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ANTLER COMBS FROM THE SALME SHIP BURIALS: FIND CONTEXT, ORIGIN, DATING AND MANUFACTURE

In 2008 and 2010, two partly destroyed ship burials were discovered near Salme on the island of Saaremaa. During the archaeological excavations, at least 41 wholly or partially preserved skeletons were discovered, and a large number of artefacts were found, including a dozen single-sided antler combs. On the basis of the finds, as well as radiocarbon dating, the ship burials were dated to the Pre-Viking Period, while both the isotopic and archaeological evidence point towards central Sweden as the most probable origin of the buried individuals.

The combs from Salme have features that are generally consistent with the 8th century, with the closest parallels coming from the Mälars region of central Sweden. According to ZooMS and aDNA analyses, they are made of elk (*Alces alces*) and reindeer (*Rangifer tarandus*) antler. Elk inhabited the Mälars region, but reindeer antler had its origin in more northern regions. Most combs were clearly manufactured with great skill, and finished with care, though some details indicate differences in the skills of comb makers.

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Introduction

In 2008 and 2010–2012, two partly destroyed mass burials in ships (Salme I and Salme II) were discovered and investigated near Salme, on the Island of Saaremaa in Estonia. During the archaeological excavations, at least 41 wholly or partially preserved skeletons were discovered, and a large number of artefacts and animal bones were found, including bones of birds of prey – goshawk (*Accipiter gentilis*) and sparrowhawk (*Accipiter nisus*) (Konsa et al. 2009; Peets et al. 2011; 2013; Maldre et al. 2018). Morphological study of weapons and other artefacts from both sites, together with radiocarbon dating confirms a date in the Pre-Viking Period (about AD 600–800, also known as the Merovingian or Vendel Period). Isotopic analysis of tooth enamel of five men from the burials confirmed that these individuals were non-locals, and most likely had been born in the Mälär region of central Sweden (Price et al. 2016). Comparing the genomes of individuals from the Salme burial using kinship analyses indicated that they were genetically homogeneous and had very similar ancestry profiles (Margaryan et al. 2019). All this suggests that both mass burials originate from a single ‘event’ that took place in the middle of the 8th century. The ‘event’ included an armed conflict, and the slain warrior-seafarers were buried in two mass graves in the ships on the seashore.

Twelve single-sided antler combs were found in the two ship burials at Salme: some of them in a relatively complete state of preservation, others in small fragments. Although these combs have been mentioned in previous papers relating to the excavations, and a number of images have been published (Konsa et al. 2009, 50, fig. 8; Peets et al. 2011, 34, fig. 9), no concise study dealing with these combs has been published to date. The aim of the present paper is to provide a review of the combs and their context in the ship burial. Where possible, their associations with particular skeletons and burial assemblages will be analysed. The characteristic form and ornament of the combs will be briefly described, and an attempt will be made to determine their provenance and date using typological comparison with archaeological data from neighbouring regions. The production of combs will also be discussed, with special emphasis on their composition, the choice of raw material and the skill of the comb makers.

The Salme ship burials

Remains of the burial ships at Salme (Fig. 1) were located close together in the narrowest part of the Sõrve Peninsula, on the left bank of the Salme River, which flows into the Livonian Bay. The Salme River is the relic of a strait¹ that was still navigable in the Late Middle Ages, joining Sõrve Island to Saaremaa, but which

¹ Strait = *salm* in the dialect of the northern coast of the Estonia, and *salmi* in Finnish (Joalaid 2014, 1199).

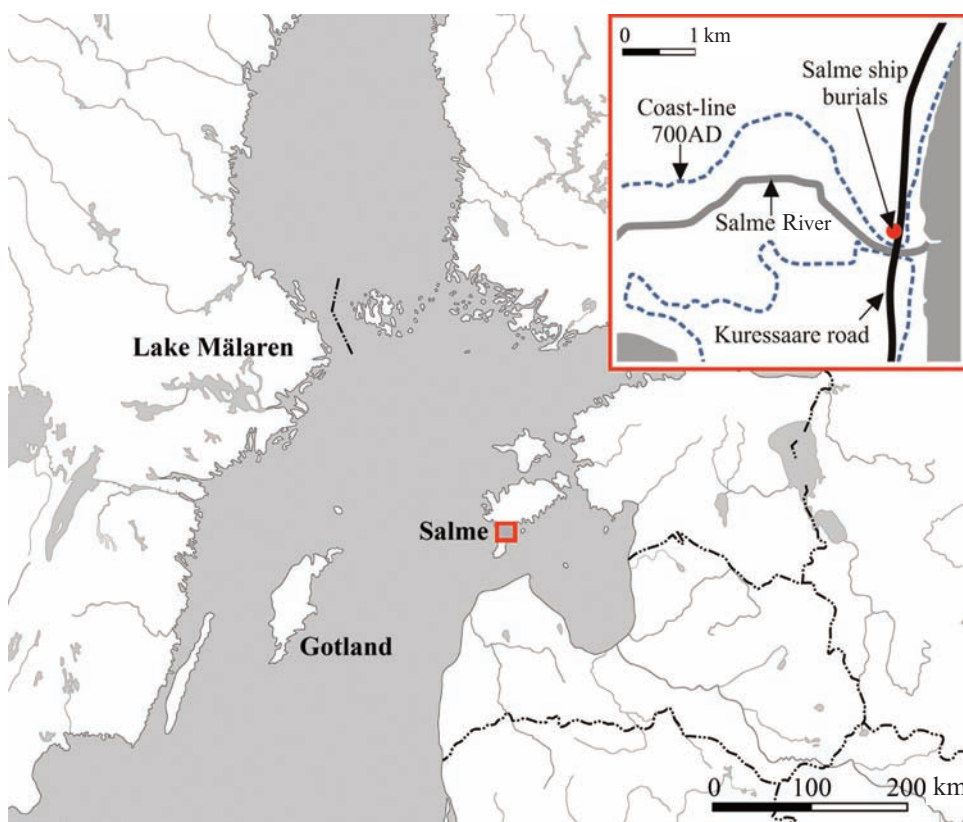


Fig. 1. Location of Salme ship burials. Large map drawn by Kersti Siitan. Small map: drawing by Reet Maldre (after Konsa et al. 2009, fig. 1).

