

Kristiina Paavel, Aivar Kriiska, Valter Lang and Alexander Kulkov

THREE BRONZE AXES WITH WOODEN HAFT REMAINS FROM ESTONIA

Estonian Bronze Age bronze artefacts are almost always discovered as stray finds without a datable context or associated samples that would enable absolute dating. Their age estimates are based on better dated parallels from elsewhere in Europe. Since 2015, three socketed bronze axes with wooden haft remains have been found in Estonia: an Akozino-Mälär axe from Astangu subdistrict in Tallinn, a Gotland type axe from Kajamaa village, and an axe with Y-shaped ornament from Kärasi village. The wood remains have been AMS dated and the tree species identified. One of the hafts was made of juniper or spruce (Kajamaa) and two of ash (Astangu, Kärasi). The AMS results confirm and specify the typological dates. Absolute dates are particularly important for dating the Akozino-Mälär type rarely found in closed contexts. The axes from Kajamaa and Kärasi date to the Late Bronze Age, the axe from Astangu dates to the transition between the Late Bronze Age and the Pre-Roman Iron Age.

Kristiina Paavel, Chair of Laboratory Archaeology, Department of Archaeology, Institute of History and Archaeology, University of Tartu, 18 Ülikooli St., 50090 Tartu, Estonia; kristiina.paavel@ut.ee

Aivar Kriiska, Chair of Laboratory Archaeology, Department of Archaeology, Institute of History and Archaeology, University of Tartu, 18 Ülikooli St., 50090 Tartu, Estonia; aivar.kriiska@ut.ee

Valter Lang, Chair of Archaeology, Department of Archaeology, Institute of History and Archaeology, University of Tartu, 18 Ülikooli St., 50090 Tartu, Estonia; valter.lang@ut.ee

Alexander Kulkov, Saint Petersburg State University, Resource Center for Geo-Environmental Research and Modeling (GEOMODEL), 7/9 Universitetskaya Emb., 199034 Saint Petersburg, Russia; aguacrystals@yandex.ru

Introduction

The possibilities for dating Bronze Age bronze artefacts found in Estonia are limited by their scarcity in datable contexts. Settlement sites have yielded casting waste and bronze scrap, but only a few tools or weapons, and graves may contain small items such as bronze buttons, tweezers, razors and ornaments. Axes and spearheads, however, are commonly single stray finds. They are dated according

to well-developed Scandinavian typologies or analogies from ‘core areas’ in south-western Baltic and the Volga-Kama region, assuming the artefacts were used here at the same time. These assumptions can be tested if the artefacts have any associated material with a specific age, for example the remains of wooden hafts, but these are rarely preserved. Studies where such samples have been radiocarbon dated and the tree species identified remain isolated in the whole Baltic Sea region (Asplund et al. in press).

Since 2015, three socketed bronze axes with wooden haft remains have been found in Estonia (Fig. 1). The axes from Kajamaa and Kärasi villages and Astangu subdistrict in Tallinn are all different in stylistic details and represent types with rather broad temporal duration. We have AMS dated the haft remains and identified the tree species (Table 1). The samples from Astangu and Kajamaa were dated at Poznan Radiocarbon Laboratory, the stable carbon isotope ($\delta^{13}\text{C}$) analyses were conducted at the Institute of Geological Sciences, Polish Academy of Sciences. The Kärasi sample was AMS dated at 14CHRONO Centre for Climate, the Environment, and Chronology of the Queen’s University Belfast. The tree species were identified in Saint Petersburg State University, Resource Center for Geo-Environmental Research and Modeling (GEOMODEL). As the axes were found by metal detectorists, we surveyed all three locations to clarify the find contexts. By combining geological and shore displacement data (Jussila & Kriiska 2004a; 2004b) we assessed the environmental conditions of the sites at the time of deposition. Here, the results are presented. Knowing the tree species informs us about hafting material selection and allows to better judge the accuracy

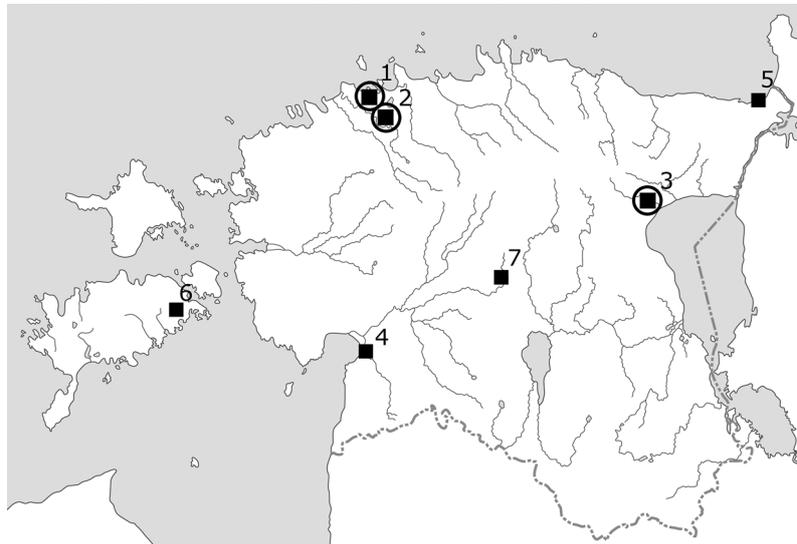


Fig. 1. Find locations of bronze axes with wooden haft remains. 1 – Astangu, 2 – Kajamaa, 3 – Kärasi. Their analogues mentioned in text: 4 – Silla, 5 – Mummassaare, 6 – Ridala, 7 – Maalasti. Map by Kristiina Paavel.

Table 1. Typological dates, ^{14}C results, stable isotope values, and tree species of the studied finds. All dates are calibrated by OxCal v4.3 (Bronk Ramsey 2017), using IntCal13 atmospheric curve (Reimer et al. 2013)

Artefact/sample	Found	Typological date	^{14}C result, calibrated date 95.4% probability	Tree species	$\delta^{13}\text{C}$ (‰)	Lab. No.
Astangu	2015	Per III–VI (1300–500 BC) or later	2345 ± 30 BP, 510–371 cal BC	Ash (<i>Fraxinus</i>)	–26.6	Poz-82895
Kajamaa	2016	Per IV–VI (1100–500 BC)	2720 ± 30 BP, 918–811 cal BC	Juniper (<i>Juniperus</i>) or spruce (<i>Picea</i>)	–23.6	Poz-82896
Kärasi	2017	Per IV–V (1100–600 BC)	2770 ± 31 BP, 998–838 cal BC	Ash (<i>Fraxinus</i>)	–	UBA-36322

of the AMS dates, which are intended to verify whether the typo-chronological age estimates made elsewhere apply to Estonian finds as well. Additionally, absolute dates may enable more accurate reconstructions of the deposition environment, particularly for seashore locations such as Astangu whose distance from water has been influenced by land uplift. Since wooden haft remains from Bronze Age bronze objects are rare in all of Europe, the finds from Astangu, Kajamaa and Kärasi villages are an important addition to the comparative material from the period.

