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T-shaped antler axes in Lithuania: previously unrevealed Middle Holocene hunter-gatherer technology

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Keywords

Antler technology, AMS ^{14}C dating, Mesolithic, Neolithic, *Cervus elaphus*, Lithuania

Abstract

This paper discusses one of the most characteristic hunter-gatherer osseous implements — the T-shaped antler axe. These are made from red deer (*Cervus elaphus*) antler beam by removing the trez tine and creating a perforation for a shaft in its place. This type of axe is quite widely known in the Late Mesolithic and Early Neolithic contexts of northern, western and central Europe. Until now, T-shaped antler axes have been only sporadically mentioned in research on Lithuanian prehistory. Ten T-axes are currently known from eight find locations, concentrated in western and southern Lithuania. These axes were mainly discovered as single finds during wetland drainage or peat extraction. Only two excavated sites contained T-axes in settlement refuse layers. This paper provides details of the find circumstances and technological features of all ten axes, as well as the results of AMS ^{14}C dating. The dating suggests that this technology had already spread among hunter-gatherers in the territory of Lithuania as early as the second half of the 6th millennium, and continued at least until the transition to the 4th millennium cal BC.

Introduction

Organic implements were essential in hunter-gatherer societies. The oldest evidence of such finds in the eastern part of the Baltic region is related to reindeer (*Rangifer tarandus*) antler and Eurasian elk (*Alces alces*) bone tools dated to the Late Glacial (e.g. Meadows et al. 2014; Philippsen et al. 2019; Rimkus et al. 2019). From the beginning of the Holocene, a gradual increase in the diversity of osseous tool types can be observed (e.g. Zagorska and Zagorskis 1989; Rimantienė 2005). These tools were used in the daily life activities of hunter-gatherers, but, compared to lithic artefacts, they degrade much faster without appropriate preservation conditions. Not many hunter-gatherer sites with organic preservation, especially of the Early and Middle Holocene, are currently known in Lithuania.

The Middle Holocene in the eastern Baltic region is marked by the introduction of multiple technologies, related to lithic, pottery, bone and antler tools (e.g. Ostrauskas 1999; Berg-Hansen et al. 2019; Courel et al. 2020). One of the characteristic antler tools of this period is the T-shaped axe (T-axe). This particular type of antler implement is manufactured from red deer (*Cervus elaphus*) antler beam by cutting its upper part and removing the antler crown, while at the lower end the beam is cut obliquely, thus shaping the axe's working edge. The perforation for a shaft is formed in the place of the removed trez tine

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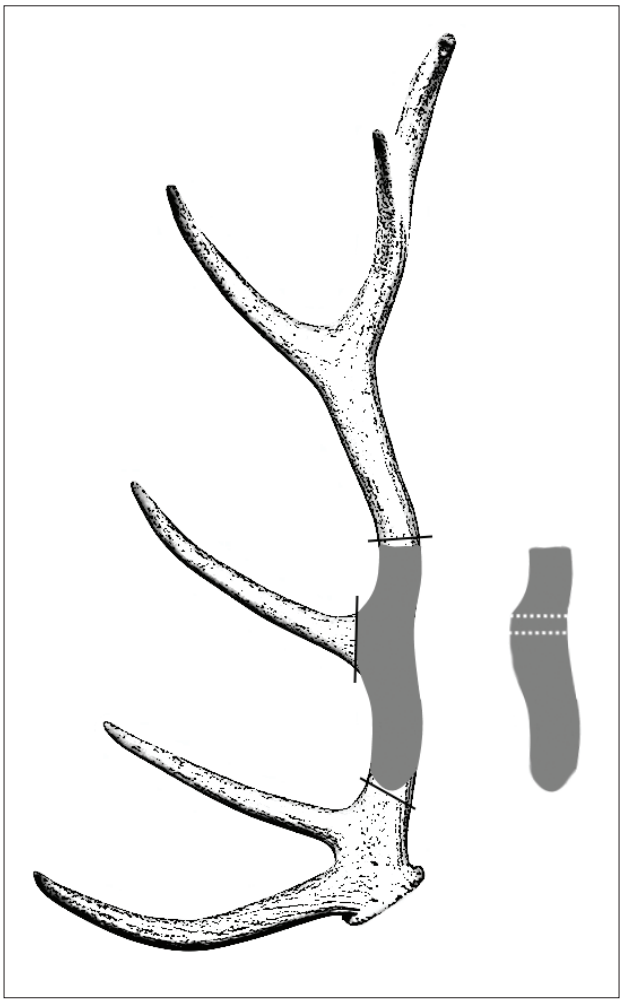

Figure 1. Red deer antler processing scheme for the T-shaped axe technology (drawing by Rimkus).

(Fig. 1). T-shaped antler axes are known in multiple European regions. In the western Baltic region, they are especially characteristic of the Late Mesolithic Ertebølle culture and date to the 5th millennium cal BC (Klassen 2004, pp. 124–125; Sørensen 2014, p. 136).

The first T-shaped antler axe in the territory of Lithuania to be directly dated was from the Palanga site in coastal Lithuania. It was dated to the end of the 5th millennium cal BC (Piličiauskas et al. 2015). More AMS dates of T-axes from the eastern Baltic were published soon after, with the dating of two artefacts from the Sise site in western Latvia, one of which was ascribed to the 5357–5216 cal BC[1] (Bērziņš et al. 2016; Zagorska et al. 2021). This date preceded all known directly dated T-axes in the Baltic region by a few hundred years, indicating a possible older phase of this technology in this area. In response, an international dating project of the T-shaped antler axes from the northeastern European plain was initiated (Lübke et al. 2018). Recently received results suggest that some of the T-axes in the territories of Belarus, Latvia and Lithuania date to ca. 5600–5200 cal BC, predating the dated artefacts from the southwestern Baltic region and western Europe. Based on these results, a data-driven model of T-shaped antler axe technology indicating its movement from the southeastern European territories towards the Baltic has been proposed (Lübke et al. in press).

Ten T-shaped antler axes from eight locations are known in the territory of Lithuania so far (Fig. 2). The majority of artefacts are single finds made during the draining of wetlands or peat extraction. Only two excavated sites — Daktariškė 5 and Palanga — contained T-axes. The T-axes from Lithuania were analysed in the recent paper by Lübke et al. (forthcoming). Here we present their detailed analysis by emphasising the find circumstances and distinctive technological features. Furthermore, we resampled three previously failed T-axes for AMS ^{14}C dating. According to the obtained results, we aim to discuss (1) the importance of red deer antler as a raw material for tool manufacturing, and (2) the continuation and variation of T-shaped antler axe manufacturing techniques in northeastern European hunter-gatherer communities.

1. T-shaped antler axes

The find locations of all T-axes are associated with existing or former water bodies, where conditions are favourable for organic preservation. Only two of the discussed sites are related to archaeological excavations where T-shaped axes were found in the settlement layers. Both settlements — Daktariškė 5 and Palanga — belong to the wetland site type.

Information on find circumstances and the names of find locations of the T-shaped axes in the territory of Lithuania was gathered based on the available records in museum books, as well as in the first volume of the Lithuanian Archaeological Atlas (Rimantienė 1974), or published research articles. Some of the artefacts remained unpublished or were only briefly mentioned in publications. All T-axes studied in this paper were examined in the museums where they are stored. They were measured, and their surface was visually inspected for any signs of unusual technological features and fractures related to possible use in the past. In the sections below, we provide a brief description of each T-axe, its find location and contextual details. Systematised results are presented in Table 1, which provides data on the find circumstances, geographical coordinates (the find spot was located as accurately as possible), museum archival data and the publication where these artefacts are mentioned for the first time. As

[1] This and other published radiocarbon dates mentioned in the text have been recalibrated using OxCal v4.4.4 (Bronk Ramsey 2009) and the IntCal20 atmospheric curve (Reimer et al. 2020).

