Journal of Archaeological Science: Reports 29 (2020) 102130

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: www.elsevier.com/locate/jasrep

An occasional ornament, part of clothes or just a gift for ancestors? The results of traceological studies of teeth pendants from the Subneolithic sites in Šventoji, Lithuania

Grzegorz Osipowicz[a,*], Giedrė Piličiauskienė[b], Justyna Orłowska[a], Gytis Piličiauskas[c]

[a] Institute of Archaeology, Nicolaus Copernicus University, Szosa Bydgoska 44/48 Street, 87-100 Toruń, Poland
[b] Departament of Archaeology, Vilnius University, Universiteto 7, 01513 Vilnius, Lithuania
[c] Archaeology Department, Lithuanian Institute of History, Kražių 5, 01108 Vilnius, Lithuania

ARTICLE INFO

Keywords:
Šventoji
Use-wear
Traceology
Subneolithic
Animal teeth
Pendants
Experimental archaeology

ABSTRACT

This article presents the results of a zooarchaeological, technological and functional analysis of a collection of animal tooth pendants from the Subneolithic sites in Šventoji, Lithuania. The technological research carried out on the artefacts showed minimal interference in the material and the use of three basic techniques for drilling the holes. Traseological research of the use-wear traces legible on the pendants established a long period of use and was a premise for making inferences on the likely differences in their way of use. These inferences were tested with an experimental programme testing different ways of wearing pendants and with different types of strings. The article also presents the results of the analysis of the spatial distribution of pendants of different types at the site Šventoji 23. The discussion compares the results of the analyses carried out with the results of studies of other European collections of animal tooth pendants of similar chronology.

1. Introduction

Animal teeth represent one of the basic raw materials in prehistory used to manufacture body accessories. Despite being simple in form, they usually conceal many meanings and social functions significant to the individuals who were using them (Taborin 1993; Álvarez-Fernandez, 2009). We know from burial contexts that they could have been worn on various parts of the body and in many ways, however, we still have little knowledge about their original purpose and hidden meaning. A significant contribution to the development of studies on this part of culture of prehistoric communities have been made by use-wear research and experimental archaeology. These methods are of key significance for interpreting the ways for manufacturing and using objects of this kind. An exhaustive description of studies conducted so far in this regard can be found in a recently published article by Catarina Guzzo Falci et al. (2019).

The fundamental questions asked during research on prehistoric pendants made from animal teeth include those concerning discrepancies in the technology of manufacturing, their specific types, the way they were worn/attached to clothes, the time of use and the reasons why and the manner in which they left the utility context, whether they were abandoned by chance or deposited intentionally. Answers to these may allow us to learn the actual function and the socio-cultural meaning of pendants from a specific collection, and could also be applied in research conducted on other assemblages by analogy.

In this article results of an archaeozoological analysis, a technological analysis and a use-wear analysis of a collection of animal tooth pendants from sites 1–4, 6 and 23 in Šventoji, Lithuania are presented. This research aims to provide an answer to a question regarding preferences of raw materials and technologies applied by the Subneolithic peoples with respect to items of this type, the way they were used and possible reasons why they were deposited. The solving of the last of these was to be facilitated by an analysis of distribution of pendants of various types in site Šventoji 23. The results of the conducted studies were compared with the information on other collections of this kind from chronologically similar European sites.

2. Context, material and methods

The complex of sites in Šventoji (Fig. 1) was discovered in 1966 by Mikelis Balčius and Rimutė Rimantienė during irrigation works carried out in the region. At the time, several tens of archaeological sites and loose finds were identified, dated now (including the sites discovered later) to the period between 6000 and 500 cal BC. They are located on a swampy Littorina sea terrace, 16 km long and up to 2.5 km wide,

* Corresponding author.
E-mail address: grezegor@umk.pl (G. Osipowicz).

https://doi.org/10.1016/j.jasrep.2019.102130
Received 5 October 2019; Received in revised form 25 November 2019; Accepted 26 November 2019
Available online 13 December 2019

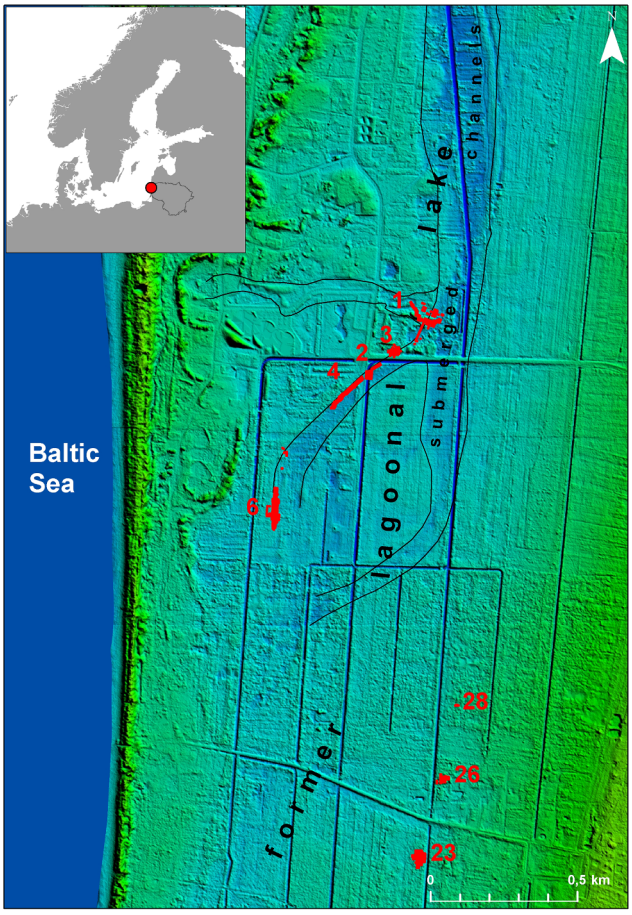

Fig. 1. Location of the sites in Šventoji.

stretching between the City of Palanga and the Lithuanian-Latvian state border (Piličiauskas et al., 2012; Piličiauskas 2016). The sites were interpreted as habitation sites, refuse layers, fishing stations and possibly pile dwelling settlements. A number are wetland sites with well-preserved organic materials found in waterlogged lake deposits (gyttja; Rimantienė, 2005; Piličiauskas, 2016; Luik and Piličiauskienė, 2016). Human occupations at different sites were ^{14}C dated to 6000 cal BC (Šventoji 40), 4000–3700 cal BC (Šventoji 43 and 45), 3200–2500 cal BC (Šventoji 1–4, 6, 23, 41A, 42, 51, 52), and 2000–700 cal BC (Šventoji 9, 41B, 47, 48) (Piličiauskas et al., 2012; Piličiauskas and Heron, 2015; Piličiauskas 2016).

At sites 1–4, 6, 23 and 26 numerous bone artefacts and working debris were found (compare Luik and Piličiauskienė, 2016) including 79 animal teeth, with traces of processing, that can be interpreted as pendants (Fig. 2). Most come from site 23 (46 pieces). At site 6, 11 products of this kind were present, 9 were found at each of sites 3 and 4, 3 pendants occurred at site 2 and one at Šventoji 1. In the studies described below 40 of these artefacts were considered in total (all of which are accessible to the authors), 13 of which were preserved whole, 21 from site Šventoji 23, 8 from site 4, 7 from site 6 and one each from sites Šventoji 1, 2 and 3 (cf. Table 1). The one remaining artefact was not attributed to any particular site.

The traceological analyses were performed using three microscopes. Studies on technological traces and general characteristic of the working edges were made using a Nikon SMZ-2T microscope with up to 12.6 magnitude (virtual magnification up to 120) fitted with a Nikon D7100 camera. The photomicrographs presented in Fig. 3 and 4A-D were made using such equipment. Additionally, a Nikon SMZ-745T microscope fitted with a Delta Pix Invenio 6EIII camera was also employed to a considerable extent. It was used to make the photomicrographs presented in Fig. 4E, L, M. Observations of polish were performed using a Zeiss-Axiotech microscope with up to 50 magnitude (virtual magnification up to 500) fitted with Axiocam 105 camera. The photomicrographs presented in Fig. 4F-K, N, O; 8, 9 were also made with this equipment. All the considered artefacts were subject to use-wear studies using an optic microscope. For reasons beyond the control of the authors, the analysis of polish using a metallographic microscope Zeiss-Axiotech was performed only on 7 selected pendants. The selection criteria were random. The only factor taken into account was the lack of macroscopically clear traces of substances used for preserving the objects.

The terminology applied in the traceological studies was based on the conceptual system existing in the literature (e.g. Campana 1989; Korobkova 1999; Sidéra and Legrand, 2006; Osipowicz 2010) and referring especially to experimentation (such as Newcomer 1974; d'Errico et al 1984; Christidou 2008; Vanhaeren et al. 2013; Orłowska 2016), description of the volume and surface alteration/deformation (such as Sidera 1993; Bonnardin 2007) and polish topography (such as Vaughan 1985; van Gijn 1989; Juel Jensen 1994; Legrand 2007; Buc 2011), which was adjusted to the needs and requirements of the conducted analysis.

During the description of location of wear traces observed inside holes in the pendants a scheme based on a dial plate was used with specific hours on the dial plate corresponding to sectors where traces occurred, i.e. sector 1 marked the area between hours 12 and 1, sector 2 the area between hours 1 and 2, and so on.

Before the analysis, experimental pendants were cleaned in water with detergent. The state of preservation of the analysed artefacts varied. Many of them had numerous cracks and other surface destructions. Only in exceptional cases (when the state of preservation was good enough) they were cleaned with alcohol.