Material and results

The axe from Astangu

The axe is 8.6 cm long and its slightly curved blade is 3.7 cm wide. Including the wood remains in the socket, it weighs approximately 200 g. The cross-section of the socket is round, its diameter measures 2.1–2.3 cm. The axe has a small loop on one side. It is decorated with a matrix of four horizontal ridges level with the loop, and three rather sparsely positioned vertical ridges, the middle of which crosses the horizontal ones, reaching the mouth (Fig. 2). This kind of ornamentation is characteristic of axes of the Akozino-Mälar type (Kuz'minych 1996, fig. 1).

The axe was found in 2015 in Astangu subdistrict of Tallinn, at the back of Kakumäe Klint Bay, about 700 m south of the southern shoreline of Lake Harku (Fig. 3). About 250 m south of the findspot, the klint bay is bordered by the steep North Estonian Klint. During the Bronze Age, the location was on seashore, as Lake Harku was isolated from the Limnea Sea only about 850 years ago (Grudzinska et al. 2014). Shore displacement chronology based on Estonian Stone Age seashore settlements¹ indicates that the find location was raised from the sea in the end of the Stone Age, more than 4000 years ago. Depending on the

¹ Date by shore displacement chronology with computer program Ranta-ajoitus Eesti 0-7700BP ver. 1.2a (6.4.04) (Jussila & Kriiska 2004a); primary data Jussila & Kriiska 2004b.

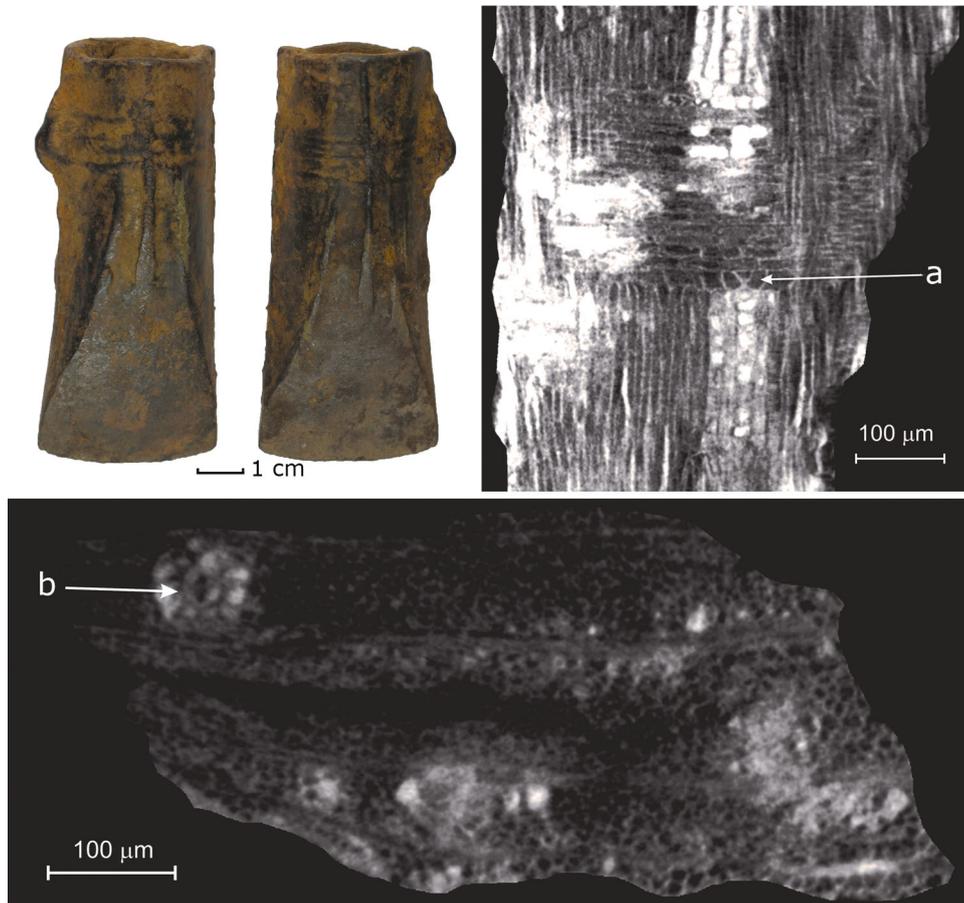


Fig. 2. The axe from Astangu and microstructure of the wooden haft fragment. Legend: a – heterogeneous ray with one row of square marginal cells, b – single vessel with vasicentric parenchyma. Photo of the axe by Kristiina Paavel, microphotos by Alexander Kulkov.

exact time of deposition (see below), the shoreline was located approximately 120–200 m from the findspot (Jüri Vassiljev, pers. comm., 01.03.18). The axe was found at a depth of 15 cm, in organic-rich sandy-silty sediments. A survey conducted in 2016 indicated no other archaeological remains or later soil disturbances in the immediate vicinity of the findspot, even though it is surrounded by the ruins of Peter the Great's naval fortress from the early 20th century.

The haft fragment was poorly preserved and partially mineralized². Two types of copper- and oxygen-containing mineral formations were observed: black-

² The anatomical examination of all wood fragments was performed using X-ray microtomography, implementing SkyScan 2011 X-ray nanotomograph (The 2011 nano-CT) with a resolution of <math>< 1 \mu\text{m}</math>. A scanning voltage of 40 kV with an average of 3–4 frames and a rotation angle of



Fig. 3. Astangu find location. Map by Kristiina Paavel / Estonian Land Board.

brown dense concretions and bluish-whitish plaque. Microtomographic study showed that mineral substitution has taken place mainly along the vessels and radial rays of the wood. The surviving elements of anatomy composed of 1–3 rows of homogeneous, seldom heterogeneous rays with one row of square marginal cells (Fig. 2: a) and single round vessels with vasicentric parenchyma (Fig. 2: b), which enabled to identify the species as ash (*Fraxinus*). The wood was AMS dated to 2345 ± 30 BP (Poz-82895), which is 510–371 cal BC with 95.4% probability³. The $\delta^{13}\text{C}$ value is -26.6‰ (Table 1; Fig. 4).

The axe from Astangu belongs to the Akozino-Mälär type. The type has many regional forms which differ in proportions, the number and placement of decorative lines, as well as the shape of the socket's cross-section (Melheim 2015, 195 ff.). They are distributed over an extensive area from Scandinavia to Tatarstan in Russia, with two main distribution clusters approximately 1200 km apart (Fig. 5: 1). In the eastern cluster between rivers Volga and Oka, approximately 265 axes have been found. The more dispersed western group of about 190 axes is centred in Mälaren Valley, Sweden, but includes Norway, Finland and the Baltic countries as well (Melheim 2015, 194 and references cited therein; Engedal 2010). Both

³ All dates in text are calibrated by OxCal v4.3 (Bronk Ramsey 2017), using IntCal13 atmospheric curve (Reimer et al. 2013).