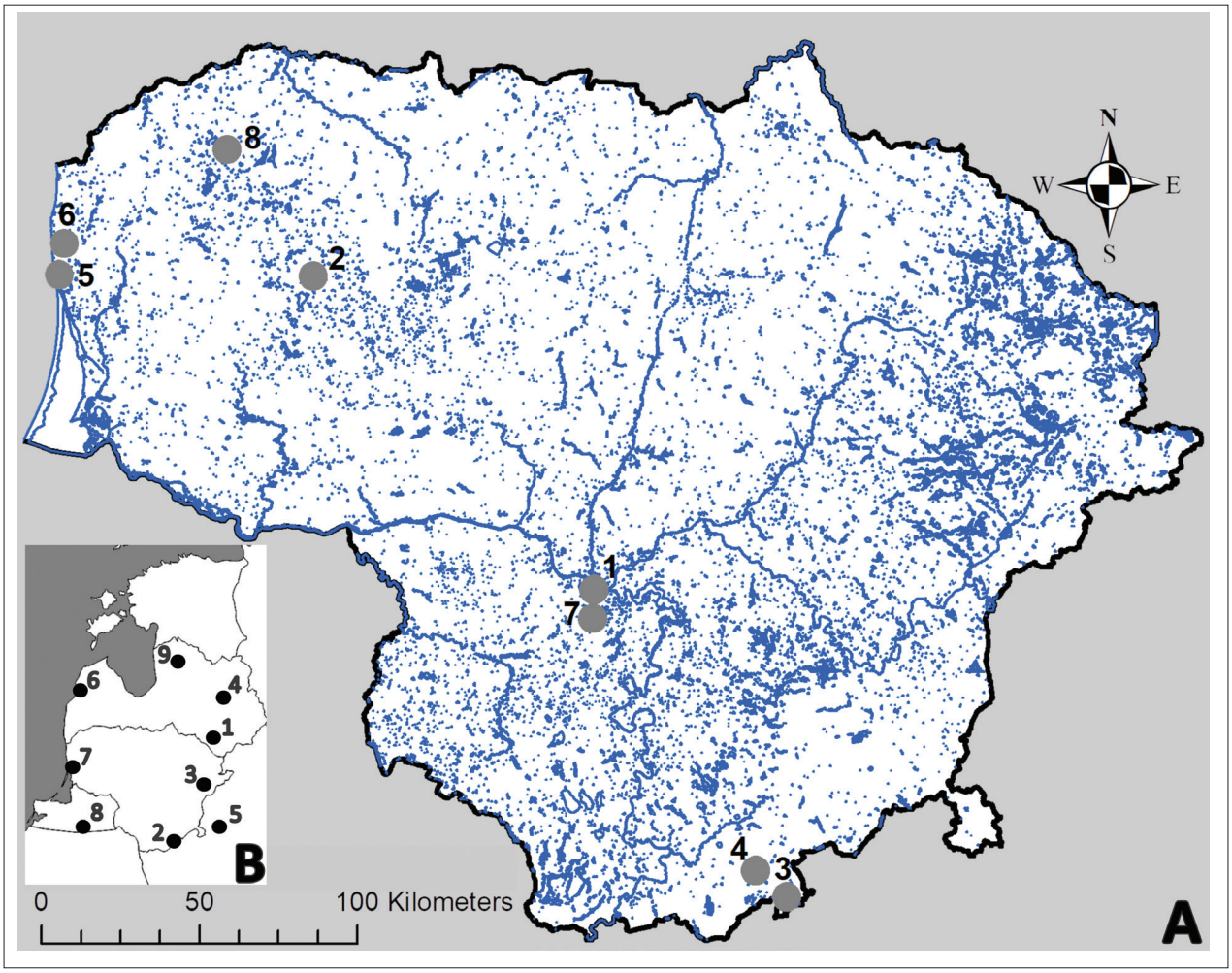

Figure 2. Locations of studied T-shaped antler axes (A) and the key sites mentioned in the text (B). A: 1. Aleksotas; 2. Daktariškė 5 site; 3. Dubičiai; 4. Kašėtos; 5. Melnragė II; 6. Palanga; 7. Rąžiškiai (Rokai); 8. Šarnelė; B: 1. Dviete River; 2. Kabeliai 2; 3. Kaltanėnai; 4. Lake Lubāns; 5. Michnievičy; 6. Sise; 7. Smeltė; 8. Zedmar; 9. Zvejnieki II (compiled by Rimkus).

the T-axes from Daktariškė 5 and Palanga are the only ones found in settlement layers, we provide more detailed data on these sites (excavation year, general dating, situation in the landscape and description of layers) and the archaeological context.

1.1 Aleksotas (AR 2309)

This axe was found during soil extraction near the Vytautas the Great Bridge in Kaunas, central Lithuania. The precise find spot was not recorded, but it is likely that the artefact was found in the accumulated organic sediments at the edge of the Nemunas River. The inventory book of the Vytautas the Great War Museum indicates that the find was handed over to the museum in 1979, but it remains unclear whether this was the same year in which it was found. Until now, the T-axe from Aleksotas has not appeared in the scientific literature.

The axe is 138 mm long, 44 mm wide in the distal part, 59 mm wide in the medial part (place of the perforation) and 41 mm wide in the proximal part (blade area). The shape of the perforation is an elongated oval, measuring 21 x 47 mm. It is the shortest T-shaped axe currently known in Lithuania. The area of the working edge is badly damaged.

1.2 Daktariškė 5 (EM 2245: 3080; EM 2245: 3081; EM 2245: 3101)

The Daktariškė 5 site is located on the former island of Biržulis Lake, in its northwestern part, in western Lithuania (Fig. 3). As shown by the coring data in the adjacent wetland area, in the second half of the Atlantic period and the sub-boreal the site was established next to the shallow strait of Biržulis Lake (Kunskas and Butrimas 1985). In 1987–1990, the site was excavated by Adomas Butrimas (1998, p. 123; 2019, pp. 165–190), 648 m^2 area in total. The trenches were located in the littoral zone, where refuse layers with preserved organic artefacts were found. Besides the three T-axes, one antler beam axe with a perforation for the shaft, ten socketed antler and bone axes and adzes, a few awls, daggers, bone points, boar tusks and one toggle harpoon head were discovered (Fig. 4). Pottery sherds

Figure 3. Situation plan of the Daktariškė 5 site with 1987–1990 excavation area (compiled by Rimkus).

tempered with organics or minerals were found at the site (Iršėnas and Butrimas 2000), as well as amber artefacts, its fragments, raw material and production waste, stone and wooden implements (Butrimas 2016a; 2016b).