vanished as a result of isostatic rebound (Grewingk 1884, 34; Konsa et al. 2009, 54, fig. 1). During the construction of a cycling track, the Salme I ship burial was discovered and excavated in 2008. The Salme II ship was found and excavated ca 40 m south-west of Salme I, in 2010–2012 (Fig. 2).

These ships were dragged to the shore and partially covered with stones and soil, before shortly afterwards being completely buried by marine sediments (Price et al. 2016, 1022 f.). To determine the existence of a mound or related structural element is hard as the area has been subject to extensive modern infrastructure development and probably water erosion and soil movement due to storms. Both ships were clinker built; the Salme I ship was ca 11.5 m long, and the Salme II ship ca 17–17.5 m long. Human skeletal remains, animal bones, and numerous iron, bronze and bone artefacts dated to the Pre-Viking Period were recovered from the ships (Konsa et al. 2009; Peets & Maldre 2010; Allmäe 2011; Allmäe et al. 2011; Peets et al. 2011; 2013; Price et al. 2016). Both ships had been damaged by cable trenches, causing some of the skeletons

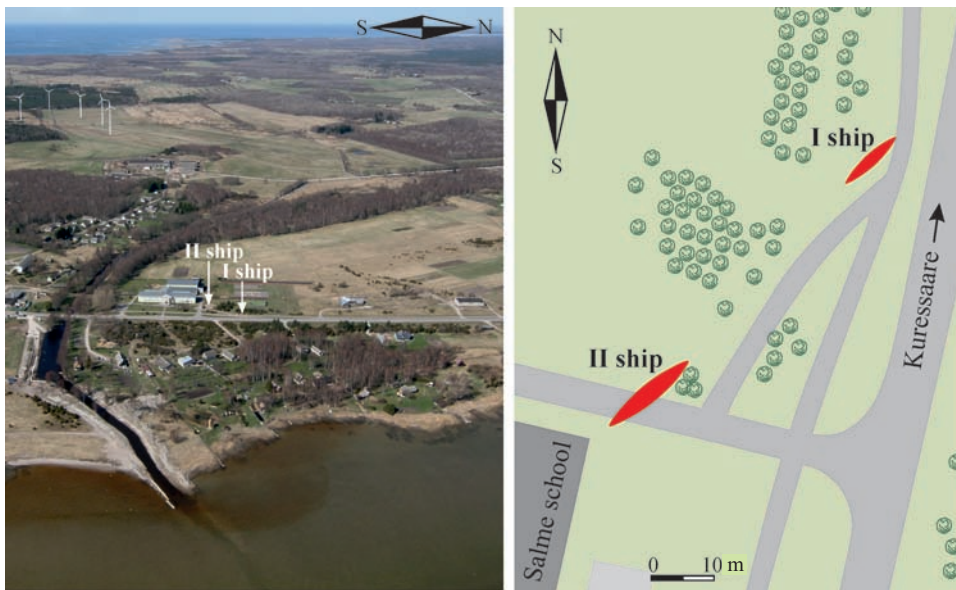


Fig. 2. Location of Salme ships. Aerial photograph of the surroundings of Salme. Photo by Ants Kraut and Tanel Moora. Map by Reet Maldre.

to be partly destroyed (Figs 3–4; Konsa et al. 2009, 53, 60, fig. 3; Peets et al. 2011, 30 ff., fig. 4).

Remains of seven human skeletons were found in the Salme I ship, while 34 skeletons were identified in Salme II. The Salme I ship was damaged by modern construction, and these skeletons were not intact (Konsa et al. 2009, 59 f.; Allmäe 2011; Allmäe et al. 2011). In ship II, the bodies were buried in three layers (Fig. 4; Peets et al. 2011, 39 ff.). In the uppermost, 1st layer, six skeletons (I–VI) were buried in a single row. In the 2nd layer skeletons were buried in three rows. In the first row, closest to the NE end of the ship, seven skeletons were placed (VII, XI–XII, XVIII–XX). Two skeletons (IX and X), were placed only when the first row of the 2nd layer was completed and equipped with grave goods. They were located somewhat higher up, and cannot therefore be regarded as belonging to this layer, although neither can they be regarded as a separate layer. The second row of the 2nd layer, with ten skeletons (VIII, XIV–XVII, XXII, XXIV–XXVII), was located SW from the first row. Only bones of lower extremities of two skeletons (XXIX and XXX) were preserved from the third, most south-western row of the 2nd layer. All skeletons in the 1st and 2nd layer were placed with heads to NE. The 3rd, bottom layer of burials, was perpendicular with the upper layers. There were seven skeletons (XXI, XXIII, XXVIII, XXXI–XXXIV), five of them with heads to SE and two in the opposite direction.