3. Results of the analyses

3.1. Results of the archaeozoological analysis of the artefacts

At sites 1, 2–4, 6 and 23 in Šventoji nearly 80 animal teeth with traces of intentional processing were found (Table 2). Among them, in all assemblages products made from elk (*Alces alces*) teeth dominated. These represented 50% (n – 23) at site 23, 54.6% (n – 6) at site 6 and and 28.6% (n – 6) at sites 2–4. The single pendant from Šventoji 1 was also made from elk tooth. The second most represented species most was seal (*Phoca*), with 32.5% (n – 15) of pendants at site 23, 19.0% (n – 4) at site 2–4 and 18.2% (n – 2) at sites 2–4. At the complex of sites Šventoji 2,3 and 4 , 4 pendants were found at each of the sites (19% of the assemblage) made from teeth of aurochs (*Bos promigenius/ Bison bonasus*) and wild boar (*Sus scrofa*). 4 pendants from aurochs teeth come from site 23, and 3 from wild boar teeth and one pendant from wild boar tooth from site 6. In the assemblage from sites in Šventoji a single pendant made from a wolf tooth was discovered, as well as 4 specimens made from teeth of other carnivora, most likely fox (*Vulpes vulpes*).

From among the 21 pendants from site Šventoji 23 analysed microscopically in this article, 16 were made from elk teeth, 3 were made from seal teeth, 1 was made from a wild boar tooth, and one from an undetermined species (cf. Table 1). Three of the analysed pendants from site 4 were from aurochs teeth, 2 elk teeth, and the remaining 3 from seal, wild boar and wolf. Of those from site Šventoji 6, 5 were made from elk teeth, 1 from seal tooth and 2 from wild boar tooth. One pendant made from elk tooth from sites Šventoji 1 and 2 each were analysed, one made from a wild boar tooth from site Šventoji 3 and 1 made from an elk tooth that was not attributed to any of the sites.

Fig. 2. A selection of the animal teeth pendants found at sites in Šventoji, with marked locations of the photomicrographs (Photo J. Orłowska).

3.2. Results of the technological analysis of the artefacts

The technological traces observed on the analyzed artefacts were only associated with the holes. There are three basic manufacturing techniques.

Type 1 (drilled hole): this technique was applied in 11 cases. Traces of its use are clearly visible on inner walls of the holes (Fig. 3A-C). In all cases, the pendant was drilled on both sides to create a hole of an hourglass-shaped cross-section (Fig. 3C). The drilling technique was used during the manufacturing of pendants made from 6 elk teeth (I), 2 seal teeth (C and I) and one wild boar tooth (I), one aurochs tooth (I) and one wolf tooth (C).

Table 1
Characteristic of the teeth pendants from Šventoji sites, studied traceologicaly.

No.	Inwentory number	Site	Excavation year	location (trench/ sq m)	Species	Tooth	Integrity	Technique of perforation	Usage traces	Figure
1	EM 2070:208	Šventoji 1	1967	11b	A.alces	I	Fragmentary (broken crown)	Type 2	**Used;** polish legible on the both sides of the tooth; on all edges of the hole	Fig. 2.21
2	EM2135:210	Šventoji 2	1969	–	A.alces	I	Fragmentary (broken crown)	Type 3	**Used;** polish legible on both sides of the tooth; on all edges of the hole	Fig. 2.32
3	EM 2110:9	Šventoji 23	1970–1971	3/6d	A.alces	I	Complete	Type 3	Not legible	Fig. 2.18
4	EM 2110:10	Šventoji 23	1970–1971	3/8b	Phocidae	C	Complete	Type 3	Not legible	–
5	EM 2110:13	Šventoji 23	1970–1971	1/9b	A.alces	I	Complete	Type 3	Used	Fig. 2.15
6	EM 2110:18	Šventoji 23	1970–1971	3/7c	A.alces	I	Fragmentary (broken hole)	Type 3	Not legible	–
7	EM 2110:20	Šventoji 23	1970–1971	3/7d	A.alces	I	Fragmentary (broken hole)	Type 2	Not legible	–
8	EM 2110:21	Šventoji 23	1970–1971	3/7e	A.alces	I	Fragmentary (broken hole)	Type 3	Used	Fig. 2.11
9	EM 2110:24	Šventoji 23	1970–1971	3/7e	A.alces	I	Fragmentary (broken hole)	Type 3	Used	–
10	EM 2110:27	Šventoji 23	1970–1971	3/7e	A.alces	I	Fragmentary (broken hole)	Type 3	Used	–
11	EM 2110:28	Šventoji 23	1970–1971	3/8e	A.alces	I	Fragmentary (broken hole)	Type 1	Not legible	–
12	EM 2110:31	Šventoji 23	1970–1971	2/6a	A.alces	I	Fragmentary (broken hole)	Type 3	Not legible	–
13	EM 2110:32	Šventoji 23	1970–1971	3/7d	A.alces	I	Fragmentary (broken crown)	Type 3	Not legible	Fig. 2.10
14	EM 2110:33	Šventoji 23	1970–1971	3/9b	A.alces	I	Fragmentary (broken crown)	Type 1	Used	Fig. 2.4
15	EM 2110:34	Šventoji 23	1970–1971	3/9e	A.alces	I	Fragmentary (broken crown)	Type 3	Used	Fig. 2.16
16	EM 2110:35	Šventoji 23	1970–1971	3/5d	A.alces	I	Fragmentary (broken crown and hole)	Type 1	Used	–
17	EM 2110:36	Šventoji 23	1970–1971	1/10b	A.alces	I	Fragmentary (broken crown)	Type 3	Used	Fig. 2.14
18	EM 2110:37	Šventoji 23	1970–1971	3/7a	Phocidae	I	Complete	Type 3	Not legible	Fig. 2.22
19	EM 2110:39	Šventoji 23	1970–1971	–	A.alces	I	Fragmentary (broken crown)	Type 1	Used	Fig. 2.5
20	EM 2110:40	Šventoji 23	1970–1971	1/8e	S.scrofa	C	Fragmentary (broken hole)	Type 3	Not legible	Fig. 2.2
21	EM 2110:54	Šventoji 23	–	1/9e	–	–	Fragmentary (broken crown and hole)	Type 2	Used	Fig. 2.9
22	EM 2110:80	Šventoji 23	1970–1971	6/9e	Phocidae	I	Fragmentary (broken hole)	Type 1	Used	Fig. 2.27
23	EM 2110:85	Šventoji 23	1970–1971	6/9d	A.alces	I	Complete	Type 3	Not legible	Fig. 2.23
24	EM 2132:6	Šventoji 3	1971–1972	stray	S.scrofa	I	Fragmentary (broken hole)	Type 1	Not legible	Fig. 2.26
25	EM 2136:167	Šventoji 4	1985–1995	11f	B. primigenius/B. bonasus	I	Fragmentary (broken hole)	Type 1	Not legible	Fig. 2.31
26	EM 2136:170	Šventoji 4	1985–1995	15ė	B. primigenius/B. bonasus	I	Complete	Type 2	**Used;** polish legible on both sides of the tooth; mostly on the upper parts of the hole	Fig. 2.17
27	EM 2136:171	Šventoji 4	1985–1995	15ė	B. primigenius/B. bonasus	I	Complete	Type 2	**Used;** polish legible on one side of the tooth; mostly on the upper and side parts of the hole	Fig. 2.7
28	EM 2136:185	Šventoji 4	1985–1995	21u	Phocidae	C	Complete	Type 3	Not legible	Fig. 2.13
29	EM 2136:186	Šventoji 4	1985–1995	21v	S.scrofa	I	Complete	Type 3	**Used;** polish legible on one side of the tooth; mostly on the upper parts of the hole	Fig. 2.8
30	EM 2136:188	Šventoji 4	1985–1995	16z	A.alces	I	Complete	Type 2	**Used;** polish legible mostly on the upper parts of the hole	Fig. 2.30
31	EM2136:901	Šventoji 4	2003	–	A.alces	I	Complete	Type 2	**Used**; polish legible on all edges of the hole	Fig. 2.3
32	EM2136:903	Šventoji 4	2003	–	C.lupus	C	Complete	Type 1	**Used;** polish legible on both sides of the tooth; mostly on the upper and side parts of the hole	Fig. 2.1
33	EM 2138:649	Šventoji 6	1983–1988	20g	A.alces	I	Fragmentary (broken hole)	Type 1	Used	Fig. 2.20
34	EM 2138:657	Šventoji 6	1983–1988	26H	Phocidae	C	Fragmentary (broken hole)	Type 1	Used	Fig. 2.28
35	EM 2138:676	Šventoji 6	1983–1988	22h	A.alces	I	Fragmentary (broken hole)	Type 3	Used	Fig. 2.6
36	EM 2138:683	Šventoji 6	1983–1988	39g	A.alces	I	Fragmentary (broken hole)	Type 1	Used	Fig. 2.24
37	EM 2138:706	Šventoji 6	1983–1988	26h	A.alces	I	Fragmentary (broken hole)	Type 3	Not legible	Fig. 2.19
38	EM 2138:707	Šventoji 6	1983–1988	26J	A.alces	–	Fragmentary (broken above the hole)	Type 3	Not legible	Fig. 2.25
39	EM 2138:708	Šventoji 6	1983–1988	28H	S.scrofa	I	Fragmentary (broken hole)	Type 2	Not legible	Fig. 2.29
40	Without number	–	–	–	A.alces	I	Complete	Type 3	Used	Fig. 2.12

