hampered by the post-depositional damage present on their surface. Among them, the most important (and most common) include various types of fractures and cracks, rounding and smoothing of the edges, and numerous compression marks resulting from the pressure on the object after its deposition. Changes caused by the applied conservation process created additional difficulties. One of its results is the thorough cleaning of the surface of artefacts from contamination originating from the context in which they were located, but also (at the same time) from any residues related to their function. The preservative used was largely absorbed by the wood and did not pose a problem during analyses using optical microscopes and low magnifications. However, it made it difficult to analyse possible usage polishes using metallographic microscopes. The conservation process did not have a significant impact on the degree of preservation of impact, compression or abrasion traces, which appear to have been preserved in good condition on the artefacts considered and were the main subject of the following analysis.

Traceological examination of the wooden artefacts in question led to the identification of quite uniform technological traces on their surface in the form of incisions and planing/chopping negatives (Fig. 3: E). At the same time, they showed considerable discrepancies in the characteristics of damage considered being (possibly) usage, visible on individual products. The results of the analysis in this regard are as follows:

In the central part of the head of the tool from the Šventoji 1 site, a large loss of wood fibres is visible macroscopically (Fig. 3: 1). This area should most likely be considered a working surface. Microscopic analysis showed that this loss is the result of strong compression and crushing of the fibres, without any clear traces of their cutting (Fig. 3: A, B). The highly destructive nature of this damage causes the surface topography in this place to be heterogeneous and its relief to be very irregular. No polish or linear traces were found.

In the case of a tool from the Šventoji 3 site, damage of possibly utilitarian origin was observed on the top of its head (Fig. 3: 2 – the range is marked with a dashed line). Its characteristics are different than in the case of the tool from Šventoji 1. The surface topography here is definitely more homogeneous and its relief is quite regular. It also appears to be slightly roughened, with the higher areas of the micro-relief being clearly smoothed and rounded (Fig. 3: C, D). However also in this case, no polish or linear traces were found. Additionally, in the central part of this specimen, on one of the wider sides, a depression was observed, the origin of which could not be clearly explained (Fig. 3: 2 – marked with an arrow). However, it seems to be post-depositional due to the lack of any impact traces in this place.

Depressions, approximately 4 cm in diameter and up to several millimetres deep, were also observed on both sides of the head of the first of the analysed tools from the Šventoji 23 site (Fig. 4: 1). In this case, however, as a result of the microscopic analysis, it was found that these are areas of strong compression and crushing of the wood fibres with a large number of small cracks between them (Fig. 4: A, B). The scope of changes in the structure of the raw material that occurred in these places is confirmed by comparing Fig. 4: A, B with a microphotograph taken just outside the border of one of them, where the course of the wood fibres is very regular and they show no signs of destruction (Fig. 4: C).

On another tool from Site 23 in Šventoji (Fig. 4: 2), changes of perhaps utilitarian origin were observed elsewhere. Most of the surface of this specimen is heavily damaged, but on the top of its head there are signs of surface crushing, associated with identically oriented (and consistent with the axis of the specimen) single linear traces in the form of shallow linear depressions (Fig. 4: D; the potentially used area is marked with a dashed line; linear depressions are marked with an arrow). The surface topography in this place is homogeneous and the microrelief is quite regular.

The last specimen from the Šventoji 23 site (Fig. 6) did not contain any traces that could be considered potentially due to usage. Its surface is too damaged post-depositionally.

3.2. Experimental tools

The use-wear traces produced on individual experimental tools differ to a large extent. The element common to all of them is the lack of a clear usage polish (it was also not legible when observed using a metallographic microscope).

As a result of experiments involving hitting wooden and antler wedges, in order to debark tree trunks and driving wooden piles into the ground, quite similar use-wear traces was produced on experimental pestles (although the degree of their development was different). All tools show significant crushing and destruction of the wood fibres, which leads to their fragmentation. This results in a significant loss of material in the working zone of the tools. What is important here is the fact that most of the fibres do not show signs of being cut, but of being crushed/broken off (Fig. 7: B). There are also numerous compression traces (irregular depressions) with different characteristics on the working surface (Fig. 7: C). The topography of the working surface is heterogeneous and its micro-relief is very irregular. The difference between pestles used for debarking and those used for driving piles into the ground is that the traces of use on the first type of tools are much less developed. However, it can be assumed that as a result of their use long enough, their characteristics would become identical to those observed on the second type of tools.