In 2016, an area of 48.6 m^2 was excavated next to the 1987–1990 excavation trenches. The finds included more well-preserved hunter-gatherer organic artefacts, including those made of cervid antler (Piličiauskas 2018, pp. 39–64), but no T-shaped antler axes were found. Summarised radiocarbon data indicate that the area was occupied

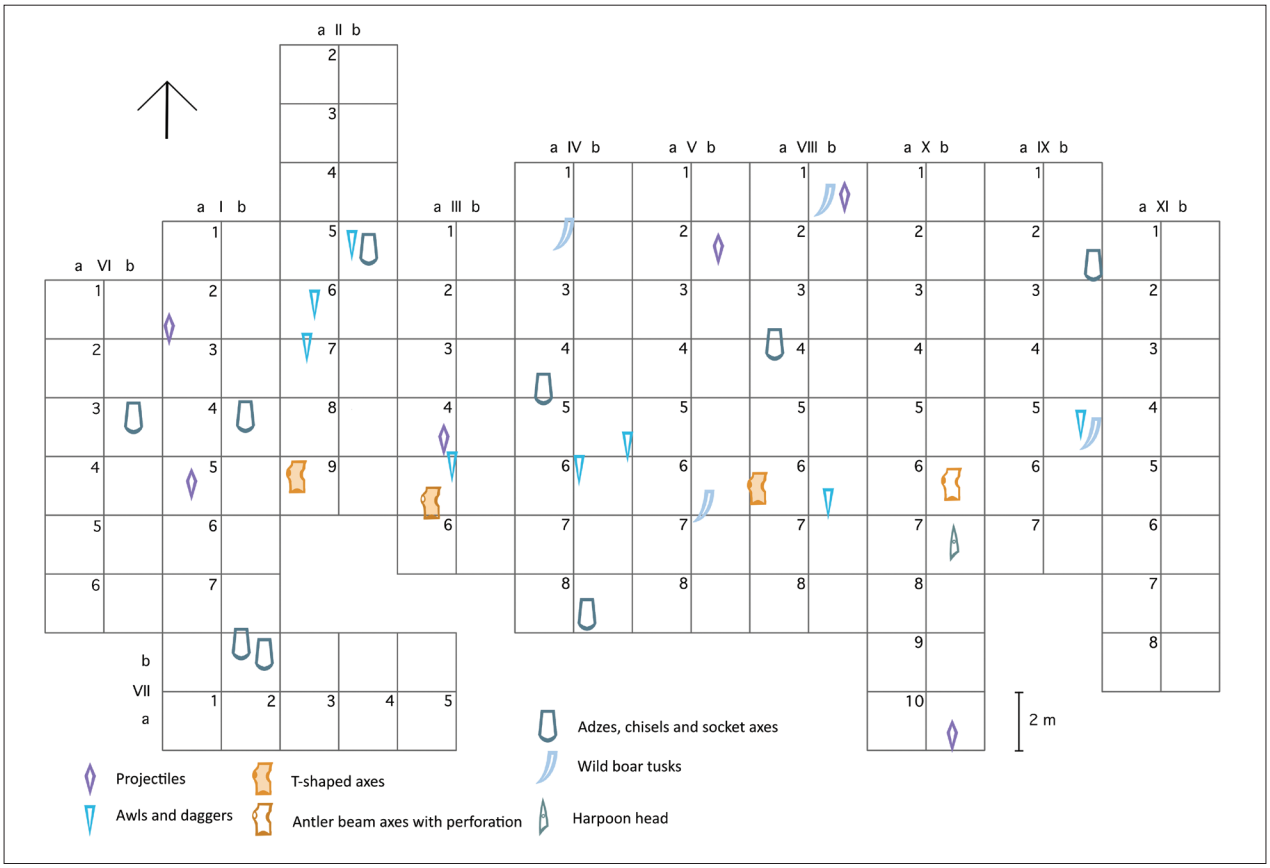

Figure 4. 1987–1990 excavation area of the Daktariškė 5 site with the distribution of bone and antler finds (compiled by Butrimas).

between the end of the 5th and the middle of the 2nd millennium cal BC (Piličiauskas 2018, p. 61).

The settlement was excavated in trenches, each 4 m wide and 10–20 m long, with trenches 1–6 and 8–9 oriented in a north–south direction, and only trench 7 in an east–west direction. All trenches oriented north–south were sloping downwards into the overgrown part of the lake. The north–south squares were numbered from 1 to 10 according to the length of the excavated area, and the width of the excavation was indicated by the letters a and b.

The stratigraphy of the excavated trenches shows that the northern part of the excavation area was in mineral soil and the find layer was thin there, whereas in the southern parts of the excavated areas it lay deeper under plough soil, and organic-rich sediments (brownish peat and gyttja), and varied in thickness between 10 and 50 cm. Antler and bone tools were found here, including the T-shaped antler axes.

The first T-axe (EM 2245: 3080) was found in the southern part of the excavation area, close to the eastern boundary of square 9a in trench 2 (Fig. 5: 1). The thickness of the turf layer here was 0.3 m. The thickness of the undegraded peat was also 0.3 m. Below this layer, at a depth of between 0.35 and 0.4 m, was a layer of brownish peat with gyttja. Beneath it, the former lakebed with carbonate gyttja with no finds was reached, at 0.95–1 m from the ground surface. The T-shaped antler axe was found 0.2 m from the eastern part of the square, at 0.93 m depth. Its length is 196 mm, its width in the distal part is 38 mm, in the proximal part 46 mm, and through the perforation 61 mm. The shape of the perforation on both sides of the antler is oval, it measures 17 x 15 mm.

The second T-shaped axe (EM 2245: 3101) was found in square 6a of trench 8 (Fig. 5: 2). Under a 30–40 cm layer of turf, a 60–75 cm layer of undegraded peat was found. At a depth of 1–1.05 m from the ground surface in the lower part of the cultural layer (ca. 0.22–0.25 m from the eastern boundary of the square), the T-shaped antler axe was found. Its length is 229 mm, and the width in the distal and proximal parts is 38 mm, and through the perforation 55 mm. The shape of the perforation in the inner part of the antler is semi-rectangular, its size 23 x 18 mm. On the side of the removed trez tine, the perforation is oval in shape.

The third T-shaped axe (EM 2245: 3081) was found in square 5a of trench 3, 30–35 cm from the southern edge of the square (Fig. 5: 3). In this square is arranged a 0.3–0.4 m thick layer of top soil covering a layer of loose peat in the first row of squares A and B, which becomes thicker towards the south and reaches a thickness of 0.1–0.12 m,

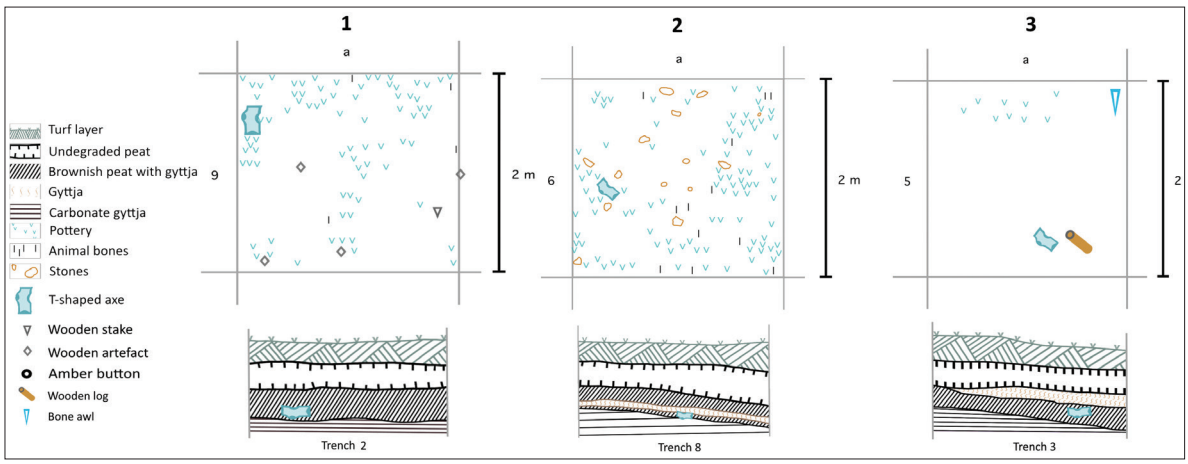

Figure 5. Find context of each T-shaped antler axe from Daktariškė 5 site: 1. Axe No. EM 2245: 3080; 2. Axe No. EM 2245: 3101; 3. Axe No. EM 2245: 3081 (compiled by Butrimas).

and nearly 0.4 m at the boundary of square 5a. A gyttja interlayer appears at the northern boundary, thickening towards the southern direction, reaching a thickness of 0.15–0.2 m at the square 5a boundary. The T-shaped antler axe was found at a depth of 0.8–0.85 m from the ground surface.