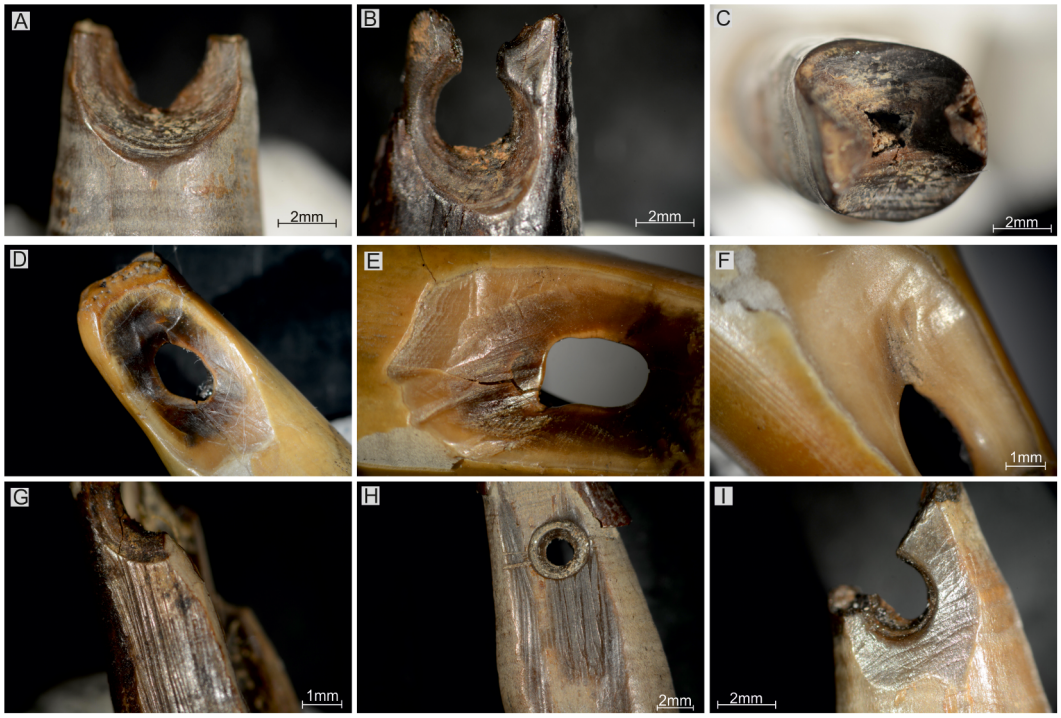

Fig. 3. Examples of the technological traces observed on pendants from Šventoji (Photo G. Osipowicz).

Type 2 (scraped hole): in 8 of the analysed cases, holes were formed as a result of a bilateral scraping and (possibly) complementary whittling (Fig. 3D-F). In some of the holes made in this way traces of cutting were identified, performed at the final stage of work to create a perforation (Fig. 3F)[1]. It cannot be ruled out that this was the standard activity in most specimens of this type. Among the pendants identified using this technique, 4 specimens were elk teeth (I), 2 aurochs teeth (I) and one a wild boar tooth (I).

Type 3 (scraped and drilled hole): 21 holes in the analysed pendants were made using a mixed technique, that is, scraping combined with drilling. First, the surface in which a hole was planned to be made was prepared by scraping. This allowed the excess raw material to be removed and a flat or even slightly concave surface was formed that facilitated subsequent drilling, (Fig. 3G-I). These treatments were applied at both sides of the pendant, giving an hourglass-like cross-section. Some also bear traces of widening by whittling. In one case, the initial scraping of the raw material was replaced with grinding, while in another the pendant was repaired (re-drilled). This technique was used for making holes in 16 pendants made from elk teeth (I), 3 from seal teeth (2-C and 1-I) and 2 of wild boar teeth (C and I).

3.3. Results of the use-wear analysis of the artefacts

During the initial stages of wear analysis, conducted using optical microscopes, traces of use-wear were observed on 25 specimens. These were primarily in the form of surface smoothing and rounding of the edges and inner parts of the holes, focused in their different parts (e.g. Fig. 4C). However, in some cases the traces formed concave surfaces (highly smoothed – Fig. 4A, B or with linear roughness – Fig. 4D), which suggests that the pendants were attached to clothes in a strong and stable manner, preventing them from moving from side to side. Clear differences were observed in the location of the surfaces in the presumed upper part of holes in sectors 12 and 1 (Fig. 4A, B), offset to one of the sides, for example in sectors 10–12 (Fig. 4C) or only on the side, for example in sector 2 (Fig. 4D). These differences reflect it is suggested, ways of attaching the pendants. This was verified in the course of experimental studies described further in the article. Further information on the characteristics of wear traces present on the pendants was provided by analyses using a metallographic microscope. Of the 7 artefacts analysed in the above manner, only 5 had clear wear traces. The other two proved impossible to analyse due to their surfaces being covered with a substance used for preserving.

The first of the pendants (Fig. 2: 1) is highly smoothed and polished on the entire surface. The origin of these wear traces is ambiguous and can be either post-depositional, or use, or both . In the lower part of the hole visible on the artefact clear technological traces can be noted (remains after scraping – Fig. 4E). In the upper part, in sectors 10–12 and 1–3, a bright polish that completely destroyed them is present. It has a flat topography, slightly rough texture and is related to linear traces in the form of dark and filled striations oriented primarily in accordance to the orientation of the hole (Fig. 4F). There is also a clear polish above the hole on the outer surface of the tooth (Fig. 4G). There, its topography is more domed with features of 'hide polish' and is definitely different to the natural surface visible below the hole (Fig. 4H).

The surface of the second analysed pendant is quite substantially worn, and the hole is preserved only fragmentarily (Fig. 2:2). Nonetheless, in its upper part on a small fragment of the edge a linear polish of a slightly domed topography and rough texture is preserved, related to multi-directional linear traces (Fig. 4I). Additionally, on the scraped surface below the hole places covered with a polish-worn traces of flat topography and slightly rough texture were observed (Fig. 4J). Their origin is most likely due to use, which shall be discussed in more detail further in the article.

In the hole of the third of the analysed pendants (Fig. 2:3) a linear polish of flat topography and slightly rough texture occurred, related to multi-directional linear traces and deep in the hole these are oriented primarily in one direction, which accords with the orientation of the hole. This polish is asymmetrical, in that it is by far more developed on one side of the pendant and centred in the upper part of the hole where it completely destroys technological traces (Fig. 4K). In its lower part,

[1] This technique has been already known from sites of a similar chronology in the region (David 2006), as well as Late Palaeolithic collections, e.g. the Rhine Kniegrotte, Teufelsbrucke (Płonka 2012).

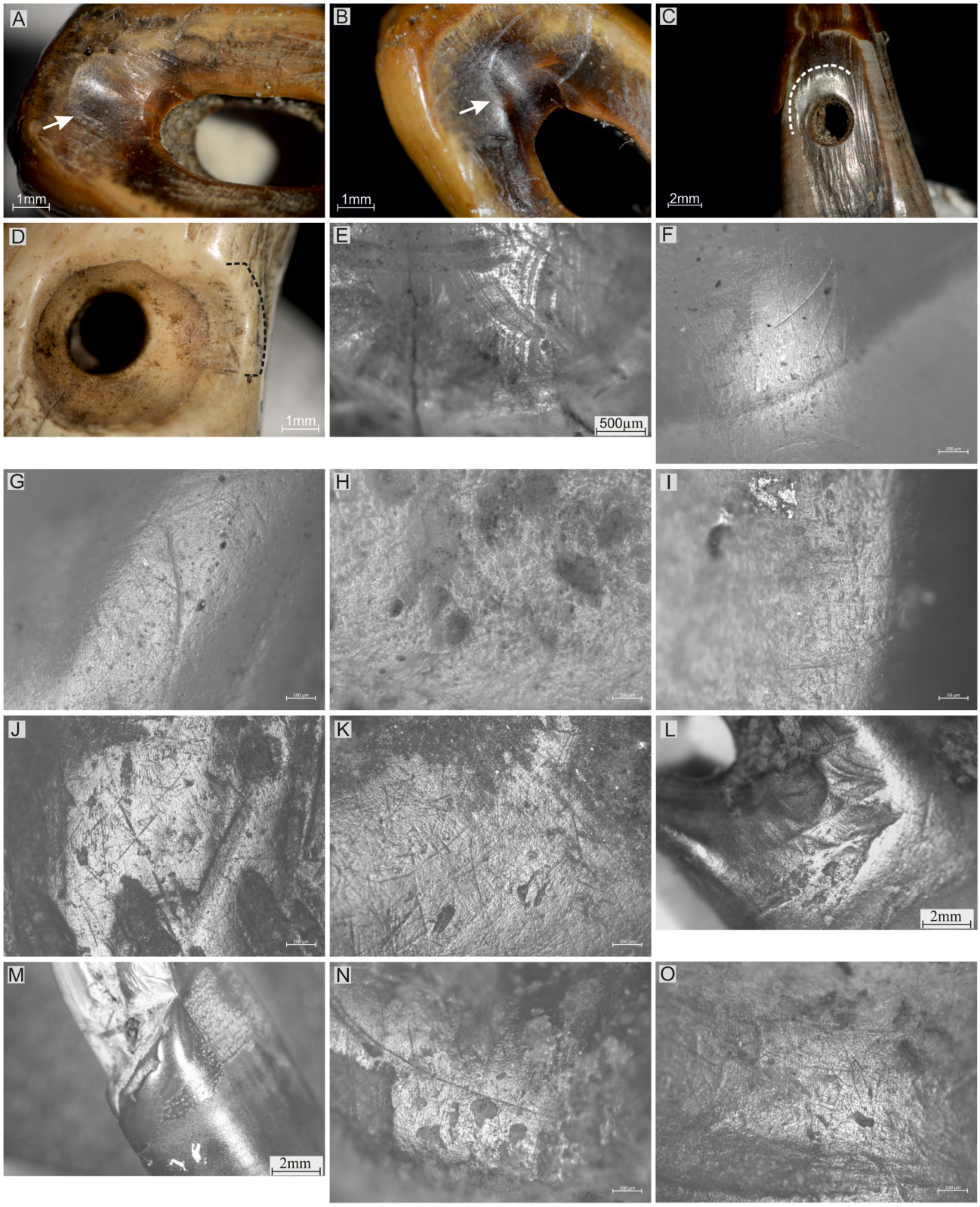

Fig. 4. Examples of the use-wear traces observed on pendants from Šventoji (Photo G. Osipowicz).

they are clearly rounded by it (Fig. 4L). In the case of this specimen, attention is drawn to a clear rounding in the upper part of the tooth (Fig. 4M), most likely caused by use.