Many of these skeletons show signs of violence. Evidence for this can be observed from injuries inflicted by weapons (sword or axe) on bones, and

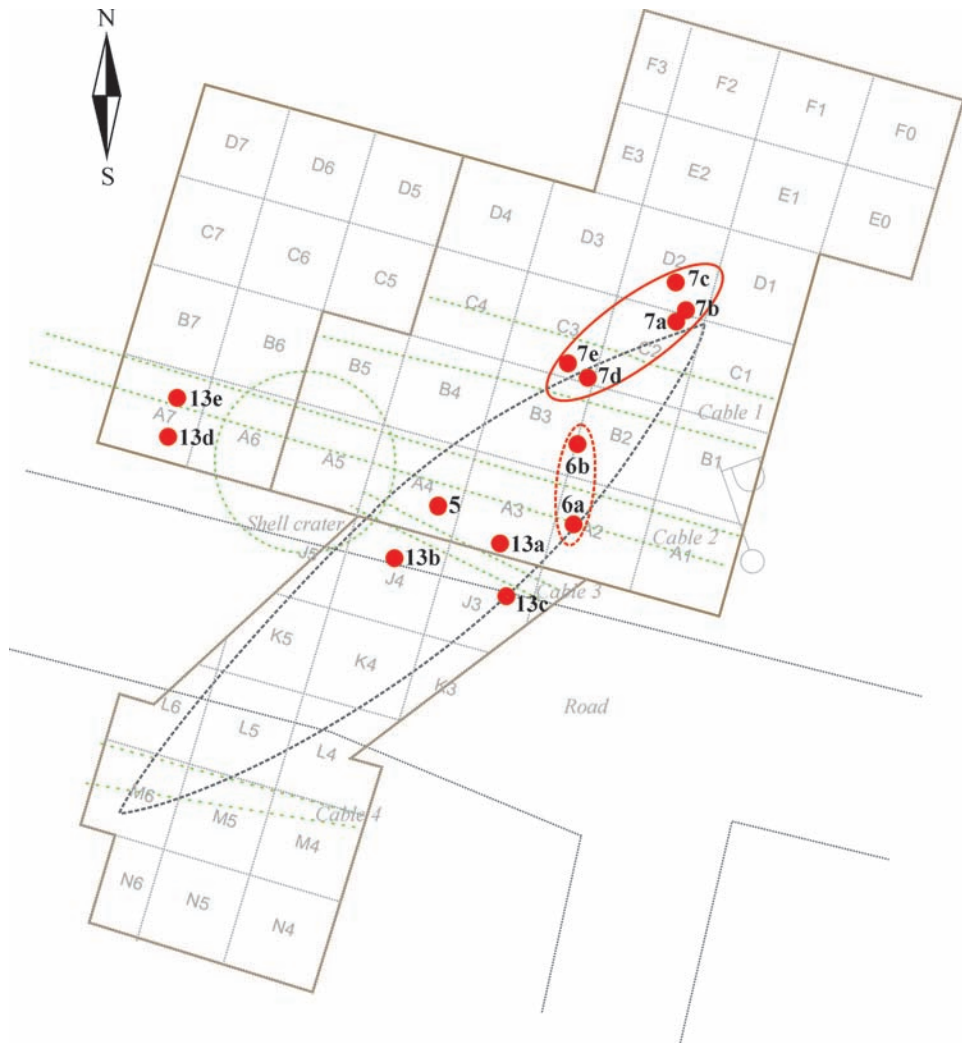


Fig. 3. II ship. Combs 5–7 and comb fragments that cannot be firmly associated with any comb (13a–e) found from the uppermost disturbed layer. Comb numbers correspond to numbers in Table 1. The red line marks the fragments of same comb. Drawing by Reet Maldre.

arrowheads located in the body areas where soft tissue would once have been, as well as *in situ* finds of arrowheads in soil colourations and in humus stripes that represent the wood from the ships and shields. In short, the context of the burials suggests that these individuals died during or shortly after a battle (Konsa et al. 2009; Allmäe et al. 2011; Peets et al. 2011; 2013; Price et al. 2016, 1025).

The finds from the ships are dominated by metal objects; swords, spear- and arrowheads, shield bosses, shears, padlocks and boat rivets. However, there are also numerous generally well preserved organic finds, including hundreds of gaming