The length of the T-shaped antler axe is 155 mm, the width in the distal part 36 mm, the proximal part 4 cm, and through the perforation 70 mm. The shape of the perforation on both sides of the antler is oval, its diameter is 15 x 15 mm.

1.3 Dubičiai (1259)

The T-axe from Dubičiai is briefly mentioned in the first volume of the Lithuanian Archaeological Atlas (Rimantienė 1974), but only a few things can be added about the artefact from the records of the Alytus Museum inventory book, which shows that the axe was found in one of the peat bogs around Dubičiai village in southern Lithuania. The find was brought to the museum in 1958 by the director of the museum at that time.

The length of the artefact is 284 mm. The width in the distal part is 53 mm, while in the proximal part it is 49 mm. The shape of the perforation in the removed trez tine part is an elongated oval 30 x 17 mm in size. In the opposite part, the perforation is slightly rounder and is 25 x 20 mm. The T-axe working edge is damaged, which is evident from a large fracture. Morphologically, the fracture resembles the damage on the axe found at the Palanga site.

1.4 Kašėtai (EM 4)

The artefact from Kašėtai was found washed up on the bank of the Ūla River in southern Lithuania. It is currently stored and exhibited at the National Museum of Lithuania. The axe is briefly mentioned by Wandalin Szukiewicz (Szukiewicz 1907). The first volume of the Lithuanian Archaeological Atlas suggested that it might be a dagger made from a tine of deer antler (Rimantienė 1974). However, it is a fragment of a T-shaped axe broken in half through the perforation, which is one of the most typical fractures of these axes. The same damage can be observed on the artefact found in the Dviete River (southeastern Latvia) (Vankina 1984), or numerous T-axes from the Netherlands (Clason 1983).

The implement is made of a large piece of red deer antler. The length of the fragment is 192 mm. It is difficult to estimate what type of shape the perforation might have been, because only a small fragment of it remains from which it is difficult to judge its final form.

1.5 Melnragė II

This artefact was discovered in 2015 washed up on the beach between Melnragė II and Olando Cape near Klaipėda city, coastal Lithuania. Information about the artefact was published soon after (Girininkas, Daugnora 2015; Rimkus 2019). Surprisingly, its calibrated radiocarbon age is close to the date of a submerged pine trunk from the RF-II site in the Baltic Sea, which was found in this area during underwater survey (Žulkus and Girininkas 2020). In a recent paper published by Žulkus and Dobrotin (2022), it is noted that the underwater landscape at this site is heavily eroded, resulting in the exposure of a large number of coarse boulders. Strong currents at this location may have washed the axe out of the submerged Mesolithic site, however, underwater surveys in this location failed to offer any results which would determine the site of former prehistoric human occupation.

The T-axe is heavily affected by water erosion. Its surface has been smoothed and the spongy tissue is completely eroded. The tool is 210 mm long and its width in the distal and proximal parts is 35 mm. The perforation is circular in shape on both sides and measures 12 x 17 mm.

1.6 Palanga (A1: 6)

The Palanga site (coastal Lithuania) was discovered in 1958, when animal bones, amber and stone artefacts were found on the banks and in the bed of the Rąžė River during straightening works (Kulikauskas 1959). Archaeological investigations followed and these revealed a collection of artefacts made of animal bone and antler. The author of the excavation indicates that the axe was found in area No. 2, 65 cm deep in a layer of brown peat (Navickaitė 1958). Unfortunately, the site is considered to have been destroyed during the straightening of the riverbed.

Although some of the faunal and possibly human remains have been lost, the assemblage of artefacts is preserved and exhibited at the Kretinga Museum. The artefacts consist mainly of heavy-duty tools — axes, adzes and chisels. There are also arrowheads, one of which is decorated with grid and X-shape patterns. The species identification of the osseous artefacts suggested that most of the tools were made from the bones and antlers of red deer (Piličiauskas et al. 2015). The first dating results of two artefacts were published by Piličiauskas et al. (2015), which showed that they both date to the period between ca. 4400 and 3900 cal BC. One of the artefacts was a T-shaped antler axe, which was dated to between 4230 and3967 cal BC. Subsequent direct dating studies of the remaining bone and antler artefacts from the site suggested that they fall within a relatively short chronological period of ca. 4400–3800 cal BC (Rimkus and Daugnora 2021; Rimkus 2022).

The T-shaped antler axe from the Palanga site is 325 mm long. The perforation is an elongated oval shape on the outer side (trez tine part) and slightly more like an irregular rectangle on the inner side. The working blade of the axe is heavily damaged by a large fracture, and two white spots on its surface are related to the requirements of the exhibition.

1.7 Ražiškiai (AR 23)

The axe was found on the bank of the River Jiesia (central Lithuania), within the accumulated sediment. It is likely that the T-axe may have been washed downstream from the eroding bank of the river some distance away. It was handed over to the Vytautas the Great War Museum. No additional information about this piece is available in the museum inventory book. It was first published in the first half of the 20th century by Puzinas (1938), in order to represent the Stone Age bone and antler industry in Lithuania. In the literature, the find location of the artefact is also known by the name Rokai (e.g. Juodagalvis 2010).

The T-shaped antler axe is fully preserved and no major damage is visible on its surface. The inner part of the antler (the spongy tissue) is completely eroded, possibly as a result of water erosion. It is 245 mm long, 41 mm wide in the distal end, 51 mm wide in the medial part, and 45 mm wide in the proximal end. The shape of the perforation is an elongated oval in the outer part (trez tine part) and an irregular rectangle in the inner part. Its size is 35 x 30 mm.

1.8 Šarnelė (Arch 1903)

An assemblage of five stray bone and antler artefacts was discovered in the bed of the Varduva River, in the village of Šarnelė (northwestern Lithuania) in 1940 and 1965 (Valatka 1968). The collection is stored in the Samogitian Museum "Alka". Recent research on this collection indicates that the artefacts belong to different periods. There is no doubt that human activity in the area began as early as the end of the Late Glacial and continued into the Mesolithic, while more finds are known from the Late Holocene period (Butrimas 2019; Rimkus et al. 2019). One T-shaped antler axe was identified among stray finds. In 1973 and 1981–1982, the banks of the Varduva River were excavated in order to locate the former settlement. Finds typical of the northeastern European Neolithic hunter-gatherers were identified, thus showing good organic preservation (Girininkas 1977; Butrimas 1996). However, no more T-axes were found during either excavation campaign.