The other two analysed pendants are preserved only fragmentarily. The original surfaces of the hole of the first one (Fig. 2:4) are partially flaked, yet on one side on its edge a clear smoothing and polish was recorded. It covers an area in sectors 10–12 and 1–3, focused in sectors 12 and 1. This polish is of a flat topography, rough texture and destroys technological traces in this location (Fig. 4N). Inside the hole, in the narrowest part, polish is clear on its entire perimeter. In the hole of the other of the fragmentarily preserved pendants, analysed using a metallographic microscope (Fig. 2:5), a polish centred on lateral surfaces

Table 2
Animal teeth pendants from Šventoji sites. Composition of the animal species.

Site	Šventoji 1		Šventoji 2,3,4		Šventoji 6		Šventoji 23		TOTAL	
Species/Pendants	n	%	n	%	n	%	n	%	n	%
Auroch/wisent	–	–	4	19,0	–	–	4	8,7	8	10,1
Elk	1	100,0	6	28,6	6	54,5	23	50,0	36	45,6
Elk/red deer	–	–	1	4,8	–	–	–	–	1	1,3
Boar	–	–	4	19,0	1	9,1	3	6,5	8	10,1
Wolf	–	–	1	4,8	–	–	–	–	1	1,3
Fox	–	–	1	4,8	1	9,1	–	–	2	2,5
Seal	–	–	4	19,0	2	18,2	15	32,6	21	26,6
Carnivore (fox?)	–	–	–	–	1	9,1	1	2,2	2	2,5
Total	1	100,0	21	100,0	11	100,0	46	100,0	79	100,0

was observed (sectors 1–4 or 9–12 depending on the side of the pendant). Again, the polish completely destroyed technological traces in these areas. In some places it is slightly linear (in accordance with the orientation of the hole) with a domed topography and rough texture (Fig. 4O).

3.4. The experimental program

The experimental programme was focused on testing the variability of use-wear traces formed on the pendants made from animal teeth as a result of them being used in various ways and using different types of twine. For the sake of the experimental work, short incisors, deciduous incisors and cuspids were obtained from a wild boar species (*Sus scrofa*) – 64 teeth in total. Then, holes were made in the teeth using several options of the bilateral drilling technique (Fig. 5A-C), by analogy to those observed in the artefacts from Šventoji. Pendants produced using this technique were used to make elements of clothing: necklaces, bracelets and bands (Fig. 5D-H). Each of the category of the accessories was made in two copies, one using a hemp twine and the other using a thong. The accessories were divided into three experimental utility groups:

Group I (pendants): Were loosely hung teeth, 3 pieces, one next to the other, contacting one another, and worn on the neck (Fig. 5E);

Group II (bracelets): One item was composed of 16 teeth loosely threaded on a twine or thong contacting one another. The side that was in contact with the user's body varied and was worn on the leg or on the arm (Fig. 5G, H);

Group III (bands): Were made from single teeth firmly fixed to leather bands by threading each with twine or thong through a hole in the band. One item included 14 teeth. The contact between the teeth was highly restricted. The contact surfaces of the teeth with the band was fixed. There were worn on the arm (Fig. 5D, E).

These were all worn for a month on daily basis by members of the archaeological expedition (both at work in the excavation and during regular activities in the base). The experiment was conducted during summertime.

3.5. Results of the use-wear analysis of the experimental pendants

In the use-wear analysis of the pendants during these experiments, traces of features typical of bone objects used in this manner were found (cf. D'Errico, Vanhaeren 2002; Bonnardin, 2007, 2009; White 2007; Rainio and Mannermaa, 2014; Falci et al. 2019). However, some discrepancies were observed and further analysis may allow more precise interpretation of the way artefacts of this sort were used. Before presenting the traces discovered on the pendants of specific experimental groups, some general observations can be made. First it should be noted that in most cases traces recorded on the experimental pendants are far less developed than those clearly visible on the prehistoric artefacts, which allows us to suggest that the latter were used for a substantially longer period of time (cf. Larsson 2006, 276) and that they were not solely of a votive character. Secondly, where several pendants were strung together, there were no definable and repeatable differences between them in the characteristics of the readable traces of use, demonstrating that their order on the string had no significance. Thirdly, clear asymmetry was observed in the degree of development of wear damage on both sides of the hole in a pendant, but at this stage of research it is difficult to be decisive in the interpretation of this discrepancy. Fourthly, in the case of pendants with small holes beaded onto a thong no wear traces were formed. This is due to the fact that when a thong was used whose thickness was equal to, or thicker than, the diameter of the hole no movement of the pendant occurred , and no traces were formed. Fifthly, in all cases the characteristics and the development of wear traces was affected to large extent by the size of the pendants. A clear pattern was observed that polish on small specimens was far less developed than on bigger specimens. This is primarily due to their smaller weight resulting in significantly more restricted movement of the pendant on the twine, thus decreasing the friction that generates wear traces. The location of polish was largely affected by the way in which a hole was drilled in a pendant. In general, in most cases use-wear traces are centred in their upper parts, which is a natural consequence of the way they were used. However, on some specimens where the hole was formed as a result of asymmetrical drilling on both sides of the item, in the holes drilled on the upper side wear traces are also centred in their lower part (cf. Fig. 6).

3.5.1. Use-wear traces on pendants from specific experimental groups

Group Ia ('loose' pendants on a hemp twine)

Traces related to the use of pendants were observed primarily inside and near the holes. In the holes, these are centred in their upper parts (sectors 12–1 – Fig. 7) where they destroy technological traces. In other sectors, drilling remains are still partially or fully readable. The observed use-wear polish is bright with flat topography and slightly rough texture. It is related to linear traces, which are either multidirectional or oriented in accordance with the orientation of the hole (Fig. 8A). Polish was also observed above the hole on the surface of the pendant in the place where the twine was located (Fig. 8B).

Group Ib ('loose' pendants on a thong)

Polish is located here (sectors 12–1 – Fig. 7) in the same places as in the case of Group Ia pendants. The characteristics of the observed traces is also similar. Inside the holes, a bright polish of flat topography (Fig. 8C) and usually smooth texture, although in some locations quite rough (Fig. 8D) can be observed, related to linear traces that are congruent with the orientation of the hole, readable mainly in the form of delicate dark filled striations. Near and at the edges of the holes, the polish has a slightly domed topography and a slightly rough texture (Fig. 8E), while the observed linear traces are multidirectional (Fig. 8F). Polish is also readable on the outer surfaces near the holes.

Group IIa (a bracelet on a hemp twine)

In the case of pendants threaded onto a twine that make up a bracelet, compared to the specimens used as necklaces, the location of the observed wear traces is slightly different. Here, their concentrations

Fig. 5. Examples of the conducted experiments: A-C – drilling the holes in pendants; D-H – the ways of wearing the pendants (Photo J. Orłowska).

were also recorded as slightly 'slanted' towards the plane tangent to the body/clothes on which the pendant was worn, that is, if it was the plance on the right side of the hole that was tangent to them, traces would be centred in sectors 1–2, and if the contact surface was the surface located on the left, traces would be centred in sectors 11–12 (Fig. 7). The characteristics of the observed traces varies significantly, primarily due to the discrepancy in the degree of development of the polish between specific pendants. In many cases, only bright spots were readable inside the hole, with no greater effect on the readability of technological traces. However, in general, in most cases a bright polish of a slightly domed topography was observed, related to multi-directional linear traces with prevailing striations that are in line with the orientation of the holes (which is especially readable inside, in the narrowest parts – Fig. 8G). This polish covers technical traces and makes them more rounded (Fig. 8H). On pendants that bear well developed wear traces, the polish destroyed technological traces completely and is characterised by flat topography and smooth or slightly rough texture. In these cases, on the polished surfaces numerous cracks were also observed (Fig. 8I), which at this stage of research should be considered a significant element, since they did not occur on pendants of other types. Wear traces were also recorded on outer surfaces of the pendants near the holes. These were of polish or tarnish as a result of them contacting the twine or one another (Fig. 8J). No wear traces were observed whose origin could be associated with the contact with the body of the person who were using the bracelet.