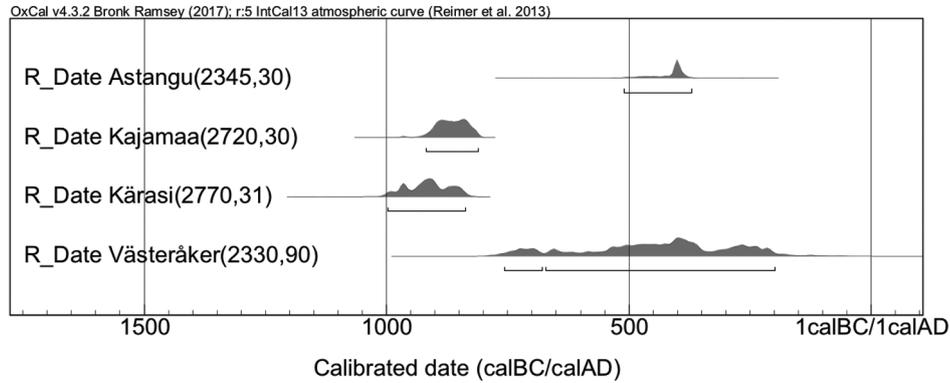


Fig. 4. Calibration of radiocarbon dates mentioned in text, calibrated using OxCal v4.3 (Bronk Ramsey 2017) and the IntCal13 atmospheric calibration curve (Reimer et al. 2013).

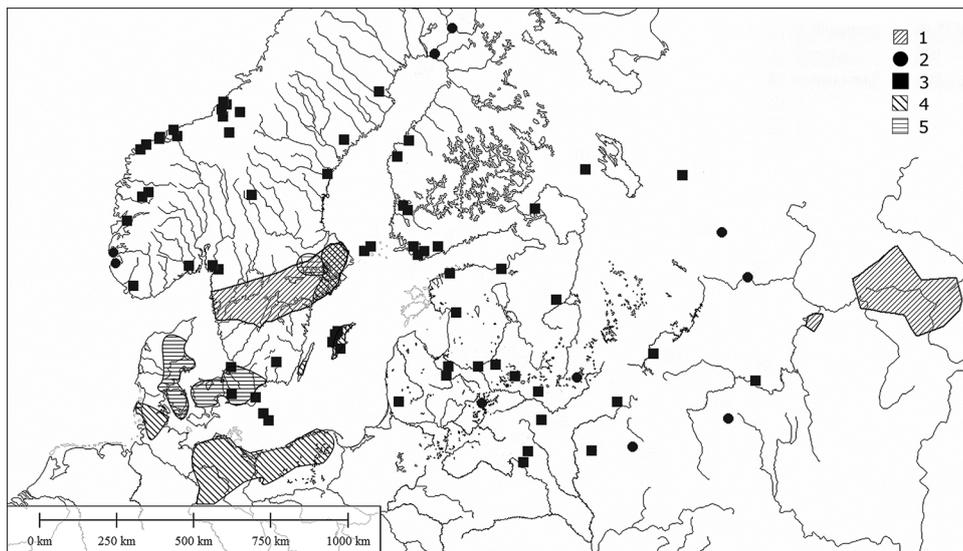


Fig. 5. Areas with the most Akozino-Mälars axes (1), casting moulds (2) and single axes (3) (after Engedal 2010; Yushkova 2012; Čivilytė 2014 and Soikkeli-Jalonen 2016) and the main regions with analogues to the axes from Kajamaa (4) and Kärasi (5) (after Baudou 1960).

the Volga-Oka and the Mälaren areas have been interpreted as centres of distribution (for overview see Čivilytė 2014, 179 ff.; Kuz'minych 1996; Melheim 2015; Ojala 2016, 174 ff.), but most of the known casting moulds have been found between the clusters (Kuz'minych 1996, fig. 2, tables 1–2; Yushkova 2012, 138 and references). The axe from Astangu has the decoration and socket shape characteristic of the so-called Swedish type (Kuz'minych 1996, fig. 1: B1a), some examples of which are also known from the middle reaches of River Volga and

elsewhere in eastern Europe (*ibid.*, figs 6: 3; 7: 5; 8: 5). The axes found in the Volga-Kama region mostly originate from graves and have earlier been dated to 8th–6th centuries BC (Kuz'minykh 1996). More recently, late 10th to late 7th centuries BC have been suggested instead (Yushkova 2012, 144 with reference to Korenyuk 2000). The Nordic axes have rarely been found in closed contexts, so their suggested dates are based on typological features and span from 1300–1100 to after 500 BC (e.g. Baudou 1953; 1960, 19 ff.; Meinander 1954, 37). Only one Akozino-Mälär axe has previously been radiocarbon dated. The haft remains of the axe from Västeråker parish in Uppland, Sweden were dated in 1958 to 2330 ± 90 BP (Hjärthner-Holdar 1998, 38), which is 757–199 cal BC (95.4% probability; Fig. 4). Such a wide calibrated probability range is attributable to the so-called Hallstatt plateau within the calibration curve and does not help to narrow down the type's chronological span. The date from Astangu appears much less affected by the plateau and places to the transition from the Bronze Age to the Iron Age.

Two more Akozino-Mälär axes have been found in Estonia, from Mummassaare village in Ida-Viru county and Silla village in Pärnu county (Fig. 1: 4–5). The example from Mummassaare has a zigzag line around the mouth in addition to the matrix of horizontal and vertical lines. Since zigzag ornament is characteristic of axes found in the River Kama region, the Mummassaare axe has been interpreted as a local form indicating both eastern and western influences (Lõugas 1970, 87). The axe from Silla is poorly preserved, with the ornamented socket partially destroyed. The remaining vertical lines are characteristic of the so-called Nordic subtypes (Swedish and Norwegian) of the Akozino-Mälär axes (Kuz'minykh 1996, fig. 1: VII B1a–b, VII B2d).

The axe from Kajamaa

The axe is 6.5 cm long, its blade is 3.6 cm wide and the oval socket measures approximately 2.2×3 cm. The small loop at the mouth could be used to secure it to the handle. It resembles axes of the Gotland type which are decorated with outwardly curved ridges on the sides (Baudou 1960, 25). On the heavily weathered find from Kajamaa, however, such a ridge can only be distinguished on the side with the loop. On both cheeks, a V-shaped decoration is faintly traceable (Fig. 6). Including the wood fragment in the socket, the artefact weighs 66 g.

The axe was found on a field in Kajamaa village, Harju county in 2016 (Fig. 7). The location on the southern foot of a low rendzina hillock is characterized by waterlogged conditions due to rising groundwater. The thick layer of blue and green corrosion products on the axe, as well as recent compression breakage on the socket indicate that the axe has been moved around in oxygen-rich surface layers during ploughing. During an initial survey in early 2017, the land plot was under cover crop, making field-walking impractical.