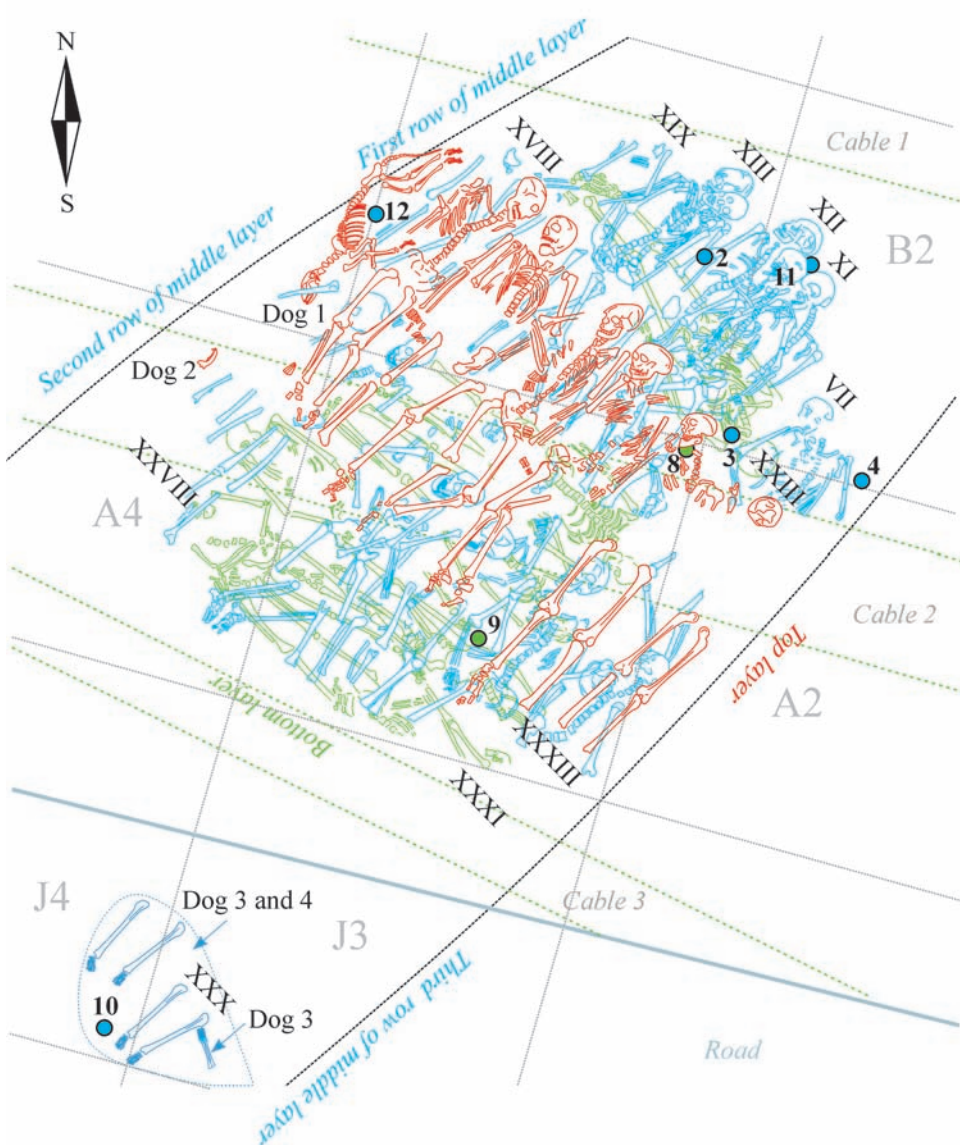


Fig. 4. II ship. Skeletons in three burial layers and combs related to skeletons. Comb numbers correspond to numbers in Table 1. 1st layer (top layer, red): no combs were found in this layer. 2nd layer (middle layer, blue), first row: comb 3, skeleton XI; comb 2, skeleton XIII; comb 4, skeleton VII; comb 11, skeleton XII; comb 19, skeleton XVIII; third row: comb 10, skeleton XXX. 3rd layer (bottom layer, green): comb 8, skeleton XXIII; comb 9, skeleton XXXIII. Comb 5, found from the upper disturbed layer (Fig. 3: 5) presumably belonged to skeleton XXXI. Drawing by Reet Maldre.

pieces of whalebone and cattle femur heads, some dice, as well as bear (*Ursus arctos*) canine pendants, antler combs and textile traces preserved on corroded metal (Konsa et al. 2009; Peets & Maldre 2010; Peets et al. 2011; 2013; Price et al. 2016).

As mentioned above, isotopic analyses of the human remains demonstrate that the buried persons were non-locals, and it is very unlikely that they originated from the eastern Baltic region (Price et al. 2016, 1032, table 1, figs 6–7). There are a number of gilt-bronze sword hilts and scabbard details decorated in Scandinavian design, with close parallels in Vendel Period graves in central Sweden and Finland. While such luxury weapons were high-status items that might frequently travel to places distant from their production centres (Price et al. 2016, 1033 f., figs 8–10), together the isotopic and artefactual evidence points to central Sweden as the probable region of origin for the men buried in the Salme ships (Price et al. 2016, 1036).

The location of the Salme comb fragments: excavation and burial context

Comb fragments of the Salme ship burials come from at least twelve combs; of these, the fragments of only one comb were found in the first ship, the remainder came to light in the second (Table 1).

The ratios of combs to buried individuals were 1 : 7 in Salme I and 11 : 34 in Salme II (i.e. approximately one comb for every three individuals). In comparison, at the approximately contemporaneous burial ground of Lunda on the Island of Lovö in central Sweden – where combs were among the most common grave goods – 111 burials contained 116 combs, and no burial was without a comb (Petré 1984a, 114; 1984b, 70). Among the 60 Migration to Viking Period cremation burials from the Valsgårde cemetery, although several were in a fragmentary state due to damage from later burials, 41 still contained combs (Ljungkvist et al. manuscript). These examples signal a remarkable difference between the number of combs in the Salme burials and the general deposition pattern in graves of the Mälär region.

In the following, the find contexts of combs, and their probable associations with skeletons are presented. The comb numbers correspond to numbers in Table 1. Because the sequence of combs in this section follows their location in the various layers and rows, the numbering of combs does not run consecutively here.

Comb from Salme I

Comb 1

Comb 1, preserved in four fragments (Table 1: 1; Konsa et al. 2009, fig. 8) was found in Salme I. It is not possible to associate this comb with any buried skeletons. Two of the comb fragments were recovered near the south-west end of the ship, south of the trench that ran across its middle; one was found from the cable trench near the end contour; and one from the sand heap in the south-east corner of excavated area. The fragments were probably scattered during the excavation of the cable trench.