Group IIb (a bracelet on a thong)

The location, characteristics and discrepancies in the degree of development of wear traces observed on the pendants used in this manner are similar to those described in the case of specimens classified to group IIa (Fig. 7). In general, in most holes a bright polish of domed topography and slightly rough texture is visible, making technological traces rounded (Fig. 8K). This polish is related to multidirectional linear

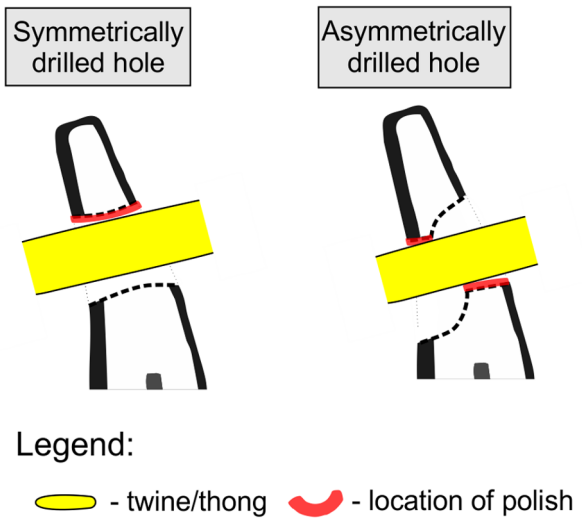

Fig. 6. Scheme of the location of use-wear traces at the pendants with holes drilled symmetrically and asymmetrically (Draw. G. Osipowicz; J. Orłowska).

traces analogous to those described for previous functional groups. In the places that were most 'damaged' due to use, its topography is flat, while texture remains slightly rough (Fig. 8L). Interestingly, in the analysed group of prehistoric pendants no linear traces were observed inside the holes that would be congruent with their orientation, like those which occurred on the specimens from experimental group IIa. Also, no cracks on the inner surfaces of the polished holes noted in the prehistoric pendants were recorded on the experimental specimens. As in the case of previous groups of experimental pendants, on outer surfaces of teeth near the holes various types of smoothing and polish were observed, formed as a result of use. (Fig. 8N, M).

Group IIIa (pendants on a leather band fixed by a hemp twine)

The wear traces observed on the pendants attached to a leather band are in many cases located in a way similar to that described for groups IIa and IIb, that is centred in sectors 1–3 or 10–12 , depending on the location of the surface tangent to the body regarding the hole. However, on some specimens use-wear traces of a substantially greater range were observed, covering sectors 1–6 (with the tangent surface on the right to the hole – Fig. 7) or a significantly smaller range and different location, that is occurring only in sector 3 (the tangent surface on the right). This situation was typical of small and light pendants.

The general characteristics of the wear traces observed on Group IIIa type pendants is not different to the ones observed in other groups of experimental specimens threaded on a hemp twine. In places where the most developed wear traces were recorded a bright polish of a slightly domed, wavy or almost flat topography and slightly rough texture occurred, related to multidirectional linear traces (Fig. 8O; 9A). Neither surface cracks nor more regular one-directional striations recorded above in the characteristics of other types of pendants threaded onto the hemp twine occurred in this group. On the edges of holes presence of a polish of domed topography was noted (Fig. 9B). The specific category of traces that can initially be distinguished in this group is the smoothing and polish recorded on the surface tangent to the leather band to which the pendants were attached (Fig. 9C). However, these traces in many cases have only an initial character so it is difficult to define them in a more specific manner at this stage of research.

Group IIIb (pendants on a leather band fixed by a thong)

On most specimens from this experimental group, poorly developed use-wear traces were observed, limited to bright spots readable in various parts of holes, centred in the same sectors as in the case of group IIIA. In these areas the polish has a flat topography, rough texture and is related to multidirectional linear traces (Fig. 9D). Only on one pendant was well developed polish of this sort observed (Photo 9E). Aside from wear traces inside the holes on the surfaces tangent to the hide of the band to which the pendants were attached, clear smoothing and tarnish were noted, as well as polish of hide-like characteristics (Fig. 9F).

4. Discussion

Animal teeth were used as pendants during the entire period of Eastern Baltic Stone Age, but with varying intensity and choice in animal species (e.g. Zagorska, Lõugas 2000; Larsson 2006, 2009; Kriiska et al. 2007; Jonuks 2009; Luik et al. 2011). The middle Mesolithic collections from this region show a restricted range of species used for tooth pendants, with wild boar and elk dominating and red deer and aurochs represented less often. In the Late Mesolithic new species appeared, such as beaver and wild horse. The widest spectrum of animals can be found in the early Neolithic[2] (Early Subneolithic) collections, where, in addition to still the dominating elk, wild boar and red deer, species such as dog, badger, brown bear, seal, marten or wolf start to be statistically important. During the Middle Neolithic (Late Subneolithic) the situation changed and only dog and seal teeth are found in burials (Zagorska 2016).

Accordingly the collection of pendants from Šventoji described in this article, with elk dominating and seal and wild boar being occasionally represented, is consistent with the human material culture in the late Mesolithic and Subneolithic in the region. No differences in the significance of species structure in the collection of pendants from specific sites were noted. No discrepancies were noted in the techniques, known from other Lithuanian and Latvian sites of a similar chronology (cf. David 2006; Butrimas 2016), applied to making holes in the pendants made from teeth of different animal species.

The results of use-wear studies of the experimental pendants showed no characteristics of wear traces which definitively distinguish the type of twine used in the experimental programme. In the initial stages of the development of wear damage, different characteristics could be discerned to an extent between some of the groups however the developed traces of both kinds are practically identical (cf. e.g. Fig. 8C and 8O). Perhaps these conclusions will be altered when more experiments are carried out, providing statistical arguments for some of the observation made here. At present, it is difficult to interpret the origin of surface cracks recorded only in the holes of experimental group IIa and the reason for their absence on other pendants where a hemp twine was also used. At this stage of research it is similarly difficult to explain the lack of one-directional linear traces inside the pendant holes in group IIb, while they were present on the specimens from groups Ib and IIIb. Unquestionably, these problems require further use-wear studies and additional experimental research that would also take into account other types of twine[3] as well as additional factors such as human sweat or impurities in the holes (cf. d'Errico 1993, p. 168; Vanhaeren et al. 2013).

Nonetheless, the experiments conducted and the microscopic analyses have confirmed the direct relationship between the location of use-wear traces inside and near the hole and the way the pendant was used (cf. Bonnardin 2009, 2012; Sidéra and Giacobini 2002; Sidéra and Legrand 2006; Van Gijn 2017). Additionally, conclusions drawn in this regard are supported by the observation of polish on the outer surfaces of teeth that were tangent to clothes to which the accessories were attached. Taking together the findings in the experimental studies and

[2] In traditional East European periodization pottery production instead of farming or animal husbandry is considered as criteria of Neolithic. In this paper, however, we are using a term of Subneolithic for a period when pottery has been produced by hunters-gatherers.

[3] For instance, made from lime (*Tilia cordata*) bast, used in Šventoji to manufacture strings used in fishing nets (Rimantiene 1979, pp. 73-78).

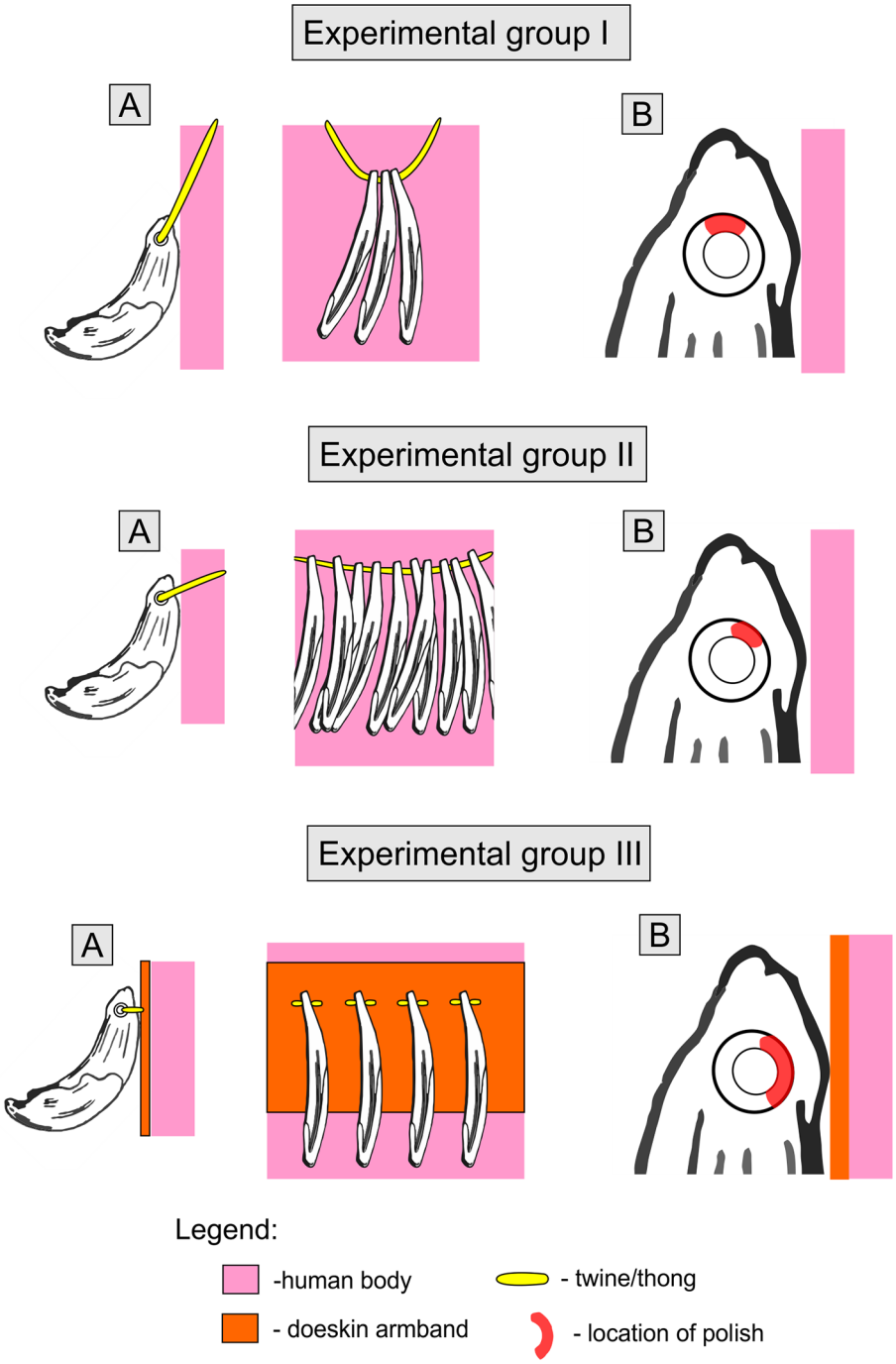

Fig. 7. Scheme of the location of polish according to the method of fixing teeth used in the experiments (experimental groups): A - the method of fixing teeth as a part of the ornament, including the twine/thong arrangement; B - location of usage traces inside holes (Draw. G. Osipowicz; J. Orłowska).