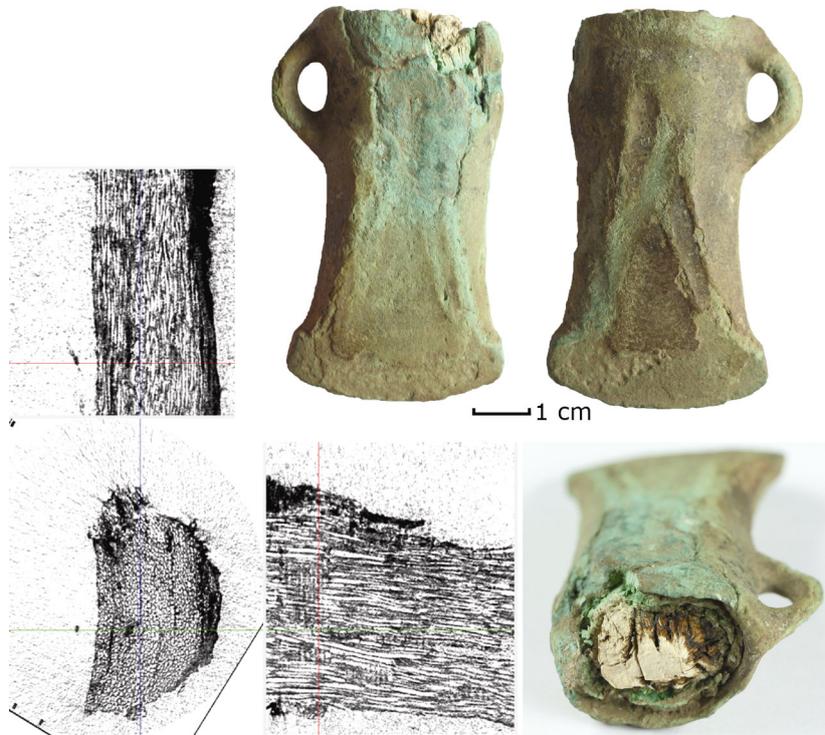


Fig. 6. The axe from Kajamaa and microstructure of the wooden haft fragment. Photo of the axe by Kristiina Paavel, microphotos by Alexander Kulkov.

Similarly to the Astangu sample, the haft fragment was very poorly preserved and partially mineralized. The tree species could not be identified with full certainty, but it clearly belongs to the class of Gymnosperms (*Gymnospermae*). Single-row radial rays with a height up to 9 cells were clearly distinguishable (Fig. 6). Resin channels were not observed. The wood is probably juniper (*Juniperus*), but spruce (*Picea*) cannot be completely excluded. The AMS date from the handle fragment is 2720 ± 30 BP (Poz-82896), 918–811 cal BC with 94.5% probability, and $\delta^{13}\text{C}$ value is -23.6‰ (Table 1; Fig. 4).

The axe from Kajamaa is similar to the Gotland (or Koppenow) type distributed in southern Scandinavia, northern Germany and northern Poland, the coastal region between Elbe and Vistula rivers (Baudou 1960, map 16; Fig. 5: 4). The typological date ranges from periods IV to VI (1100–500 cal BC), based on some examples found in hoards (Baudou 1960, 25; Hansson 1927, 125, Pl. 12: 66, 68). From Estonia, four similar axes have been found so far, but each of them is unique in details or measurements⁴. The only example from

⁴ Jüri village in Harju county (Lõugas 1970, 90); Järveküla village in Tartu county (Lang 2012; Paavel 2017a, fig. 2: 4), Ridala village in Saare county (Lõugas 1970, 91; Jaanits et al. 1982, 151), and Sõtke village in Rapla county (Paavel 2017b).

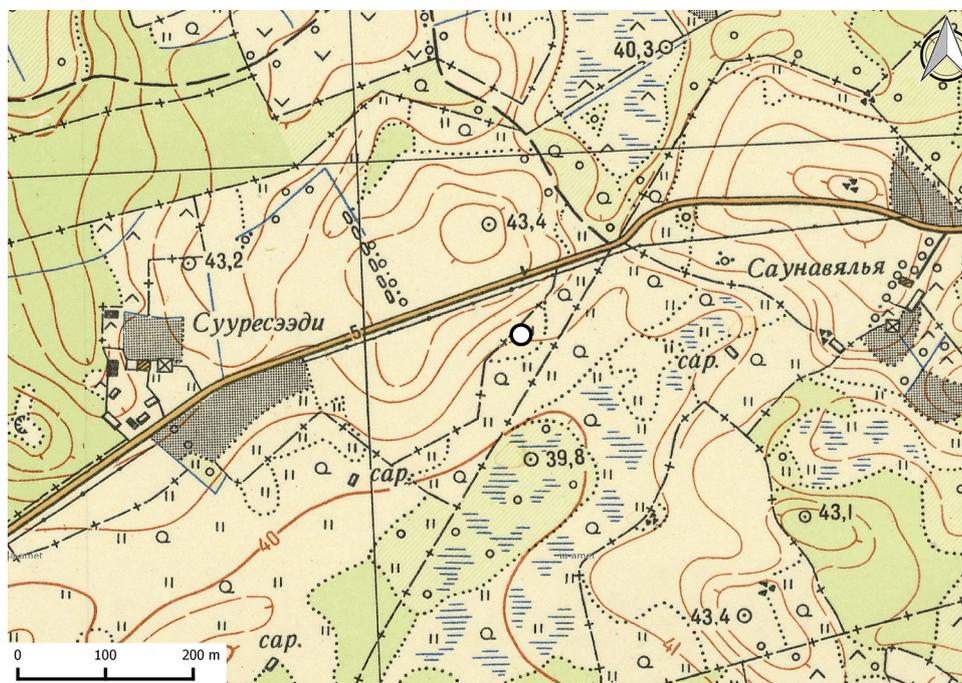


Fig. 7. Kajamaa find location on a Soviet o-42 series topographic map with 1:10000 scale (compiled between 1946–1989). Map by Kristiina Paavel / Estonian Land Board.

a clearly identified archaeological context is the axe found in Ridala fortified settlement on Saaremaa Island (Fig. 1: 6). So far, no radiocarbon dates have been obtained for the settlement site, but it has been dated to period VI on the basis of pottery and bronze finds (Sperling & Luik 2010, 149; Sperling 2014, 79, 314 f.).

The axe from Kärasi

The axe weighs 97.2 grams and is 7.2 cm long. Its slightly curved blade is 3.5 cm wide. The socket is oval and measures 2.9 × 3.4 cm. Both cheeks are decorated with seven vertical ridges. The decoration starts at the socket, covering about $\frac{2}{3}$ of the axe length. In the socketmost part, the middle ridge splits in two, forming a Y-shape (Fig. 8). The axe has neither a fastening loop at the socket, nor internal ridges supporting the blade. The heavily weathered artefact is covered with a light brownish green oxidation crust.

The haft fragment was quite well preserved and could be removed from the socket for examination⁵ under a microscope. It was worked into a shape to snugly

⁵ Removing the haft fragments from the other axe sockets was not possible as they were securely attached.