Table 1. Combs from Salme: find context, decoration, riveting style, raw materials

No.	Comb	Find context	Decoration	Riveting style	Raw material/ identification method (Genbank accession)
1	Comb 1a–d SM 10601: 272, 232, 231, 273 (Fig. 9)	I ship, SW end of the ship	Ring-and-dot motifs, triple edge lines, decorated end plates and back	Edges (?)	Red deer/ fallow deer/ elk/ ZooMS
2	Comb 2 SM 10602: 416 (Figs 6: a, 10, 22: b, 23: c)	II ship, 2nd layer, between skeletons XII and XIII, presumably skeleton XIII	Double ring-and-dot motifs and arcs, triple edge lines, decorated end plates	Every edge	Elk/ ZooMS, aDNA (MN810315)
3	Comb 3a, b SM 10602: 330, 690 (Figs 5, 11, 22: a, 23: b)	II ship, 2nd layer, between skeletons VII and XI, presumably skeleton XI	Double ring-and-dot motifs, triple edge lines, decorated end plates	Every edge + central	Elk/ ZooMS, aDNA (MN810316)
4	Comb 4 SM 10602: 450 (Fig. 12)	II ship, 2nd layer, skeleton VII	Double ring-and-dot motifs, triple edge lines, decorated end plates and back	At both ends of tooth plates	Elk/ ZooMS, aDNA (MN810317)
5	Comb 5 SM 10602: 219 (Figs 13, 23: a)	II ship, mixed layer, presumably skeleton XXXI (or XXVIII)	Ring-and-dot motifs, triple edge lines, decorated end plates and back	Through tooth plates + edges	Elk/ ZooMS, aDNA (MN810318)
6	Comb 6a, b SM 10602: 107, 267 (Fig. 14)	II ship, intermediate soil layer between 1st and 2nd burial layer	Ring-and-dot motifs, single edge lines, decorated end plates and back	Every edge	Not analysed
7	Comb 7a–e SM 10602: 167, 142, 144, 214, 153 (Figs 15, 21)	II ship, upper mixed layer	Ring-and-dot motifs, single edge lines, decorated end plates	Central	Not analysed
8	Comb 8 SM 10602: 844 (Figs 8, 16)	II ship, 3rd layer, skeleton XXIII	Ring-and-dot motifs, lines forming rhombs, single edge lines, decorated end plates and back	Every edge	Reindeer/ ZooMS
9	Comb 9 SM 10602: 894 (Figs 7, 17)	II ship, 3rd layer, skeleton XXXIII	Ring-and-dot motifs, single edge lines, decorated end plates	Every edge	Reindeer/ ZooMS

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Table 1. Continued

No.	Comb	Find context	Decoration	Riveting style	Raw material/ identification method (Genbank accession)
10	Comb 10 SM 10602: 581 (Fig. 18)	II ship, 2nd layer, presumably skeleton XXX	Groups of parallel lines, single edge lines, decorated back	Central	Reindeer/ ZooMS (two samples)
11	Comb 11 SM 10602: 685 (Fig. 19)	II ship, 2nd layer, between skeletons XI and XII, presumably skeleton XII	Single edge lines, no other decoration visible (badly preserved)	Central	Elk/ ZooMS, aDNA (MN810319)
12	Comb 12 SM 10602: 742 (Fig. 20)	II ship, 2nd layer, skeleton XVIII	Not identifiable (badly preserved)	Central (?)	Not analysed
13	Fragments 13a–e SM 10602: 41, 913, 951, 1711, 1729	II ship, mixed layer, small fragments, not firmly associated with any comb	Mostly not identifiable, one end plate (SM 10602: 1711) with triple edge lines and decorated back	Not identifiable	Not analysed

Combs from Salme II

All other combs were found in Salme II. At least three combs were recovered from its uppermost disturbed layer (Fig. 3). One better preserved comb – comb 5 – was found in the central part of the ship, in square A/3 (Table 1: 5; Fig. 3: 5), but since it most probably belonged to a skeleton from the bottom layer, it will be discussed below.

Comb 6

The toothplate from square A/2 (Fig. 3: 6a) and an endplate together with the fragments of a connecting plate found at the limit of B/2 and B/3 (Fig. 3: 6b), could be parts of the same comb – comb 6 (Table 1: 6). This comb cannot be associated with any skeleton according to its find context. The loose toothplate came from the area disturbed by the 2nd cable trench, but the endplate was found in the soil covering the 2nd burial layer, and not disturbed by later activity. Presumably this comb was already broken before its pieces reached the intermediate soil layer between the 1st and 2nd burial layers.

Comb 7

Fragments of comb 7 (Table 1: 7) were scattered in different places. It is not possible to associate this comb with any particular skeleton, but it probably originated from one of the skeletons in the 2nd burial layer that were damaged by a cable trench. The comb's middle part (Fig. 3: 7a), an endplate (Fig. 3: 7b), and fragments of a connecting plate (Fig. 3: 7c), were found in squares C/2 and D/2, outside the ship contour. Another fragment of an endplate (Fig. 3: 7d) and a single comb tooth (Fig. 3: 7e) were recovered from the soil filling the cable trench.

Five more comb fragments that cannot be firmly associated with any comb come from the soil mixed by digging cable trenches (Table 1: 13; Fig. 3: 13a–e).

Among the three layers of buried individuals in the ship (Fig. 4), no combs were found in the 1st layer or in the second row of the 2nd burial layer, while as many as five combs could be related to certain skeletons in the first row of the 2nd layer. The find contexts of these combs are described below, moving north-west from the south-eastern skeleton. One comb was found in the third row of the 2nd burial layer.