The T-shaped antler axe is fully preserved. It is 260 mm long, 46 mm wide in the distal part and 56 mm wide in the proximal part. The size of the perforation is 21 x 32 mm. Its shape is an elongated oval on both sides. No major damage is visible on the surface of the axe. Only a long split in the blade area can be observed, which, according to the records in the museum inventory book and old drawings (Valatka 1968), was already present when the find was delivered to the museum.

2. AMS ^{14}C dating

The T-shaped antler axe from the Palanga site was dated by AMS and has been published previously (Piličiauskas et al. 2015). The remaining nine T-shaped antler axes from the territory of Lithuania were sampled for the international radiocarbon dating project (Lübke et al. forthcoming). Samples were processed and dated at the Leibniz-Laboratory for AMS Dating and Stable Isotope Research, Christian-Albrecht-University, Kiel, Germany (KIA) (Grootes et al. 2004; for the sampling and samples preparation procedure, see Lübke et al. forthcoming). Five samples were successfully dated, but in the case of the remaining four, dating was not possible due to low collagen yield (Table 2).

Two T-axes from the Daktariškė 5 site (EM 2245: 3080 and EM 2245: 3101) and one from Ražiškiai were resampled for this study. Samples for these axes were taken from their inner parts by abrading the surface and removing the spongy tissue. After that, a drill was used to collect powder from the solid part of the antler. Samples were processed

Table 1. Archival data of T-shaped antler axes from Lithuania.

Site	Context	Coordinates (WGS)	Museum	ID	Figure No.	Reference
Aleksotas	Single find	54.8933 23.8878	VDKM	AR 2309	6: 1	Lübke et al. in press
Daktariškė 5	Cultural layer	55.7913 22.3938	LNM	EM 2245: 3081	6: 2	Butrimas 2019
Daktariškė 5	Cultural layer	55.7913 22.3938	LNM	EM 2245: 3080	6: 3	Butrimas 2019
Daktariškė 5	Cultural layer	55.7913 22.3938	LNM	EM 2245: 3101	6: 4	Butrimas 2019
Dubičiai	Single find	-	AM	1259	6: 5	Rimantienė 1974
Kašėtos	Single find	-	LNM	EM 4	6: 6	Szukiewicz 1907
Melnragė II	Single find	55.7731 21.0758	Private collection	-	7: 1	Girininkas, Daugnora 2015
Palanga	Cultural layer	55.9184 21.0627	KM	A1: 6	7: 2	Kulikauskas 1959
Ražiškiai (Rokai)	Single find	54.8297 23.9300	VDKM	AR 23	7: 3	Puzinas 1938
Šarnelė	Single find	56.1062 21.9499	ŽMA	Arch 1903	7: 4	Valatka 1968

at the Accelerated Mass Spectrometry Laboratory at the Centre for Physical Sciences and Technology (Vilnius Radiocarbon) (FTMC). The acid-base-acid procedure followed by gelatinisation was used for bone collagen extraction (Molnár et al. 2013). Samples were treated with 0.5M HCl (~18 hours), 0.1M NaOH (30 minutes), and 0.5M HCl (1 hour). Collagen was gelatinised in pH 3 solution at 70°C for 20 hours. The solution was filtered using a cleaned Ezee-filter and freeze-dried. Graphitisation of the samples was performed using Automated Graphitisation Equipment AGE-3 (IonPlus AG). A single-stage accelerator mass spectrometer (SSAMS, NEC, USA) was used for radiocarbon (^{14}C) measurements. The background of measurements was estimated to be 0.25 pMC using phthalic anhydride (Alfa Aesar). The NIST-OXII (134.06 pMC) standard was used as reference material. The $^{14}C/^{12}C$ ratio was measured with an accuracy better than 0.3%. For the isotopic fractionation correction, the ratio of ^{13}C to ^{12}C was used. Typical SSAMS system parameters can be found in the paper by Ežerinskis et al. (2018).

All radiocarbon dates in this paper were calibrated using OxCal v4.4.4 (Bronk Ramsey 2009) and the IntCal20 atmospheric curve (Reimer et al. 2020). Calibrated dates are presented at 95.4% probability.

3. Dating results

Dating of one of the resampled T-shaped antler axes from the Daktariškė 5 site (EM 2245: 3101) failed. The sample of T-axe No. EM 2245: 3080, however, was successfully dated this time. Unfortunately, dating of a new sample from the Ražiškiai T-axe also failed due to low collagen yield. Altogether, seven T-shaped antler axes from the territory of Lithuania are now directly dated.

The T-shaped antler axe from Daktariškė 5 (EM 2245: 3081), dated to 5375–5213 cal BC, is the oldest in this assemblage. Another T-axe from the Daktariškė 5 site (EM 2245: 3080) and the one from Melnragė II are slightly younger, dating to 5210–4999 and 5214–5009 cal BC respectively. The other four T-axes are dated to between ca. 4700 and3800 cal BC, making the artefacts from Palanga and Šarnelė the youngest in this assemblage.

Even if all T-shaped antler axes from the territory of Lithuania had been successfully dated, the database of the directly dated implements of this type would still be very modest In future research, this hopefully might be improved by the continuing and promising studies in wetland areas. However, the current data divide T-axes into two stages — 1) the end of the 6th millennium and 2) the 5th/beginning of the 4th millennium cal BC (Fig. 8).

Table 2. AMS ^{14}C data of T-shaped antler axes.

Site	ID	Lab. code	^{14}C BP	cal BC (95.4%)	Reference
Aleksotas	AR 2309	KIA-53037	5565±30	4452–4347	Lübke et al. in press
Daktariškė 5	EM 2245: 3081	KIA-52530	6325±40	5375–5213	Lübke et al. in press
Daktariškė 5	EM 2245: 3080	KIA-52529	-	-	Lübke et al. in press
Daktariškė 5	EM 2245: 3080	FTMC-JV91-4	6147±33	5210–4999	This study
Daktariškė 5	EM 2245: 3101	KIA-52531	-	-	Lübke et al. in press
Daktariškė 5	EM 2245: 3101	FTMC-IJ19-2	-	-	This study
Dubičiai	1259	KIA-53039	5728±29	4680–4462	Lübke et al. in press
Kašėtos	EM 4	KIA-56912	-	-	Lübke et al. in press
Melnragė II	-	KIA-53036	6170±35	5214–5009	Rimkus 2019
Palanga	A1: 6	Poz-66588	5240±40	4230–3967	Piličiauskas et al. 2015
Ražiškiai (Rokai)	AR 23	KIA-53038	-	-	Lübke et al. in press
Ražiškiai (Rokai)	AR 23	FTMC-KE90-1	-	-	This study
Šarnelė	Arch 1903	KIA-52528	5180±35	4158–3820	Lübke et al. in press

4. Discussion

4.1 Chronology and technology aspects

Mentions of the T-shaped antler axes in the eastern and southeastern parts of the Baltic region go back as far as reports by archaeologists from former eastern Prussia. In the scientific literature, they are mentioned at the Zedmar site in the Kaliningrad area (Gaerte 1929). Extensive archaeological excavations at Zedmar A and D sites were carried out between 1970 and 1980. According to Timofeev et al. (1994), T-shaped antler axes were especially common at the Zedmar D site. Based on the similar artefact types, it was thought that T-axe technology at the Zedmar sites was the influence of the Central European Lengyel and Funnel Beaker cultures and that it reached the southeastern Baltic from western and southwestern directions (Timofeev et al. 1994, p. 132; Timofeev 1998, p. 232). A recent analysis of Zedmar D radiocarbon dating samples suggests that the main phase belongs to the second half of the 5th millennium cal BC and the beginning of the 4th millennium cal BC (Kozicka 2017). Therefore, it is highly probable that the T-axes from this site also belong to the same time horizon. The dating results in this paper would support the idea that the technology of T-shaped antler axes in the eastern and southeastern Baltic region was known from the end of the 6th millennium cal BC and continued in the area throughout the 4th millennium cal BC. Therefore, it is highly plausible that T-axes in Zedmar-type sites were introduced by the local hunter-gatherer societies that continued the red deer antler tools technology when the pottery was introduced in the region.