The first, macroscopically noticeable result of using a wooden pestle to break hazelnut shells was the creation of an irregular, shallow depression on its working surface with a diameter of about 2.5 cm. Within it, numerous compression traces were observed, including irregular deformations of the tool's working surface (depressions), visible surface cracks and a type of linear traces, *i.e.*, linear depressions with different characteristics and course (Fig. 7: E, F). Compression of the fibres within the working surface of the tool also led to their fraying and a type of peeling/delamination of the wood, consisting in the separation of its layers belonging to different rings (Fig. 7: E). The microtopography of the working surface can be described as homogeneous and the micro-relief is regular.

As a result of crushing/pulping hazelnuts, very faint traces of use were created on the experimental tool. In this case, no significant crushing of the wood fibres or their splitting/breaking was observed. On the working surface, only a slight rounding of the higher parts of the raw material relief and a slight fraying of the fibre ends are visible (Fig. 7: H, I).

A relatively large number of small fragments of ground nuts were pressed into the relief (readable as brown dots in the photos).

Different functional damage was caused by grinding the shells. In this case, a clear crushing and compression of the fibre "terminations" was observed on the working surface, resulting in their splitting and "pressing" into the working surface (Fig. 7: K, L). As a result, it becomes clearly rounded. Its topography is heterogeneous and the microrelief is very irregular. Also in this case, fragments of the processed material pressed deep into the working surface were documented (Fig. 7: K, L – marked with arrows).

4. DISCUSSION

Traces considered as (probably) utilitarian observed on the analysed artefacts and the use-wear damage visible on experimental tools are so well developed that they allow their comparison with each other and verification (at least to some extent) of the hypotheses put forward by the authors of the research in Šventoji regarding the artefacts' functions. However, a certain problem here is (both in the case of prehistoric and experimental specimens) the lack of usage polish, which is one of the basic diagnostic indicators during traceological (functional) analyses of stone and bone products (*e.g.*, Vaughan 1985; Van Gijn 1989; Sidera 1993; Juel Jensen 1994; Legrand 2007; Osipowicz 2010; Buc 2011; Orłowska *et al.* 2023). At this stage of research, it is difficult to say whether its absence is due to the specificity of activities performed with wooden pestles, post-deposition processes (in the case of artefacts), or differences in use-related damage that occur (generally) on wooden tools (although it should be noted here that the presence of usage polish on tools made of this raw material has already been indicated in the literature – *cf.*, Caruso Fermé *et al.* 2014, 2015; Caruso Fermé and Aschero 2020). This problem certainly requires much more multi-aspect studies, especially experimental ones, and cannot be solved at the stage of preliminary research such as that reported in this article.

Apart from this issue, the results of the traceological analysis presented here allow the making of several observations about the functions of the examined wooden products from Šventoji and the possibility of interpreting the (potential) use-wear damage observed on them.

First of all, it should be stated that the traces visible on the artefact from the Šventoji 1 site are very similar to those observed on the tools used to hit wedges during the experimental debarking, and basically identical to those visible on pestles used to drive wooden pegs into the ground. The suggestions of the authors of the research at the site regarding the function of this tool (a stick, maul for driving, beating poles; Rimantienė 2005, 244) therefore seems very likely.

The remaining wooden artefacts from Šventoji included in this study were considered probable nut shellers (tools used to crush hazelnuts and/or water chestnuts; Rimantienė

2005, 64, 346). The use-wear damage caused to a wooden pestle as a result of experimental hazelnut cracking is, to some extent, similar to that observed only on one of them, namely the specimen from the Šventoji 23 site shown in Fig. 4: 1. On this artefact and on the experimental tool, in the central part of the working surface, a shallow depression is visible, created as a result of crushing wood fibres during nut cracking. In both cases, clear compression traces were observed on the working surface, although their characteristics are slightly different. What they have in common is the presence of microcracks in the surface of the raw material. However, the difference is that in the case of the artefact, we basically only observe the crushing of wood fibres, while on the experimental tool we can also see (perhaps even primarily) various types of compression deformations (depressions), which do not significantly affect the structure of the raw material fibres (apart from the fact that lead to their splitting). These discrepancies do not, however, seem to exclude the possibility of using this artefact for cracking nuts, as they may result from raw material factors (the artefact and the experimental tool are made from different types of wood) or morphological factors (the use of morphologically different branch fragments). This problem undoubtedly requires further experimental and traceological research.