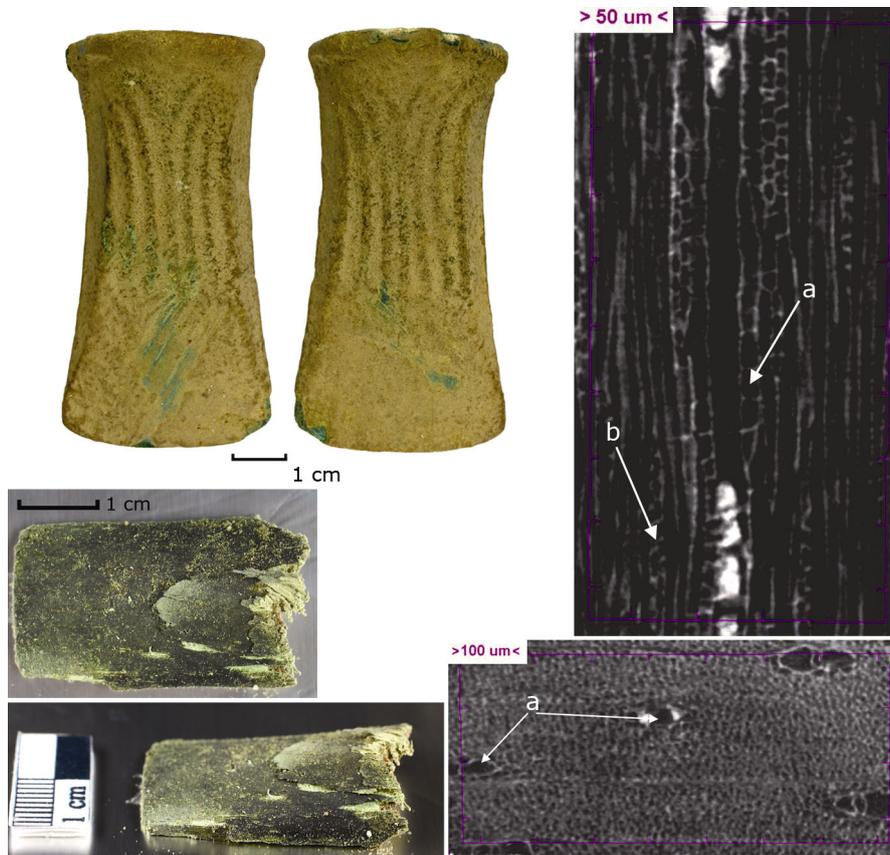


Fig. 8. The axe from Kārasi, the haft fragment and its microstructure. Legend. a – single vessel with vasicentric parenchyma, b – biseriata radial ray. Photo of the axe by Kristiina Paavel, microphotos by Alexander Kulkov.

fit in the socket and finely finished to a smooth surface. No tool marks could be detected. Microtomographic study of the wood remains showed the same features of wood anatomy as the Astangu sample. Vasicentric parenchyma (Fig. 8: a) and 1–3 seriate rays (Fig. 8: b) enabled to identify the tree species as ash (*Fraxinus*). The wood from the axe socket was AMS dated to 2770 ± 31 BP (UBA-36322; Kivirüüt in prep.), 998–838 cal BC with 95.4% probability (Table 1; Fig. 4).

The axe was found in 2017 in Kārasi village, Jõgeva county, on a plain with sandy quaternary sediments (Fig. 9), in podzol at a depth of about 25–30 cm (finder R. Alberi, pers. comm. 06.05.18). On the eastern and north-eastern sides the plain is bordered by flat lowland. The findspot was surveyed in 2018. Even though the land plot was recently cultivated, no traces of cultural layer could be detected. The only finds were small fragments of animal bones from the ploughed layer.

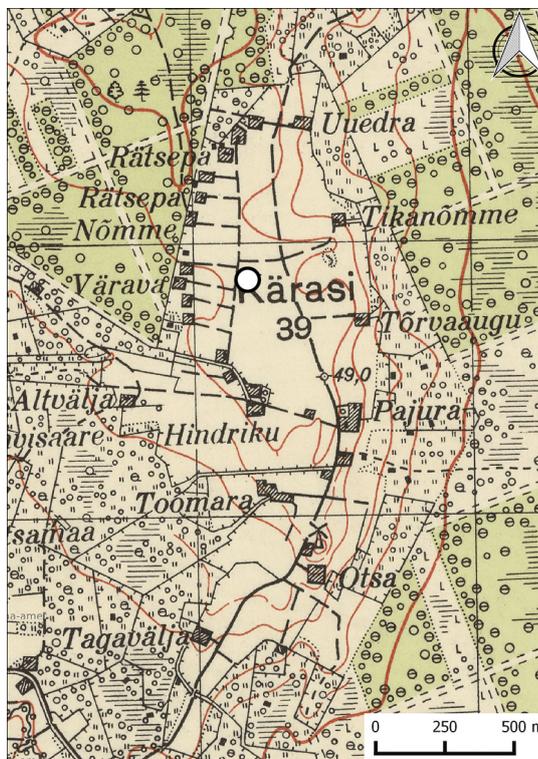


Fig. 9. Kärasi find location on a 1:25000 topographic map (compiled between 1923–1935). Map by Kristiina Paavel / Estonian Land Board.

The axe from Kärasi belongs to a type characterized by a decoration on the cheeks consisting of straight or slightly outwardly curved ridges, the middle of which branches in two at the socket (Baudou 1960, 18). Commonly, the decoration consists of three to six ridges. Above the bifurcated middle ridge may be a small dot or circle. Such axes generally measure 6–8 cm in length (*ibid.*), but some may be over 12 cm long (e.g. Oldeberg 1974, fig. 2714). They have straight sides and a straight or slightly curved blade, which is often narrower than the socket. Most axes lack inner ridges at the blade, some have loops at the socket (Baudou 1960, 18). Based on hoards, they have been dated to the Late Bronze Age, to periods IV–V (Åberg 1935, 153, fig. 63: 13; Baudou 1960, 18 f., Pl. XXX; Oldeberg 1974, 254; 1976, 9; Larsson 1986, fig. 36: 2). Similar axes are mainly found on northern Zealand and north-western Funen (Baudou 1960, Map 9; Fig. 5: 5). In addition, some are known from Scania, northern Jutland, and the Lake Mälaren area. From period V, axes with similar Y-shaped decoration are also known from the Lusatian (Lausitz) culture area, as well as from Hungary (Baudou 1960, 18 f.). The closest analogue to the Kärasi axe from Estonia was found in Maalasti, Viljandi county (Fig. 1: 7; Paavel 2016). It has fewer decorative ridges and the bifurcated middle ridge is not Y-shaped, but V-shaped. Additionally, a small circle is visible on one axe cheek above the ‘V’.