Two samples from the Daktariškė 5 site were successfully dated, however, the sample EM 2245: 3101 failed both times. The two dated samples belong to ca. 5400–5000 cal BC, suggesting that they are both from the older settlement phase. It is possible that the undated T-axe also belongs to this phase as in the later chronological stages of the settlement, different types of antler axes and adzes were identified (Piličiauskas 2018, p. 60). However, artefact No. EM 2245: 3101 differs in perforation technology (see the discussion below) compared to the other two T-axes from the Daktariškė 5 site. This axe has a semi-rectangular shaped perforation with no remains of the trez tine. Therefore, it is also plausible that this tool could be more recent.

Figure 6. T-shaped antler axes from Lithuania: 1. Aleksotas (AR 2309); 2. Daktariškė 5 (EM 2245: 3080); 3. Daktariškė 5 (EM 2245: 3081); 4. Daktariškė 5 (EM 2245: 3101); 5. Dubičiai (1259); 6. Kašėtos (EM 4) (photographs by Artūras Balčiūnas and Rimkus).

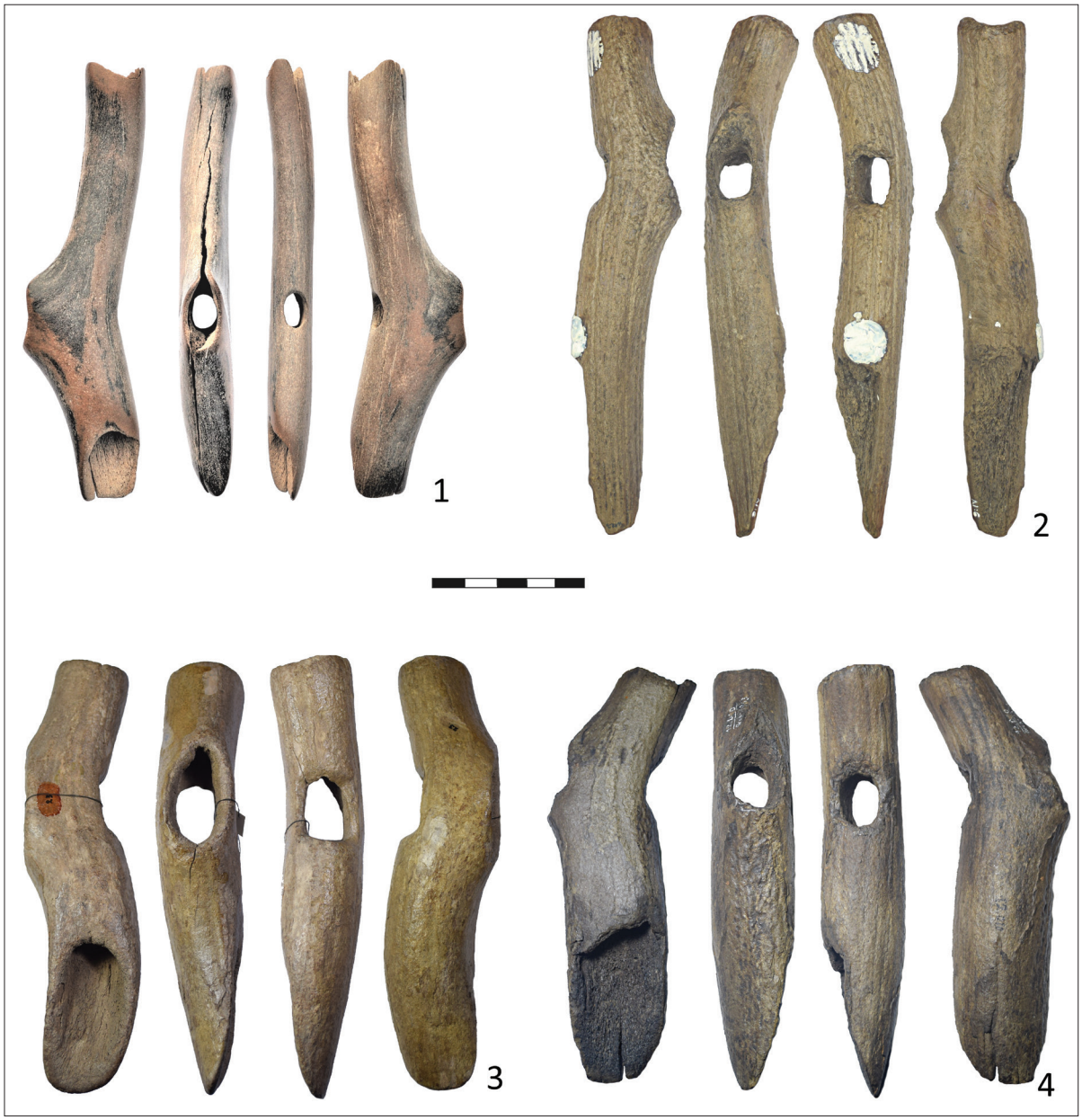

Figure 7. T-shaped antler axes from Lithuania: 1. Melnragė II; 2. Palanga (A1: 6); 3. Ražiškiai (Rokai) (AR 23); 4. Šarnelė (Arch 1903) (photographs by Saulius Bučas and Rimkus).

One major difference in the technology and chronology of T-shaped antler axes was observed during this study. The older artefacts from the Daktariškė 5 site and Melnragė II contain a longer stump of the removed trez tine, whereas on the T-axes dated to the 5th millennium cal BC, such a feature is not visible. It is interesting to note, however, that the T-axe from Sise (Latvia) dated to the 6th millennium cal BC has a similar feature (Zagorska et al. 2021, p. 5), and also the oldest T-axes from Michnievičy quarry in northwestern Belarus (Vashanau et al. 2020a; Lübke et al. forthcoming). This pattern could be related to the technological tradition of a supposed older type of the antler axes which closely resembles red deer antler axes with the removed trez tine, and distal and proximal parts of the beam, although in this case, the perforation is shaped through the beam and not through the trez tine. This type of antler axe is known in southeastern and western Europe (e.g. Crombé et al. 1999; Beldiman 2012), and in the Michnievičy quarry (Vashanau et al. 2020b). However, this type of axe from Michnievičy is not dated, therefore, it is difficult to associate their chronology with T-shaped antler axes. No exact parallels of such axes are known in the territories of Latvia and Lithuania. As noted by David (2019), the longer remnant of trez tine could be related to the Mesolithic hafting techniques, but further studies on a larger assemblage of T-shaped antler axes dated to the 6th millennium cal BC is necessary to see if this feature repeats.