Comb 4

The substantially complete comb 4 could have belonged to skeleton VII, located at the south-eastern end of the first row of the 2nd layer (Table 1: 4; Fig. 4: 4). It was found in grid square B/2, within the contour of the ship, near the eastern side of it, beneath two half-upright broken swords that came to light immediately under the sod layer. One of these was a double-edged sword with bronze guards and a plain pyramid-shaped pommel, decorated with a single silver cross. The other was a long seax, broken in two. Somewhat deeper, above the left humerus of skeleton VII, further fragments of the same comb were found, together with a padlock, a heavily worn knife and a piece of light flint. These parts of the comb had evidently been 'nudged' apart when swords were thrust between the dead and the side of the ship. Owing to the steep profile of the ship's hull, the artefacts were located slightly higher up than the skeleton and the dented iron boss that remained of a shield that had originally covered the dead, but without doubt they belonged together.

Comb 3

Comb 3 might have belonged to skeleton XI in the first row of the 2nd burial layer (Table 1: 3; Figs 4: 3; 5). It was found between skeletons VII and XI, but since comb 4 had already been found next to skeleton VII, it most likely belonged to skeleton XI. The broken end of the same comb (Table 1: 3b) was found in the torso region of skeleton XI.

Comb 11

Comb 11 presumably belonged to skeleton XII in the middle of the first row of the 2nd burial layer (Table 1: 11; Fig. 4: 11). It was found close to the skulls of



Fig. 5. Comb 3 (SM 10602: 330), found between skeletons VII and IX. Photo by Liina Maldre.

skeletons X, XI and XII; all located practically side by side, and partly overlapping. According to its depth, it is most likely that the comb fragments belong to skeleton XII. Skeleton XII was evidently the central person for the whole burial. The congenital atlanto-occipital fusion (an anatomical defect considerably complicating turning of the head and thus inhibiting physical activities) observed on this skeleton (Peets et al. 2013, 51, fig. 13) would exclude military service for a common man. Thus skeleton XII probably represents an individual of higher status, which seems to be confirmed by the gilt-bronze ring-sword hilt, as well as the youth of the deceased. Another peculiar characteristic of this individual was a ‘king’ gaming piece found in his mouth. The probability that this specific piece, among more than 200, had found its way into his mouth by chance, must be considered very small.

Comb 2

Comb 2 is the fourth comb found in the first row of the 2nd burial layer (Table 1: 2; Fig. 4: 2). It presumably belonged to skeleton XIII, located in the middle of the row. It was found – together with broken shears and a long rectangular whetstone – between skeletons XII and XIII, approximately at their waistline (Fig. 6).



Fig. 6. Artefacts found between skeletons XII and XIII. a – comb 2 (SM 10602: 416), b – seax (SM 10602: 392), c – sword (SM 10602: 417), d – shears (SM 10602: 413), e – whetstone (SM 10602: 414). Photo by Liina Maldre.

The shears had blades that were 84–85 mm long, 24–25 mm wide and 4.1–4.2 mm thick, with a straight back and curved cutting edge. The blades were connected by a large oval spring which is mostly perished. Now heavily damaged by corrosion, the total length of the complete tool (including the spring), could have been 210–220 mm. Both the blades and spring were decorated with stripes of pattern-welded steel.

The whetstone of fine-grained slate is rectangular, 230 mm long, with faces evenly worn in the middle (15 × 12 mm in the middle, 18 × 14 mm and 16 × 16 mm at the ends) by a long period of use. Pending full analysis, it is possible that the material is a mineral of the Eidsborg or Mostadmarka schist (slate) type, occurring in Norway, for example in the Telemark and Trøndelag area (Hansen 2011, 66 ff.; Baug et al. 2019). While the comb and shears could have been personal toilet items, the large and finely worked whetstone could have possessed a special meaning emphasizing the leader's position – such notions can be found in ancient Scandinavian and Anglo-Saxon writings, mythological texts and archaeological material (see Mitchell 1985). In short, this quite broad range of artefacts that extends beyond precious weapons may indicate that some individuals in the burial had a status and character that differed from the group as a whole.

Since the artefacts were located more towards the lower body than the fragments of the ring-sword, and stratigraphically slightly higher (Fig. 6), they had apparently been placed in the grave at the end of the process by which the burial row was formed, prior to the placement of individuals IX and X covering the middle of the row. Since the aforementioned comb 11 (Table 1: 11) most probably belonged to skeleton XII, it seems likely that this comb belonged to skeleton XIII. Still, we cannot exclude the possibility that this comb also belonged to the former, the central person of the whole burial. The burial of multiple combs with an individual is precedented; for example, in the above-mentioned burial ground of Lunda, five burials contained two combs (Petré 1984b, 70).

Comb 12

Comb 12, preserved in a fragmentary state, can be connected with skeleton XVIII (Table 1: 12; Fig. 4: 12), which was the last in the row, located at the western side of ship. Its rich grave goods to some extent resemble those of skeleton VII, located at the other end of the same row. Beneath the iron boss that represents the shield that once covered the legs of the skeleton, there were fragments of a broken double-edged sword and a double-bent long seax, as well as a matchbox-sized lump of dark organic matter resembling resin, and a piece of strike-a-light flint. A unique and surprising inclusion was the coracoid fragment of a mallard (*Anas platyrhynchos*), found next to the distal end of the skeleton's right femur (Peets et al. 2013, 55). There was also a small knife found at the pelvis, and near the left wrist four beads were found (one of amber; three of glass). Near the thorax, damaged by the cable trench, two pendants made of bear canines were found in the mixed soil.