Discussion

Since organic material generally does not survive well, the instances where wooden haft remains have been found in the sockets of Bronze Age axes are rare, as are systematic programmes for dating them (but see e.g. Needham et al. 1997). In the Baltic region, only two artefacts have been subjected to such studies: a bronze axe of pre-Maaninka type from Paimio, Finland (Asplund et al. in press), and a stone axe found in Vaibla, Estonia (Kriiska 1998). Wood remains have been found in several socketed bronze items from graves in the Volga-Kama region, for example from the Earlier Akhmylovo (Patrushev & Khalikov 1982), Seima, Turbino I, Skorodum, Akozino (Bader 1964, 65; 1970, 106) and Koz'modem'yansk (Kuz'minych 1996, figs 3–5) cemeteries, but only select few of such samples have been radiocarbon dated and the tree species identified (Yunger & Karpelan 2005).

One-piece knee-shaped hafts, as well as composite hafts have been recovered elsewhere in Europe, although rarely (e.g. Dietrich 2010, fig. 2: 1–3; Gross et al. 2017, fig. 7). The haft fragments from Astangu, Kajamaa and Kärasi are too small to say which method was used, but we do know that one haft was at least partially made of juniper or spruce and two of ash wood. The popularity of ash in the Baltic region is somewhat surprising, as the stone axe haft from Vaibla and the bronze axe haft from Paimio were made of common ash as well (*Fraxinus excelsior* L.; Kriiska 1998, 154; Asplund et al. in press). Solid and hard ash wood has been a highly valued material in Estonian traditional woodworking (Viires 1960, 19). It is possible that these properties have also contributed to the wood preservation in the soil. Juniper and spruce are not as hard as oak or ash wood, but are nevertheless relatively tough, flexible and durable. Elsewhere in Europe, copper and bronze axes have been hafted with oak, beech, and conifers such as spruce, yew, and pine (e.g. Gryaznov 1947, 170; Bader 1970, 106; Gross et al. 2017, 218; Marchenko et al. 2017, 6, Table 1 with reference to Yunger & Karpelan 2005).

All three AMS dates of axe handles presented here match the axes' typological dates. As these span five or more centuries, the AMS dates are invaluable for specifying when the individual items were used⁶. The Akozino-Mälär axes, in particular, have a noticeably broad, tentative typological date based on few closed finds. The relatively late AMS result of the Astangu sample, 6th–4th centuries cal BC, points to the transition from the Bronze Age to the Iron Age. The type's late date at the end of the Bronze Age or in the Early Iron Age has earlier been put forward for example by Carl F. Meinander (1954), Vello Lõugas (1970, 88 f.) and Lembit Jaanits et al. (1982, 151). It has also been suggested that the Pre-

⁶ Two cautionary aspects should be considered when evaluating the acquired dates. Firstly, we do not know which parts of trees were used to make the hafts, as cutting cross-sections of the fragments was deemed too destructive. Wood from the split centre of a broad trunk would give a somewhat older date than branches. Secondly, hafts may have been replaced several times and an axehead may be older than the date based on its final haft suggests. Nevertheless, the date still indicates the latest use of the artefact and can be used to delimit the type's chronological span.

Roman Iron Age socketed axes made of iron were modelled after the Akozino-Mälar examples (Salo 1984, 192). The results from Kajamaa and Kärasi axes demonstrate that they were used here at the same time as in Scandinavia from where most of the parallels are known. Their AMS dates place in the 10th–9th centuries cal BC, to the earlier halves of the typological date ranges, but are not earlier than the second half of period IV. This result supports the hypothesis according to which the import of metal artefacts from Scandinavia resumed in late period IV, after a somewhat less active period in the last quarter of the second millennium BC (Lang 2007, 40; Sperling 2013; 2014, 20 f., 24 ff.).

The findspots of Astangu, Kajamaa and Kärasi axes are all topographically different: flat seashore in a klint bay, a waterlogged slope of a rendzina hillock, and a sandy plain. Astangu and Kärasi sites lack other Bronze Age remains. Kärasi would likely have been suitable for a settlement site, and might have been one, but has not left easily detectable traces. The Kajamaa findspot was probably too wet for a settlement site. Although it cannot be determined why the axes were left in these specific locations, they are similar to most sites in Estonia where bronze axes have been found, as these typically yield no other archaeological remains of the same time period. The majority of the finds have been recovered from existing or dried-up water bodies, wetlands or waterlogged soils, possibly indicating intentional depositing in wet locations (Paavel 2017a). The handle remains presented in this paper indicate that at least some of the axeheads were left behind either hafted, or with a broken-off haft bit remaining in the socket.

Conclusions

As wooden hafts of bronze items are rarely preserved, the three new finds from Estonia have given an extraordinary possibility to study the wood chosen for hafting and AMS date it to compare the results to axe typochronology. The axe from Astangu appears to be one of the latest examples of the Akozino-Mälar type, as it dates to the transition between the Late Bronze Age and the Early Iron Age, to late 6th to 4th centuries cal BC. The AMS dates for Kajamaa and Kärasi axes coincide with the typological dates based on Scandinavian material, confirming that the typochronologies hold here as well. As the axes' typological dates span five hundred or more years, the AMS results have specified their ages by placing them to the earlier halves of the typological date ranges, to 10th–9th centuries cal BC.

The wood fragments preserved in the axe sockets were too small to provide information about the shape of the hafts, but the tree species could be identified. The axe from Kajamaa village was hafted with juniper or spruce wood and the axes from Astangu and Kärasi villages with ash wood. Whereas elsewhere in Europe, Bronze Age axe hafts have been commonly made of oak, beech, and conifers, ash wood seems to have been a popular or best preserved choice in the Baltic region.

Acknowledgements

This study was supported by the research project of the Estonian Research Council ‘Estonia in Circum-Baltic space: archaeology of economic, social, and cultural processes’ (IUT20-7) and Arheograator Ltd. AMS dating of the Kārasi haft remains was financed by the National Heritage Board of Estonia. The authors are grateful to Jüri Vassiljev for the shore displacement information for the Astangu findspot. Our gratitude goes to the finders of the artefacts Rene Alberi, Egert Klaas and Alexander Poderachev for their willingness to share information about the find circumstances, as well as people who have helped with the field surveys, and those who have provided feedback on earlier versions of this paper. The publication costs of this article were covered by the Estonian Academy of Sciences, the Institute of History and Archaeology at the University of Tartu, and the Institute of History, Archaeology and Art History of Tallinn University.