the results of the analysis of selected pendants from Šventoji using a metallographic microscope, it can be suggested that the specimen presented in Fig. 2: 1 most likely was hanging loose as a kind of an amulet not firmly fixed to clothes. This is indicated by the location of polish in its hole and the general smoothing of outer surfaces, suggesting that surfaces tangent to the clothing/user's body were changing. The pendants presented in Fig. 2:3 and 2:4 could have been used in a similar manner. The situation is completely different in the case of the accessories presented in Fig. 2: 2 and 2:5. In both cases, on one of the outer surfaces of the teeth a hide-like polish was observed, determining a specific plane tangent to clothes. Additionally, the hole of the other of the mentioned products bears traces whose location clearly indicates it was threaded on the side. Hence, both pendants were most likely permanently fixed to clothes in a manner similar to that of the specimens of the third experimental group described above.

In the case of studies on the pendants from Šventoji, a significant matter is the attempt to answer the question about the origin of their deposition. By far the majority of these types of artefacts found in the eastern part of the Baltic region come from burial contexts (e.g. Stenberger, 1943; Gurina 1956; Jaanits, 1957; Janzon, 1974; Zagorska and Lõugas, 2000; Burenhult, 2002; Zagorskis, 2004; Larsson, 2006; Česnys and Butrimas, 2009). At site Šventoji 23, where most of the pendants were discovered, three pieces of a human skull (from different individuals) and several other bones were found. Thus, a hypothesis can be made that destroyed graves exist within this area of the site (Piličiauskas 2016). However, the dispersion analysis performed for the

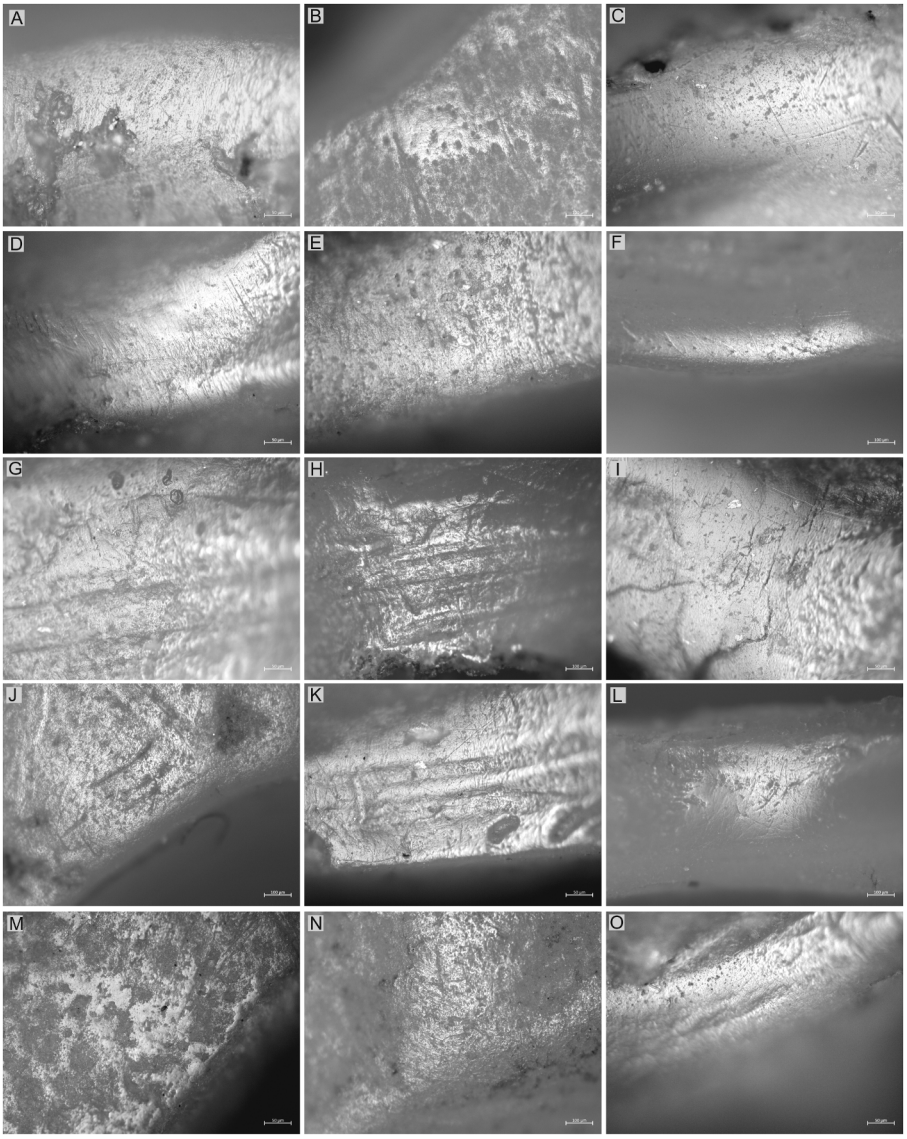

Fig. 8. Examples of the use-wear traces observed on the experimental pendants (Photo G. Osipowicz).

pendants proved that they are almost absent in the dwelling zone of this site, marked by numerous vertical poles (Fig. 10). They are mostly found in the lower western part of the site, within a refuse layer which accumulated on litoral part of lagoonal lake.

Comparing the zone of their occurrence with the location of human bones found at the site, only in the central part of trench 1, where

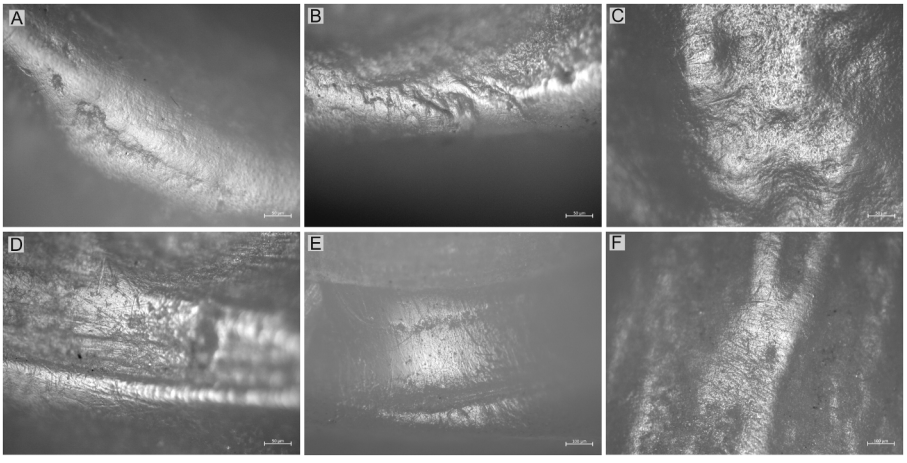

Fig. 9. Examples of the use-wear traces observed on the experimental pendants (Photo G. Osipowicz).