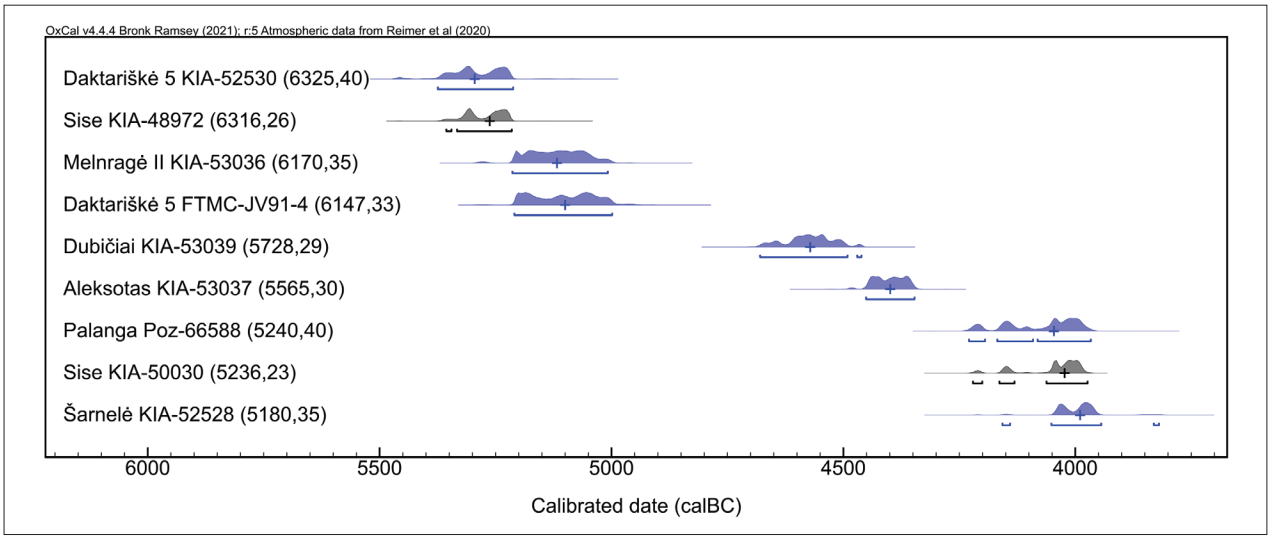

Figure 8. Calibration plot of dated T-shaped antler axes. Blue colour represents T-axes from the territory of Lithuania (Lübke et al. in press), grey — Latvia (Zagorska et al. 2021). Dates were calibrated by OxCal v4.4.4 (Bronk Ramsey 2009) and the Intcal20 atmospheric curve (Reimer et al. 2020).

4.2 Technology versus function

No antler waste products in Lithuanian wetland sites or museum collections are associated with the T-shaped antler axe production. The zooarchaeological material from Palanga is lost, so it was not possible to review it for any possible antler waste pieces from tool production. Red deer remains were not abundant at the Daktariškė site, and the published data does not provide any information on whether bones or antlers at the site might have any working traces[2] (Daugnora, Girininkas 1996, p. 78; Girininkas, Daugnora 2015, p. 109). Antler processing to produce a T-axe is very similar in many hunter-gatherer sites around the Baltic. For instance, Ertebølle culture sites in the southwestern Baltic area contain typical antler waste products from the manufacture of T-shaped antler axes, harpoons and other tools. This is evident at Bodzia 1, Dąbki 9, Drigge, Neustadt LA 156 and many other sites (Terberger 1999; Czekaj-Zastawny et al. 2013; Kabaciński et al. 2014; David 2015; Glykou 2016, pp. 340–343). Yet, so far, no waste pieces of red deer antler have been ascribed to the manufacturing of T-shaped antler axes in Lithuanian Stone Age studies.

Although such waste products are not known of at present, some of the T-shaped antler axes from the territory of Lithuania contain preserved characteristic manufacturing traces on their surface. For example, the axe from Dubičiai contains round cut marks and small signs of removal breakage on the remnant of trez tine (Fig. 9: 1). These traces indicate that multiple cuts were made in order to remove the trez tine. The perforation stage could have been conducted in a few ways, but the example of the unfinished T-axe from Brześć Kujawski in Poland demonstrates that cutting, scraping and scooping using flint, and then spongy interior drilling with a bone tool were applied in order to make a perforation for a shaft (Grygiel and Bogucki 1990). The perforation on the inner part of the antler was probably performed using lithic tools as it required more force to perforate the antler's compact part. As the perforation was made, scraping and cutting actions were further applied. This is evident on the perforation edges of the Ražiškiai axe. There, the flattening of the edge and scraping can be observed (Fig. 9: 2). This also affected the shape of the perforation, which in the case of the Ražiškiai axe can be seen as more of an irregular rectangle.

According to the T-axes from Dubičiai and Ražiškiai, the distal part of the antler beam was cut off evenly; the breakage damage was likely removed in further steps of finishing the tool as some rounding on the edge of the beams distal part of Dubičiai axe can be observed (Fig. 9: 3, 4). The examples given here do not necessarily include all the techniques used to make T-shaped antler axes, but they cover all the T-axes found in the territory of Lithuania.

The use of the term 'axe' for the T-shaped antler tools would suggest that they were employed for heavy-duty tasks in the daily life of the hunter-gatherer communities. Heavy damage to the T-axes from Dubičiai, Kašėtai and Palanga would support this, but the rest of the artefacts do not have such wear marks, although in some cases the tool's working surface is not preserved. Experimental studies support the concept of the T-axes as tools suitable for woodworking, which suffer heavy impact damage only when the antler completely dried out (Jensen 2001; van Gijn 2007). Use-wear studies also suggest that the proximal parts of broken T-shaped antler axes were sometimes repurposed into another tool, as in the example from the Netherlands suggesting that parts of them were used

[2] The zooarchaeological material from the Daktariškė 5 site was not available for revision.

Figure 9. Details of T-shaped antler axe technological aspects: 1. Cut marks on the remnant of trez tine (Dubičiai axe); 2. Perforation on the inner antler part (Ražiškiai axe); 3. Distal part of the antler beam removal area (Dubičiai axe); 4. Distal part of the antler beam removal area (Ražiškiai axe) (photograph by Rimkus).

for scraping hides (van Gijn 2005). T-shaped antler axes found in the territory of Lithuania have not been studied by microwear analysis yet, so it is difficult to give suggestions as to their use.

4.3 Red deer antler as a raw material

Red deer was an important game animal in northeastern European forest zone hunter-gatherer communities. Not only T-axes but also other types of heavy-duty implements were made from these animals' antlers. The recent study by Niedziałkowska et al. (2021) indicates that after the Late Glacial, the red deer population recolonised western and northwestern European territories more rapidly compared to the northeastern part. Therefore, the first evidence of red deer in the eastern Baltic comes only from the Boreal period, with the development of broadleaf forests and favourable climate conditions for this species. There are very few directly dated remains, and many of the bones in the settlements are only dated by stratigraphy or contextual dating. Therefore, the existing data may be subject to future corrections.

There are very few directly dated red deer remains from the Boreal in Lithuania, with only one bone found, in middle layer B of the Kabeliai 2 site (Ostrauskas 2002). However, recent data on bone and antler dating from Lithuanian and Latvian coastal settlements (Palanga, Sise and Smeltė sites) show an increase in red deer hunting during the Atlantic period, the number of different types of tools made from their antlers, and the presence of waste products in settlement layers (Zagorska et al. 2021; Rimkus 2022). In inland Lithuania, apart from the above-mentioned case of the Kabeliai 2 site, there are also less data, but one antler adze has been directly dated to the Atlantic period at the Kaltanėnai site, eastern Lithuania (Piličiauskas et al. 2020).