References

- Åberg, N.** 1935. Bronzezeitliche und früheisenzeitliche Chronologie. Teil V. Mitteleuropäische Hochbronzezeit. Kungl. Vitterhets Historie och Antikvitets Akademien, Stockholm.
- Asplund, H., Lempiäinen, T., Luoto, J., Riikonen, J. & Tomanterä, L.** in press. The dating of a shaft from a bronze celt found in Paimio SW Finland. – *Iskos*.
- Bader, O. N.** 1964. = **Бадер О. Н.** Древнейшие металлурги Приуралья. Наука, Москва.
- Bader, O. N.** 1970. = **Бадер О. Н.** Бассейн Оки в эпоху бронзы. Наука, Москва.
- Baudou, E.** 1953. De svenska holkuxorna under bronsåldern. – *Fornvännen*, 48, 241–261.
- Baudou, E.** 1960. Die regionale und chronologische Einteilung der jüngeren Bronzezeit im Nordischen Kreis. (Acta Universitatis Stockholmiensis, Studies in North-European Archaeology, 1.) Stockholm.
- Benkova, V. E. & Schweingruber, F. H.** 2004. Anatomy of Russian Woods. An Atlas for the Identification of Trees, Shrubs, Dwarf Shrubs and Woody Lianas from Russia. Haupt Verlag, Bern, Stuttgart, Wien.
- Bernabei, M. & Bontadi, J.** 2011. Distinguishing root- and stem-wood of *Picea Abies*. – *IAWA Journal*, 32: 3, 375–382.
- Bronk Ramsey, C.** 2017. OxCal (computer program). Version 4.3. The Manual (available at <http://c14.arch.ox.ac.uk/oxcal/OxCal.html>).
- Čivilytė, A.** 2014. Žmogus ir metalas priešistorėje: žvilgančios bronzos trauka. Piemedžio leidykla, Vilnius.
- Dietrich, O.** 2010. “Hammerbeile” – Zu einer speziellen Variante der Schäftung von bronzezeitlichen Tüllenbeilen. – *Archäologisches Korrespondenzblatt*, 40, 351–362.
- Engedal, Ø.** 2010. The Bronze Age of Northwestern Scandinavia. Dissertation for the Degree Doctor Philosophiae (PhD). University of Bergen.
- Gross, E., Schaeren, G. & Villa, I. M.** 2017. The copper axe blade of Zug-Riedmatt (Canton of Zug, Switzerland) – a key to chronology and metallurgy in the second half of the fourth millennium BC. – *Archäologische Informationen*, 40, 213–227.
- Grudzinska, I., Saarse, L., Vassiljev, J. & Heinsalu, A.** 2014. Biostratigraphy, shoreline changes and origin of the Limnea Sea lagoons in northern Estonia: a case study of Lake Harku. – *Baltica*, 27: 1, 15–24.
- Грязнов, М. Р.** 1947. = **Грязнов М. П.** К методике определения типа рубящего орудия. – Краткие сообщения о докладах и полевых исследованиях Института истории материальной культуры, 16, 170–173.

- Hansson, H.** 1927. Gotlands bronsålder. Akademiens förlag, Stockholm.
- Hjärthner-Holdar, E.** 1998. Samspel mellan olika regioner i Sverige och Rysland under yngre bronsålder sett utifrån järntecknologins införande. – Bronsealder i Norden – Regioner og interaksjon. Foredrag ved det 7. norske bronsaldersymposium i Rogaland, 31. august – 3. september 1995. Ed. T. Løken. (AmS-Varia, 33.) Arkeologisk museum i Stavanger, 35–44.
- Jaanits, L., Laul, S., Lõugas, V. & Tõnisson, E.** 1982. Eesti esiajalugu. Eesti Raamat, Tallinn.
- Jussila, T. & Kriiska, A.** 2004a. Ranta-ajoitus Eesti 0-7700BP ver. 1.2a (6.4.04). Computer program (<http://www.dlc.fi/~microlit/vironranta/vironranta.htm>).
- Jussila, T. & Kriiska, A.** 2004b. Shore displacement chronology of the Estonian Stone Age. – EJA, 8: 1, 3–32.
- Kivirüüt, A.** in prep. Neli radiosüsinikdateeringut: Kärasi pronkskirves, Papsaare nuiapea ja kaks skeletti Längalt.
- Kriiska, A.** 1998. Vaibla kivikirves. – EAA, 2, 154–157.
- Kuz'minych, S. V.** 1996. Osteuropäische und Fennoskandische Tüllenbeile des Mälartyps: ein Rätsel der Archäologie. – Fennoscandia Archaeologica, 13, 3–27.
- Lang, V.** 2007. The Bronze and Early Iron Ages in Estonia. (Estonian Archaeology, 3.) Tartu University Press.
- Lang, V.** 2012. Pronkskirves Järvekülüst, Rannu khk. Manuscript in the archives of MKA.
- Larsson, T. B.** 1986. The Bronze Age Metalwork in Southern Sweden. Aspects of Social and Spatial Organization 1800–500 BC. (Archaeology and Environment, 6.) Umeå Universitet.
- Lõugas, V.** 1970. Eesti varane metalliaeg (II a.-tuh. keskpaigast e.m.a. – 1. sajandini m.a.j.): dissertatsioon ajalooteaduste kandidaadi kraadi taotlemiseks. Eesti NSV TA Ajaloo Instituut, Tallinn. Manuscript in the archives of TLÜ AT.
- Marchenko, Z. V., Syvatko, S. V., Molodin, V. I., Grishin, A. E. & Rykun, M. P.** 2017. Radiocarbon chronology of complexes with Seima-Turbino type objects (Bronze Age) in southwestern Siberia. – Radiocarbon, 59: 5, 1381–1397.
- Meinander, C. F.** 1954. Die Bronzezeit in Finnland. (SMYA, 54.) Suomen muinaismuistoyhdistys, Helsinki.
- Melheim, L.** 2015. Late Bronze Age axe traffic from Volga-Kama to Scandinavia? The riddle of the KAM axes revisited. – Archaeometallurgy in Europe III: Proceedings of the 3rd International Conference Deutsches Bergbau-Museum Bochum, June 29 – July 1, 2011. Eds A. Hauptmann & D. Modarressi-Tehrani. (Der Anschnitt. Beiheft, 26.) Deutsches Bergbau-Museum, Bochum, 193–202.
- Needham, S., Bronk Ramsey, C., Coombs, D., Cartwright, C. & Pettit, P.** 1997. An independent chronology for British Bronze Age metalwork: The results of the Oxford Radiocarbon Accelerator Programme. – Archaeological Journal, 154, 55–107.
- Ojala, K.** 2016. I bronsålderns gränsland: Uppland och frågan om östliga kontakter. (Occasional Papers in Archaeology, 61.) Uppsala Universitet.
- Oldeberg, A.** 1974. Die ältere Metallzeit in Schweden, I. Kungl. Vitterhets-, historie- och antikvitetsakademien, Stockholm.
- Oldeberg, A.** 1976. Die ältere Metallzeit in Schweden, II. Kungl. Vitterhets-, historie- och antikvitetsakademien, Stockholm.
- Paavel, K.** 2016. Pronkskirves Viljandimaalt Maalasti külüst. Ekspertiinnang. Manuscript in the archives of MKA.
- Paavel, K.** 2017a. Pattern or random? Contextualising Estonian Bronze Age bronze stray finds on the landscape. – Archaeologia Baltica, 24, 26–42.
- Paavel, K.** 2017b. Pronkskirves Rapla maakonnast Märjamaa kihelkonnast Sõtke külüst. Ekspertiinnang. Manuscript in the archives of MKA.
- Patrushev, V. S. & Khalikov, A. Kh.** 1982. = Патрушев В. С. & Халиков А. Х. Волжские ананьинцы (Старший Ахмыловский могильник). Наука, Москва.
- Reimer, P. J., Bard, E., Bayliss, A., Beck, J. W., Blackwell, P. G., Bronk Ramsey, C., Buck, C. E., Cheng, H., Edwards, R. L., Friedrich, M., Grootes, P. M., Guilderson, T. P., Haflidason, H., Hajdas, I., Hatte, C., Heaton, T. J., Hoffmann, D. L., Hogg, A. G., Hughen, K. A., Kaiser, K. F.,**