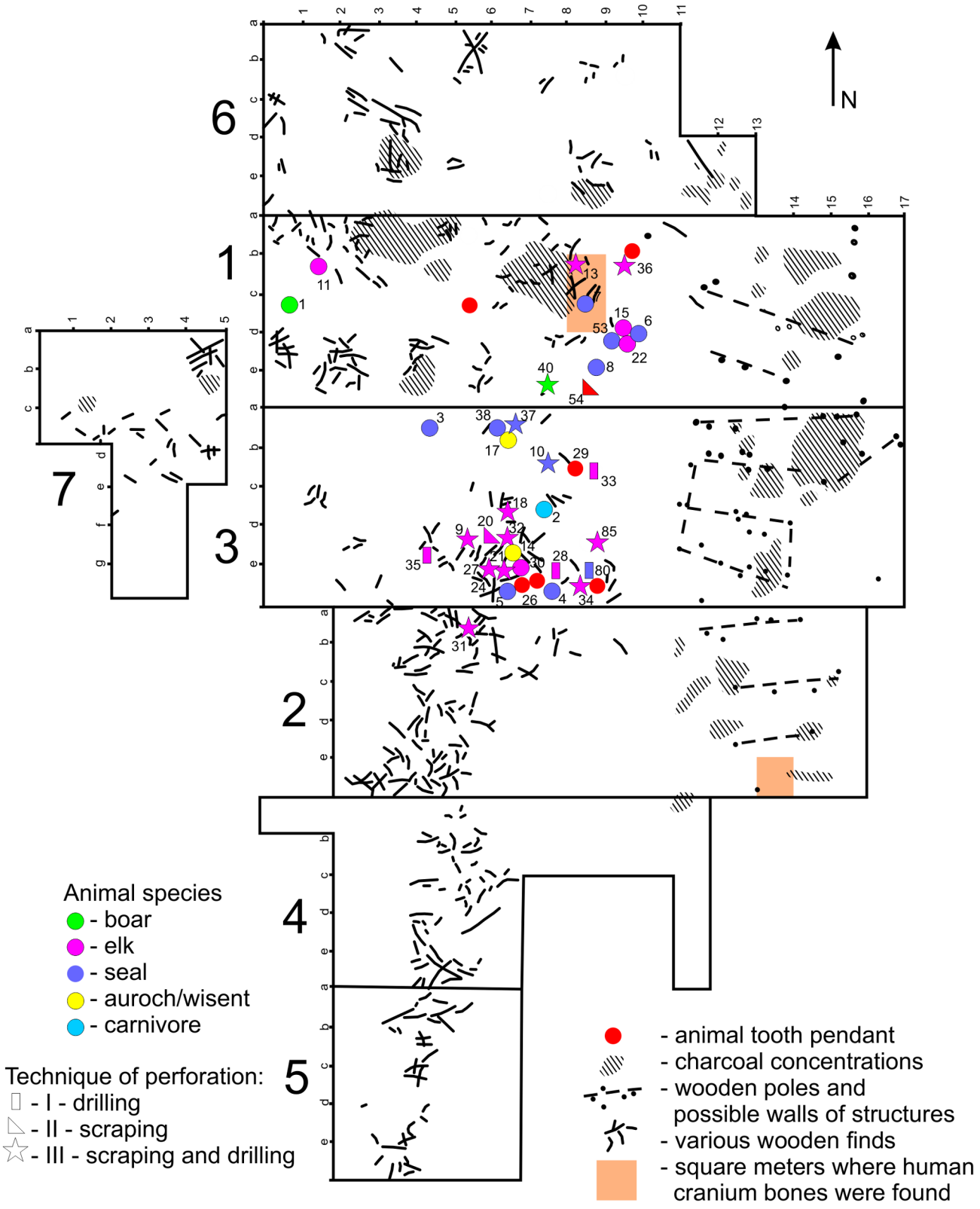

Fig. 10. A distribution of animal tooth pendants, taking into account the animal species and technique of perforation, plotted onto a plan of the excavated area at Šventoji 23 (based on Rimantienė 1979).

within the squares 9b and 9c two fragments of human skulls were found, can an argument be made for their connection with destroyed graves. The vast majority of pendants occurred in a high concentration, in the middle of trench 3, where no human bones were found. No pendants were found in neighbouring trenches. Given the number of pendants found here and their good state of preservation, it is unlikely that they would be the only surviving evidence of destroyed (in this case probably washed out) graves, especially since the cluster characteristics in which they occurred, within a large surface and fairly uniform density, does not indicate significant influence of post-

positional processes. It seems that their significance was not high at the eastern part of the site, at the dwelling zone, where faunal bones and a large quantity of amber were found. Taking all of this into consideration it can be suggested that in this zone of the site the animal tooth pendants could have been deliberately deposited into the water.

How do the results of the conducted use-wear analyses contribute to solving this problem? First of all the results of the microscopic analysis clearly show that the pendants from Šventoji were not made solely for ritual deposition in the lake, but that a large number of pendants were used for a long time. Secondly, the specimens that make up the analysed collection have been made using several technological methods. Nothing was recorded that could indicate a homogeneity in terms of function, culture or meaning of the assemblage as in the case of the Latvian site Zviejniki where differences in the production technology of specimens from depositional and burial contexts were established (David 2006). Thirdly no significant regularities were shown by the dispersion analysis of various types of pendants at site Šventoji 23 (Fig. 10). Some similarities were recorded here, indicating that some of the specimens could have been an element of the same set of accessories, such as three pendants made from elk teeth (EM 2110:21, EM 2110:24, EM 2110:27), identified within the same square meter (3/7ė), whose holes were formed in the same way (type 3), and bore similar wear traces including damage to the hole. However, it has not been possible to distinguish with complete certainty those assemblages which contain only, or primarily, artefacts made using one technological method or bear identical wear traces. What can be said is that it is likely that these products were used on a daily basis and were created for that purpose, and were then at a certain point in time excluded from the utility context and intentionally deposited in the littoral zone of the lake, or possibly included in burial contexts, as in the case of the pendants from trench 1. In the case of site Šventoji 23. The intentional character of these suggested depositions in the lake is supported by the fact that the pendants were assembled in very limited areas, the good state of preservation of most of the specimens, so lack damage that could be the reason for losing or abandoning them, as well as the identification of some pendants without any traces of use. Ideally to provide a better justification for this interpretation, all those Šventoji pendants not included in this research should be analysed.

5. Conclusion

The use-wear studies of a collection of animal teeth pendants from the complex of sites in Šventoji described in the article were difficult. Wear traces formed on artefacts of this sort are very specific, determined by many factors and, additionally, centred in their holes which are inaccessible or poorly accessible for microscopic testing. Nonetheless, due to its size and archaeological context, the collection from Šventoji is unquestionably a highly important archaeological source for research on the meaning of these items for the early-Holocene communities not only in the Baltic region but also in the whole of Europe. The remarks made in this article based on the conducted experimental studies and microscopic analyses are important not only in the context of individual technological or functional interpretations regarding these artefacts, but they also might constitute a significant contribution to the formulation of the interpretation of the function of the sites in Šventoji, at least of the wider role of bone products among the human communities that used them. These studies will undoubtedly complement previous analyses in this regard to an extensive degree (cf. Luik, Piličiauskienė 2016; Osipowicz et al. 2019a,b) and the continuation of this research would allow further important information to be obtained on the material and spiritual culture of early-Holocene communities in this part of Europe.

Acknowledgments

We are very grateful to Amanda Satchell (York University, UK) for the language correction of this article. We would also like to thank the employees of the National Museum of Lithuania for allowing access to the materials, creating workplaces and atmosphere that facilitated the conduct of analyses. Finally, we wish to thank Alfred Pawlik (Guest Editor of the volume) and the two anonymous Reviewers whose comments improved the final version of the article.

Grzegorz Osipowicz: Conceptualization Methodology Validation Investigation Resources Data Curation Writing, Writing - Review & Editing, Visualization, Supervision, Project administration,

Giedrė Piličiauskienė: Investigation, Resources, Data Curation, Visualization.

Justyna Orłowska: Investigation, Resources, Writing, Data Curation, Visualization.

Gytis Piličiauskas: Resources, Data Curation, Visualization

References

Álvarez-Fernandez, E., 2009. Magdalenian personal ornaments on the move: a review of the current evidence in Central Europe. Zephyrus 63, 45–59.

Buc, N., 2011. Experimental series and use-wear in bone tools. J. Archaeol. Sci. 38 (3), 546–557. https://doi.org/10.1016/j.jas.2010.10.009.

Bonnardin, S., 2007. From traces to function of ornaments: some Neolithic examples. In: L. Longo, N. Skakun (Eds.), "Prehistoric Technology" 40 years later (BAR Int. Ser. 1783). Archaeopress, Oxford, pp. 297-308.

Bonnardin, S., 2009. La parure funéraire au Néolithique ancien dans les Bassinsparisiens et rhénans e Rubané Hinkelstein et Villeneuve-Saint-Germain.Mémoire de la Société Préhistorique Française, Paris.

Bonnardin, S., 2012. Parures de coquillages du néolitique en Europe (VIe-Ve millénaires av. J.-C.). Techniques and Culture 59, 26–43.

Burenhult, G., 2002. The Grave-field at Ajvide. In: In: Burenhult, G. (Ed.), Remote Sensing: Applied Techniques for the Study of Cultural Resources and the Localization, Identification and Documentation of Sub-surface Prehistoric Remains in Swedish Archaeology Volume 2. Stockholm University, Hässleholm, pp. 31–168.

Butrimas, A., 2016. Biržulis lake islands Donkalnis and Spiginas Mesolithic cemeteries (West Lithuania). In: J.M., Grünberg, B., Gramsch, L., Larsson, J., Or-Schiedt, H., Meller, eds. International conference Halle (Saale), Germany, 18-21 September. -, Tagungen des Landesmuseums für Vorgeschichte Halle, 13/1. Halle (Saa-le): Landesmuseums für Vorgeschichte Halle, pp. 193–217.

Campana, D.-V., 1989. Natufian and Protoneolithic Bone Tools: the Manufacture and Use of Bone Implements in the Zagros and the Levant, Oxford, Archaeopress (BAR International Series, 494).

Česnys, G., Butrimas, A., 2009. Reinventing Mesolithic skulls in Lithuania: Donkalnis and Spiginas sites. Acta medica Lituanica 16, 1–8.

Christidou, R., 2008. An application of micro-wear analysis to bone experimentally worked using bronze tools. J. Archaeol. Sci. 35, 733–751.

David, É., 2006. Technical Behaviour in the Mesolithic (9th–8th Millennium Cal. BC): The Contribution of the Bone and Antler Industry from Domestic and Funerary Contexts. Back to the Origin. In: Larsson, L. & Zagorska, I., (eds.) New Research in the Mesolithic-Neolithic Zvejnieki Cemetery and Environment, Northern Latvia. Acta Archaeologica Lundensia. Series in 8° 52. Stockholm: Almqvist & Wiksell, pp. 235–52.

d'Errico, F., 1993. La vie sociale de l'art mobilier paléolithique. Manipulation, transport, suspension des objets on os, bois de cervidés, ivoire. Oxford Journal of Archaeology 12 (2), 145–174. https://doi.org/10.1111/j.1468-0092.1993.tb00289.x.