In the case of the remaining artefacts from Šventoji, for which the function of nut shellers was suggested, the similarity of the damage visible on them to the use-wear traces created as a result of experimental cracking of hazelnuts was not confirmed. A certain analogy to the linear depressions visible on this experimental tool may be traces of this type observed on the top of the head of the artefact from the Šventoji 23 site, shown in Fig. 4: 2. However, no other types of damage caused to the experimental product were recorded on this specimen, which does not allow it to be associated with nut cracking with greater probability (especially considering the heavy destruction of the specimen). Nevertheless, the surface on which the above-mentioned traces were observed can be considered as probably used.

The potential origin of the traces observed on the top of the head of the artefact shown in Fig. 3: 2 was initially associated with grinding of some material. However, they are not similar to the damage caused by experimental grinding of nuts and shells in wooden bowls. Of course, this does not definitively rule out their utilitarian origin. However, it cannot be ruled out that we are dealing here with a post-depositional modified surface.

As already mentioned in the introduction, prehistoric wooden artefacts, especially those dating back to the Stone Age, are extremely rare archaeological sources. Work on creating a methodology for traceological research adequate to their specificity is ongoing and each subsequent study in this area is valuable. Previous research indicates that it is undoubtedly possible to conduct reliable technological analyses of prehistoric wooden objects (see Caruso Fermé *et al.* 2014; 2015; 2023; Schoch *et al.* 2015; Lozovskaya and Lozovski 2016; Rios-Garaizar *et al.* 2018; Caruso Fermé and Aschero 2020; Vidal-Matutano *et al.* 2021; Barham *et al.* 2023; Gibaja *et al.* 2023). The traces resulting from wood processing using stone tools are in many respects similar to those observed on bone products, which simplifies analytical procedures because it is possible to use the findings made for them.

The situation seems to be slightly different in the case of use-wear (functional) analyses. Answering the question posed in the title of this article, it can be said that this type of research is most likely also possible, but the traces of use created on wooden objects as a result of their use as tools are specific and in many respects different from those observed on stone and bone products. At this stage of research, in the vast majority of cases, their correct interpretation seems to be very difficult, if not impossible. Improving the situation in this respect undoubtedly requires conducting a large number of experiments, taking into account various types of wood and other variables, the ultimate goal of which will be to create a reliable classification of traces on wooden tools, corresponding to the specificity of the raw material. This is extremely important, because even the traceological studies carried out for the purposes of this article – very preliminary in their profile – indicate that taxonomic and morphological factors may be of key importance for the characterization of traces of use visible on wooden objects. The issue of the formation and characteristic of usage polishes, which could not be identified through the reported research, also seems to be very important here.

A major problem for traceological studies of prehistoric wooden objects is their state of preservation. It is obvious that the possibilities of identifying technological and (especially) use-wear (functional) traces depend on the degree of post-depositional destruction of artefacts. The preservative substances and processes used in the case of prehistoric objects are also of great importance for their readability. Future experimental work should undoubtedly also include studies in this area.

The Šventoji collection seems to be an excellent material for testing the possibility of conducting traceological research of prehistoric wooden objects, because these artefacts are very well preserved, and the conservation process used did not have a destructive impact on many categories of technological and functional traces. However, the interpretative possibilities and limitations resulting from these analyses will become visible only in the future, after more research has been conducted and their application to the results of other analyses conducted in Šventoji.

5. CONCLUSIONS

The studies presented in the article were of a preliminary nature, therefore the conclusions drawn here may still change. However, this type of research should be considered very promising and should therefore be continued, despite the difficulties that we will certainly have to face again and again. Traceological analyses of wooden products can be carried out using equipment and methodology used for examining stone and bone artefacts. The intensification of studies in this area depends solely on the availability of the subject of analysis, *i.e.*, prehistoric wooden products, and on our willingness. We consider the most important for research in the near future to be multi-aspect experimental studies aimed at replication and precise classification of traces of use created on wooden objects during various activities. In the case of Šventoji, further categories of artefacts should be subjected to microscopic analysis. This may help in assessing the impact of post-depositional processes and conservation on their surfaces and constitute an excellent material for cross-verification of conclusions drawn during experimental research.

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