- Kromer, B., Manning, S. W., Niu, M., Reimer, R. W., Richards, D. A., Scott, E. M., Southon, J. R., Staff, R. A., Turney, C. S. M. & van der Plicht, J.** 2013. IntCal13 and Marine13 radiocarbon age calibration curves 0-50,000 years cal BP. – *Radiocarbon*, 55: 4, 1869–1887.
- Salo, U.** 1984. Pronssikausi ja rautakauden alku. (Suomen historia, 1.) Espoo, 99–249.
- Soikkeli-Jalonen, A.** 2016. Pronssikautiset pronssiesinelöydöt Suomessa. Pro gradu -tutkielma. Turun yliopisto.
- Sperling, U.** 2013. Der Bronzebruchhort von Tehumardi in Estland – verstecktes Altmetall oder ritueller Weihefund? Ein Deutungsversuch am Erscheinungsbild der Bronzen. – *Man, His Time, Artefacts, and Places: Collection of Articles Dedicated to Richard Indreko*. Eds K. Johanson & M. Tõrv. (MT, 19.) Tartu, 261–316.
- Sperling, U.** 2014. Aspekte des Wandels in der Bronzezeit im Ostbaltikum: die Siedlungen der Asva-gruppe in Estland. – *EJA*, 18: 2S.
- Sperling, U. & Luik, H.** 2010. Arrowheads, palisades, and an attack scenario. Ridala Bronze Age hill-fort revisited. – *Archaeologia Baltica*, 13, 140–152.
- Viires, A.** 1960. Eesti rahvapärane puutööndus. Ajalooline ülevaade. Eesti Riiklik Kirjastus, Tallinn.
- Yushkova, M.** 2012. Northwestern Russia at the periphery of the north European and Volga-Uralic Bronze Age. – *Local Societies in Bronze Age Northern Europe*. Eds N. Anfinset & M. Wigglesworth. Sheffield, Bristol, 148–168.

Kristiina Paavel, Aivar Kriiska, Valter Lang ja Alexander Kulkov

KOLM PUITVARREJÄÄNUSTEGA PRONSKIRVEST EESTIST

Resüme

Pronksiaegsete pronkskirveste putkedes on puit nii Eestis kui ka mujal harva säilinud. Eesti pronkskirved on valdavalt juhuleiud, mistõttu neid dateeritakse mujal põhjapoolses Euroopas koostatud tüpoloogiatele tuginedes. Võimalused absoluutdateeringute abil meie regioonis tüpoloogiate paikapidavust kontrollida on siiani praktiliselt puudunud. Pronksiaegse leiumaterjali tüpoloogilised dateeringud võivad ühtlasi hõlmata pooletuhandaastasi või pikemaidki perioode, mistõttu on üksikesemete täpsed dateeringud eriliselt väärtuslikud. Hiljuti leiti Eestist kolm pronksist putkkirvest koos puitvarrejäänustega: Tallinnast Astangult, Kajamaa külast Harjumaalt ja Kärasi külast Jõgevamaalt (jn 1). Varrepuit dateeriti AMS-meetodiga ja määrati puuliigid (tabel 1; jn 4). Tehti ka süsiniku isotoopanalüüsid, ent võrdlusmaterjali puudumisel ei ole neid tulemusi võimalik veel tõlgendada.

Astangult leitud kirves (jn 2–3) kuulub Akozino-Mälari tüüpi, mille sarnased kirved on levinud laial alal Skandinaaviast Volga ja Kama jõe piirkonnani Venemaal (jn 5). Tüübi dateering on pikalt ebaselge olnud ja hinnangud jäävad ajavahemikku 1300–500 eKr ning mõnevõrra hilisemassegi aega. Astangu putkepuidu kalibreeritud AMS-dateering 510–371 eKr viitab, et tegu on ühega hilisematest seda tüüpi kirvestest, mida viimati kasutati pronksi- ja rauaaja vahetuse paiku. Samasse üleminekuperioodi jääb ka teine seni teadaolevalt ainus AMS-dateeritud kirves Västeråkerist Rootsist. Astangu kirve vars oli tehtud saarepuust (*Fraxinus*).

Kajamaa ja Kärasi kirves (jn 6–9) on Skandinaavia analoogide põhjal dateeritavad mitte täpsemalt kui ajavahemikuga 1100–600/500 eKr. Kalibreeritud AMS-dateeringud paigutasid mõlemad kirved selle pika perioodi esimesse poolde, 10.–9. sajandisse eKr. Tüpoloogia ja absoluutdateeringu kokkulangevus kinnitab, et Skandinaavia tüpokronoloogiad on rakendatavad ka meie pronkskirveste vanuse määramiseks. Kajamaa varrefragment oli sedavõrd halvasti säilinud, et puuliiki ei saanud täie kindlusega määrata. On selge, et see oli tehtud kadakast (*Juniperus*) või kuusest (*Picea*). Kärasi kirve vars oli valmistatud saarepuust nagu Astangu omagi. Kui mujal Euroopas on vasest ja pronksist kirveste varsi valmistatud tammest, pöögist ning okaspuudest, siis vähesed Balti regioonis leitud varrejäänused on huvitaval kombel just saarepuust. Võimalik, et seda on mõjutanud nii eelistused varrepuidu valimisel kui ka teiste puuliikidega võrreldes saare parem säilivus siinses pinnases.

Kirveste leiukohad on kõik eriilmelised. Astangu kirves jäi maha laugele mere-rannale klindilahes, tollasest veepiirist umbes 120–200 m kaugusele, Kajamaa kirves rähkmullaga künka liigniiskele nõlvale ja Kärasi kirves leetunud mullaga tasandikule. Kõik leiukohad on üle vaadatud. Astangult ja Kärasist ei leitud kinnismuistisele viitavat materjali, ent Kärasi leiukoht on asulakohaks iseenesest sobilik. Kajamaa leiukohas jäi kinnismuistise olemasolu lahtiseks, kuna põllul olnud taimkate ei võimaldanud põllulkõndi. Paiga liigniiskust arvestades paiknes potentsiaalne asulakoht pigem künka kõrgemal osal. Üldiselt sobivad leiukohad seni täheldatud seaduspäraga, mille kohaselt ei jäänud Eesti pronkskirved enam-jaolt maha samaaegsetesse asulakohtadesse, vaid pigem asustuskõlblike alade liigniisketesse servadesse või veekogudesse.