D'Errico, F., Giacobini, G., Peuch, P.F., 1984. Varnish replicas: a new method for the study of worked bone surfaces. Ossa International Journal of Skeletal Research 9–11, 29–51.

ÉEricco F., Vanhaeren M, 2002. Criteria for Identifying Red Deer (Cervus elaphus) Age and Sex from Their Canines. Application to the Study of Upper Palaeolithic and Mesolithic Ornaments. Journal of Archaeological Sciences 29, 211–232.

Falci C.G., Cuisin J., Delpuech A., Van Gijn A., Hofman L. C., 2019. Journal of Archaeological Method and Theory, June 2019, Volume 26, Issue 2, 755–805. https://doi.org/10.1007/s10816-018-9389-8.

Gurina, N. N., 1956. Oleneostrovskij mogilnik. Materialy I Issledovanija po Archeologii SSSR 47, Leningrad.

Jaanits, L., 1957. Neue Gräberfunde auf dem spätneolithischen Wohnplatz Tamula in Estland. Suomen muinaismuistoyhdistyksen aikakauskirja 58, 80–100.

Janzon, G., 1974. Gotlands mellanneolitiska gravar. Almqvist & Wiksell, Stockholm.

Jonuks, T., 2009. Eesti muinasusund. Dissertationes archaeologiae Universitatis Tartuensis 2. University Press, Tartu, Tartu.

Juel, Jensen H., 1994. Flint tools and plant working, hidden traces of stone age technology. A use wear study of some Danish Mesolithic and TRB implements, Aarhus.

Korobkova, G.F., 1999. Narzędzia w pradziejach. Podstawy badania funkcji metodą traseologiczną, Toruń.

Kriiska, A., Lõugas, L., Lõhmus, M., Manner-Maa, K., Johanson, K., 2007. New AMS dates from Estonian Stone Age burial sites. Estonian Journal of Archaeology 11 (2), 83–121.

Larsson, L., 2006. Tooth for a Tooth for a Grave: Tooth Ornaments from the Graves at the Cemetery of Zvejnieki. In: Larsson, L., Zagorska, I. (Eds.), Back to the Origin: New Research in the Mesolithic-Neolithic Zvejnieki Cemetery and Environment, northern Latvia. Almqvist & Wiksell, Stockholm, pp. 253–288.

Larsson, L., 2009. Symbols around the body: tooth ornaments from the graves at the Zvejnieki cemeteries, northern Latvia. In: Mccartan S., Schultingr., Warren G.,

Woodman P. (eds), Mesolithic Horizons: Papers presented at the Seventh International Conference on the Mesolithic in Europe, Belfast 2005. Oxbow Books, Oxford : pp. 664-670.
Legrand, A., 2007. Fabrication et utilisation de l'outillage en matières osseuses du Néolithique de Chypre: Khirokitia et Cap Andreas-Kastros, Oxford, Archaeopress (BAR International Series, 1678).
Luik, H., Ots, M., Maldre, L., 2011. From the Neolithic to the Bronze Age: continuity and changes of bone artefacts in Saaremaa, Estonia. In: Baron, J., Kufel-Diakowska, B. (Eds.), Written in Bones. Studies on Technological and Social Context of Past Faunal Skeletal Remains, Uniwersytet Wrocławski, Instytut Archeologii, Wrocław, pp. 243–261.
Luik, H., Piličiauskienė, G., 2016. Bone tools at the Neolithic sites of Šventoji, Lithuania: used materials and working methods. In: S. Vitezović (ed.), Close to the bone: current studies in bone technologies. Belgrade, pp. 188-200.
Newcomer, M., 1974. Study and replication of bone tools from Ksar Akil (Lebanon). World Archaeology 6, 138–153.
Orłowska, J., 2016. Reading osseous artefacts – an application of micro-wear analysis to experimentally worked bone materials. In: S. Vitezović (ed.). Close to the bone: current studies in bone technologies. Belgrade: Institute of Archaeology, 236-247.
Osipowicz, G., 2010. Narzędzia krzemienne w epoce kamienia na ziemi chełmińskiej. Studium traseologiczne, Toruń.
Osipowicz, G., Piličiauskas, G., Piličiauskienė, G., Bosiak, M., 2019a. "Seal scrapers" from Šventoji – In search of their possible function. J. Archaeolog. Sci.: Rep. 27, 101928. https://doi.org/10.1016/j.jasrep.2019.101928.
Osipowicz G., Orłowska J., Piličiauskas G., Piličiauskienė G., 2019b. The story of one harpoon. An example of the reutilization of osseous projectile weapon in the Subneolithic Šventoji (Lithuania). In: M. A. García & E. A. García (eds.). Spotlighting Bone Tools. Proceedings of the XII Meeting of the ICAZ Worked Bone Research Group in Granada. Cuadernos de Prehistoria y Arqueología de la Universidad de Granada number 29 (2019). https://10.30827/CPAG.v29i0.9775.
Piličiauskas, G., 2016 Coastal Lithuania during the Neolithic. In: Zabiela, G. & Baubonis, Z. (eds.): Archaeology: the Greatest Discoveries in Lithuania. Vilnius: 64-77.
Piličiauskas, G., Heron, C., 2015. Aquatic radiocarbon reservoir offsets in the Southeastern Baltic. Radiocarbon 57 (4), 539–556.
Piličiauskas, G., Mažeika, J., Gaidamavičius, A., Vaikutienė, G., Bitinas, A., Skuratovič, Ž., Stančikaitė, M., 2012. New archaeological, paleoenvironmental, and ^{14}C data from Šventoji Neolithic sites, NW Lithuania. Radiocarbon 54 (3–4), 1017–1031.
Płonka, T., 2012. Kultura symboliczna społeczeństw łowiecko-zbierackich środkowej Europy u schyłku paleolitu. Wydawnictwo Uniwersytetu Wrocławskiego, Wrocław.
World Archaeology 46 (3), 332–348. https://doi.org/10.1080/00438243.2014.909105.
Rimantiene, R., 1979. Sventoji. Narvos kulturos gyvenvietes, Vilnius.
Rimantienė, R., 2005. Die Steinzeitfischer an der Ostseelagune in Litauen. Litauisches Nationalmuseum, Vilnius.
Sidera, I., 1993. Les assemblages osseux en bassins parisien et rhénan du VIe au IVe millénaire B.C. Histoire, techno-économie et culture. Thèse de doctorat. Université de Paris I.
Sidéra, I., Giacobini, G., 2002. Outils, armes et parures en os funéraires à la fin du Néolithique d'après Valde-Reuil et Porte-Joie (Eure) [Représentations individuelles et pratiques collectives]. Gallia préhistoire 44 (1), 215–230. https://doi.org/10.3406/galip.2002.2035.
Sidéra, I., Legrand, A., 2006. Tracéologie fonctionnelle des matières osseuses: Une méthode. Bulletin de la société préhistorique française 103 (2), 291–304.
Stenberger, M., 1943. Das Grabfelt von Västerbjers auf Gotland. Royal Swedish Academy of Letters, History, and Antiquities, Stockholm.
Taborin, Y., 1993. Traces de façonnage et d'usage sur les coquillages perforés. In: Anderson, P.C., Beyries, S., Otte, M., Plisson, H. (Eds.), Traces et fonction: Les gestes retrouvés. Actes du colloque international de Liège Vol I (255–267). Service de Prehistoire, Liège.
Van Gijn, A.L., 1989. The wear and tear of flint: principles of functional analysis applied to Dutch Neolithic assemblages. Analecta Praehistorica Leidensia 22, Leiden.
Van Gijn, A.L., 2017. Bead biographies from Neolithic burial contexts: contributions from the microscope. In: Bar-Yosef Mayer, D., Bonsall, C., Choyke, A.M. (Eds.), Not just for show: the archaeology of beads, beadwork, and personal ornaments (103–114). Oxbow Books, Oxford.
Vanhaeren, M., d'Errico, F., Van Niekerk, K.L., Henshilwood, C.S., Erasmus, R.M., 2013. Thinking strings: additional evidence for personal ornament use in the Middle Stone Age at Blombos Cave, South Africa. J. Hum. Evol. 64 (6), 500–517. https://doi.org/10.1016/j.jhevol.2013.02.001.
Vaughan, P. C., 1985. Use-wear analysis of flaked stone tools, Tucson.
White, R., 2007. Systems of personal ornamentation in the Early Upper Palaeolithic: Methodological challenges and new observations. In: Mellars, P., Boyle, K., Bar-Yosef, O., Stringer, C. (Eds.), Rethinking the Human Revolution. McDonald Institute, Cambridge, pp. 287–302.
Zagorska I., Lõugas L., 2000. The Tooth Pendant Head-Dresses of Zvejnieki Cemetery. In: V. Lang and A. Kriiska, eds. 2000. De Temporibus Antiquissimis ad Honorem Lembit Jaanits. Tallinn: Institute of History, 223–244.
Zagorska I., 2016. Mesolithic burial traditions in Latvia. A case study from Zvejnieki burial ground. In: J.M., Grünberg, B., Gramsch, L., Larsson, J., Orschiedt, H., Meller, eds. International confer-ence Halle (Saale), Germany, 18-21 September. Tagun-gen des Landesmuseums für Vorgeschichte Halle, 13/1, Halle (Saale): Landesmuseums für Vorgeschichte Halle, 225–240.
Zagorskis, F., 2004. Zvejnieki (Northern Latvia): Stone Age Cemetery. Translated from Latvian by V. Bērziņš. BAR International Series, 1292. Oxford: Archaeopress.