In the territory of Latvia, the abundant zooarchaeological material from the Zvejnieki II settlement would indicate that in the Early Mesolithic, elk and beaver (*Castor fiber*) predominated as species hunted by local communities, while red deer only appeared later, in the Boreal (Lõugas 2006; 2017). But zooarchaeological material at Zvejnieki does not provide any evidence of T-axes, therefore, the distribution of these artefacts is limited to certain eastern Baltic territories.

According to the available data on T-shaped antler axes in the eastern Baltic area, the most northern find spot of T-axes is the Sise site in western Latvia (Bērziņš et al. 2016; Zagorska et al. 2021), while the single find from the Dviete River is the most easterly known location of such tools (Vankina 1984). Both sites are located in larger waterscape systems, related to the Venta and Daugava river basins, suggesting that this technology might have reached the

local societies through the waterways. The absence of T-axes in the largest known osseous collection in the eastern Baltic, in Lake Lubāns, is quite surprising, although, according to the catalogue published by Vankina (1999), it seems that elk antler was preferred for heavy-duty tool manufacturing there. However, the collection is not sufficiently investigated by direct dating and animal species identification, therefore, future studies might provide more data on why some particular antler tool types are absent here.

Looking at the total distribution of T-axes in Lithuania and Latvia, all of them, with the Dviete River artefact being the single exception, are located in the western areas of the countries. Further conclusions can be drawn by suggesting the total absence of T-axe technology in the eastern parts, yet the modest database of artefacts and the lack of investigated wetland sites at the moment means there is insufficient data for reaching firm conclusions.

So far, there is no evidence of T-shaped antler axes in the territory of Estonia. Zooarchaeological data of terrestrial fauna suggest the presence of red deer in Late Mesolithic Estonia, however, compared to elk remains, those of red deer are in much lower numbers (Kriiska et al. 2017; Lõugas 2017). It might be the case that the technology of the T-shaped antler axe did not reach the northernmost areas of the eastern Baltic, as not even one is known from osseous assemblages of various sites, or as single finds.

Conclusions

The main goal of this paper was to discuss the chronology and technological features of T-shaped antler axes found in the territory of Lithuania. The available assemblage of ten artefacts is too small to draw large-scale conclusions from, however, some tendencies can be observed, which might be improved after studies of a larger database of T-axes found in Lithuania. The main part of the studied assemblage comprises single finds, only four axes have been discovered in the settlement layers. The long-term continuity of the T-shaped antler axe technology and the sustained presence of red deer in the territory of Lithuania throughout the second half of the Mesolithic and Neolithic would suggest that this type of artefact could be expected in larger numbers in the hunter-gatherer wetland sites.

The AMS ^{14}C dating of seven artefacts allows the statement that the technology of T-shaped antler axes in the territory of Lithuania was already established in the second half of the 6th millennium cal BC, which is evident from the dating of two axes from Daktariškė 5 and one from Melnragė II. However, the remaining four axes date to certain stages of the 5th millennium cal BC, a period to which the majority of T-axes are dated in the Baltic region (see Lübke et al. forthcoming). Current data indicate that this red deer antler technology was established in the region before the introduction of the earliest hunter-gatherer ceramics, however, it continued in the pottery-using groups in northeastern Europe and the early agricultural communities in the European Early Neolithic.

The manufacturing technique of T-shaped antler axes was maintained similarly among the Middle Holocene societies in Europe. The artefacts dated to the 6th millennium cal BC, however, might demonstrate slightly different features compared to the later dated ones. This is related to the longer remnant of trez tine and the oval shape of the perforation, which has not been discussed before. Yet it is necessary to study older phase T-axes in order to get a glimpse of a clear possible pattern in technological characteristics and changes. Most likely their function was also related to similar working materials. Experimental studies emphasise their efficiency in woodworking, however, as some suggest, the broken T-axes could also have been reutilised for other domestic activities.

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Abbreviations

Archaeol. Baltica — Archaeologia Baltica

FA — Fennoscandia Archaeologica

Hundred Years — G. Zabiela, Z. Baubonis, E. Marcinkevičiūtė eds. A Hundred Years of Archaeological Discoveries in Lithuania

Lietuvos Arch. — Lietuvos Archeologija. Vilnius

MAD'A — Lietuvos TSR Mokslų akademijos darbai. A serija. Vilnius (1955–1989)

Museums

AM — Alytus Museum

KM — Kretinga Museum

LNM — National Museum of Lithuania

VDKM — Vytautas the Great War Museum

ŽMA — Samogitian Museum "Alka"

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T formos rago kirviai Lietuvoje – neatskleista vidurinio holoceno medžiotojų-rankiotojų technologija

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Santrauka

Šiame straipsnyje pristatomas vienas iš charakteringiausių mezolito ir neolito medžiotojų-rankiotojų įrankių – T formos rago kirvis. Tokie kirviai gaminti iš taurio elnio (*Cervus elaphus*) rago ašies, pašalinus pokarūninę ataugą ir suformavus skylę mediniam kotui (1 pav.). Mūsų duomenimis, Lietuvos teritorijoje kol kas žinoma dešimt šio tipo kirvių iš aštuonių radaviečių (2 pav., 1 lentelė). Dauguma radinių yra pavieniai, rasti sausinant šlapynes ar kasant durpes. Tik dviejose archeologinėse gyvenvietėse – Daktariškės 5-ojoje ir Palangoje – rasta T formos kirvių (3–5 pav.). Kirvis iš Palangos senovės gyvenvietės datuotas AMS metodu ir publikuotas anksčiau. Likusių devynių T formos kirvių iš Lietuvos teritorijos mėginiai buvo paimti vykdant tarptautinį radiokarboninio datavimo projektą (6, 7 pav.). Šiame straipsnyje datavimui pakartotinai buvo paimti trijų T formos kirvių mėginiai iš Daktariškės 5-osios gyvenvietės ir vienas iš Ražiškių radavietės (2 lentelė).

T formos kirvis iš Daktariškės 5-osios gyvenvietės (EM 2245: 3081) yra seniausias šiame rinkinyje, datuojamas 5375–5213 cal BC. Kitas T formos kirvis iš šios gyvenvietės (EM 2245: 3080) ir kirvis iš Melnragės II radavietės yra šiek tiek jaunesni, datuojami atitinkamai 5210–4999 ir 5214–5009 cal BC. Likusių dirbinių datavimas rodo jų amžių maždaug iš 4700–3800 cal BC laikotarpio. Kirvis iš Šarnelės šiuo metu yra jauniausias šioje kolekcijoje (8 pav.).

Ankstyviausiuose T formos kirviuose iš Daktariškės 5-osios radavietės ir Melnragės II radavietės yra ilgesnė pašalintos pokarūninės ataugos liekana, o ant dirbinių, datuojamų V tūkstantm. pr. Kr., to nematyti (9 pav.). Kai kuriuose tyrimuose taip pat teigiama, kad skylės forma gali būti vienas iš mezolito laikotarpio bruožų šių įrankių technologijoje. Eksperimentiniai tyrimai patvirtintų, kad T formos kirviai efektyviai naudoti medienai apdirbti, tačiau sulūžę jie kartais būdavo naudojami kitai, pavyzdžiui, gremžimo, funkcijai.

Šiuo metu T formos kirvių šiaurinėse Rytų Baltijos regiono dalyse nerasta. Kol kas šiauriausi šio tipo dirbiniai yra du T formos kirviai iš Sisės (Sise) radavietės Vakarų Latvijoje.