It is interesting to note the association of some individuals with dogs (*Canis familiaris*). This can be observed in at least two cases, where the remains of canids were discovered together with human skeletons. Bones of the rear part and tail of the first came to light immediately beneath the sod layer, before the discovery of human skeletons. The dog, with the spine cut in half in the middle, had been placed on the shield of the aforementioned skeleton XVIII, so that its femora and a part of the tail lay upon the shield boss, while the front legs and ribcage were positioned upon the shins (tibiae and fibulae) and feet of the skeleton (Fig. 4). The head of the dog was placed beneath the humerus of skeleton XIV (buried in the second row, with an expensive double-edged sword, furnished with a blade ornamented with an inlay of gold wire, and with a handle of gilded bronze, incorporating a pommel decorated with 25 garnets). Beside the right femur of the same skeleton, by the western side of the ship, a part of the skull of the second dog was found (Fig. 4). Unfortunately, precisely in this spot, a World War II grenade impact had created a crater and destroyed the rest of the skeleton, though some parts of it are still preserved among the numerous dog bones found in the backfill of the shell crater.

Comb 10

Comb 10 was found in the badly preserved third row of the 2nd layer; it probably belonged to skeleton XXX (Table 1: 10; Fig. 4: 10). In addition to this comb, several gaming pieces, a die, some arrowheads, and other artefacts were found in square J/4. In the same square was a considerable number of bones from two large dogs (dogs 3 and 4), of which the hind legs of dog 3 were preserved in their original position (Fig. 4). Unfortunately, the topmost layers in this part of the grave had been disturbed by various modern construction and levelling activities, altering the position of some artefacts and bones.

Together with the individuals buried in the 3rd (bottom) layer, at least three combs had been placed there.

Comb 5

Comb 5, mentioned above, was found in the upper disturbed layer (Table 1: 5; Fig. 3: 5; Peets et al. 2011, 34, fig. 9). This comb was probably related to skeleton XXXI in the south-western end of the 3rd layer. According to find context, it cannot belong to the skeletons damaged by the 2nd cable trench (it was found deeper, beneath the sod layer and beyond the cable trench that damaged skeletons IV, VI in the 1st and VII in the 2nd burial layer), but only to skeleton XXVIII or XXXI of the bottom layer, which had been damaged by the 3rd cable trench (Fig. 4). The comb was most likely related to skeleton XXXI, whose torso and head were missing, rather than skeleton XXVIII (Fig. 4). This assumption is based on the observation that most of the combs related to well preserved skeletons were placed on the torso or on the left side. This excludes the latter skeleton which had only its right side damaged. Presumably both the upper body and the grave goods of skeleton XXXI were removed to the upper layer during the excavation of the 3rd cable trench.

Comb 9

Comb 9 was found in the 3rd layer; it was located under the pelvis of skeleton XXXIII, which was the third skeleton from the south-west in this row (Table 1: 9; Figs 4: 9; 7). Near the comb, a fibula and a fragmentary knife were found, presumably also belonging to this individual.

Comb 8

Comb 8 was found beside the left humerus of skeleton XXIII, buried separately in the north-eastern end of the 3rd layer, and can undoubtedly be related to this individual (Table 1: 8; Figs 4: 8; 8). The comb had been placed with its teeth pointing towards the buried man. By the left side of the deceased, a long single-edged sword had been placed with the blade edge facing downwards, and tip



Fig. 7. Comb 9 (SM 10602: 894), located under the pelvis of skeleton XXXIII. Photo by Liina Maldre.

pointing towards the feet. On the left side of the thorax, an iron fibula was found. This skeleton is also associated with a large whetstone that had been broken in two pieces. Beside the left hand of the skeleton was an assemblage of bones from a sheep. The bones came from the fleshy parts of the left side of the animal.

Thus, the distribution of combs in each mass grave varies. In the case of Salme II we can observe the complete absence of combs from the skeletons of the 1st burial layer and the second row of the 2nd burial layer, optional deposition of combs in the 3rd layer and probably also in the third row of the 2nd burial layer, and it seems likely that combs were related to almost every skeleton in the first row of the 2nd burial layer (Table 1; Fig. 4). A particularly notable finding is the deposition of only one comb in the Salme I ship.

Introduction to composite combs

Bone and antler combs are one of the most recognizable and frequently encountered artefact types from early-medieval northern Europe. Emerging in the Late Roman Period, composite combs were constructed by securing a series of small, rectangular toothplates between two or more longitudinal ‘connecting plates’

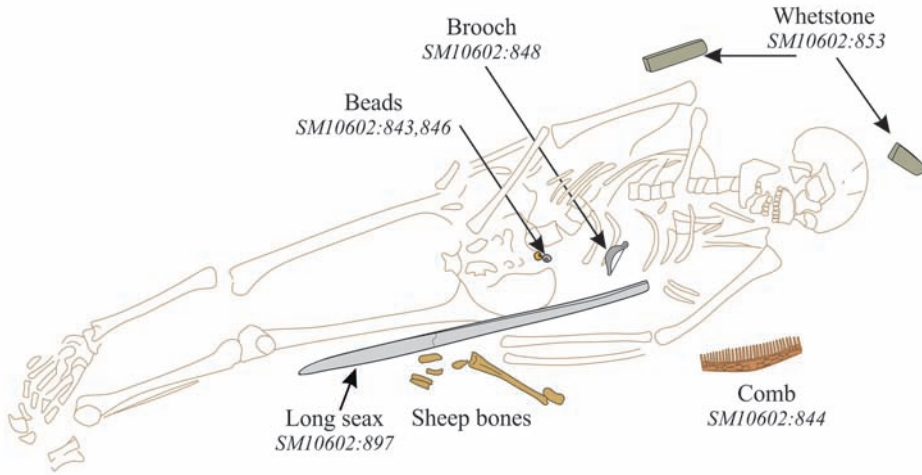


Fig. 8. Skeleton XXIII. Comb 8 (SM 10602: 844) was found beside the left humerus of the skeleton. Drawing by Reet Maldre.

using bone pegs or iron/copper-alloy rivets (MacGregor 1985, 74 f.). The combs are usually decorated, and some can have very fine teeth, though in Late Iron Age Scandinavia and northern Europe, combs had a relatively coarse gauge, more appropriate for grooming and styling rather than the removal of lice.

Comb production became increasingly standardized as the first millennium progressed, and one can discern a development from rather bespoke, highly ornate combs that must have been produced to commission, to serialised urban production by the 9th, 10th and 11th centuries AD (e.g. Ashby 2006, 99 ff.; 2011).

Morphology and ornament

The Salme combs are single-sided composite combs (i.e. they have one row of teeth, and are constructed from a series of toothplates, placed side-by-side, between two endplates, and fastened with rivets between a pair of connecting plates (for more on the construction of combs see Ulbricht 1978, 52 ff., figs 3, 8; Ambrosiani 1981, 94 ff., fig. 48; MacGregor 1985, 74 ff.).

The combs from the Salme ship burials are large. The better preserved examples measure between 19 and 21 cm in length, and 4.5–5.0 cm across the central point (Table 1; Figs 9–20). The connecting plates do not have the rounded back shape which is typical for Viking Age combs, but rather a wave-shaped or sinuous form with wide middle part in comparison with long narrow terminals (Figs 10, 16). This shape is defined as *concave/convex/concave* (e.g. Petré 1984b, 71) or *curved back* (e.g. Brynja 1998). All the combs feature graduated teeth. Some combs have

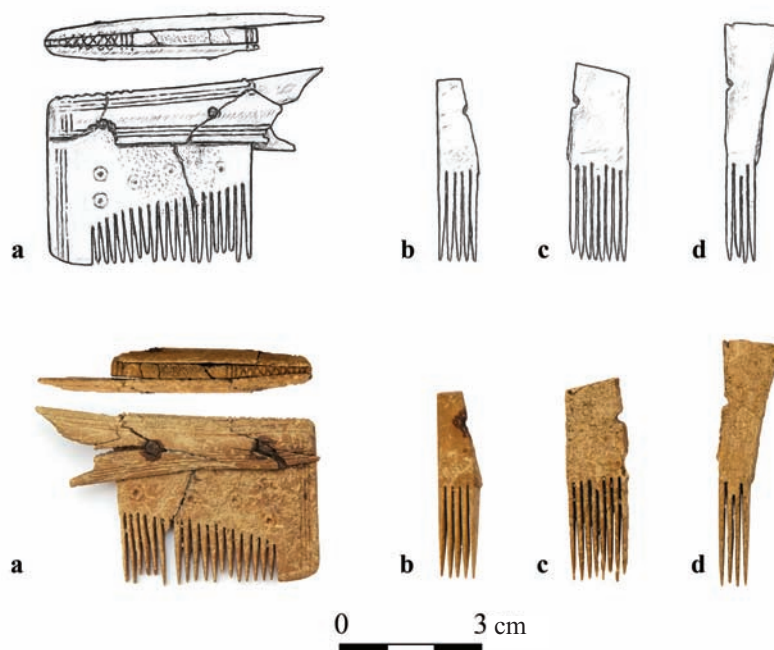


Fig. 9. Fragments of comb 1 from I ship (SM 10601: 272 (a), 232 (b), 231 (c), 273 (d)). Drawing by Riina Vesi, photo by Reet Maldre.

a line at the foot of the tooth row (combs 3, 6 and 10; Table 1: 3, 6, 10), which presumably was intended to act as a baseline and aid precision in sawing the teeth. The cross section of the connecting plates is characterized by a shallow plano-convex shape.

Most of the combs are decorated with ring-and-dot ornament; three examples (combs 2–4) feature motifs with double rings (Table 1: 2–4; Figs 10–12). The ring-and-dot motifs exist in a variety of arrangements, including longitudinal and vertical rows (combs 3–5 and 7; Table 1: 3–5, 7; Figs 11–13, 15). One comb decorated with double ring-and-dot has curved lines between these motifs (comb 2; Table 1: 2; Fig. 10), and another with simple ring-and-dots has straight lines forming rhombs and polygons (comb 8; Table 1: 8; Fig. 16). Comb 10 is decorated with small rectangular dots and pairs of short incised lines, but since the surfaces of this comb's connecting plates are badly preserved, the overall design is not clear (Table 1: 10; Fig. 18).

Most of the combs feature at least one set of incised edge lines. Seven combs have only a single edge line close to the connecting plate edges (combs 6–11; Table 1: 6–11; Figs 14–19). Five combs feature triple edge lines (combs 1–5; Table 1: 1–5; Figs 9–13), while on one example (comb 3) these grooves exist only along the straight edge of the connecting plate (close to the teeth); its curved back edge is not incised (Table 1: 3; Fig. 11). Nevertheless, these lines are irregular, being partly



Fig. 10. Elk antler comb 2, found between skeletons XII and XIII (SM 10602: 416). Drawing by Heidi Luik, photo by Reet Maldre.

double and partly triple. Most likely these were not intended as double lines, and rather represent a mistake on the part of the craftsman, who was perhaps not sufficiently skilled to produce the ‘correct’ ornament. Notably, this comb also has quite irregular and rough teeth, which further indicate the work of an unskilled manufacturer (see below).

All preserved endplates are decorated. Most commonly, this decoration is composed of between two and five ring-and-dot motifs (combs 1–9; Table 1: 1–9; Figs 9–17); one example (comb 2) features double ring-and-dot connected with

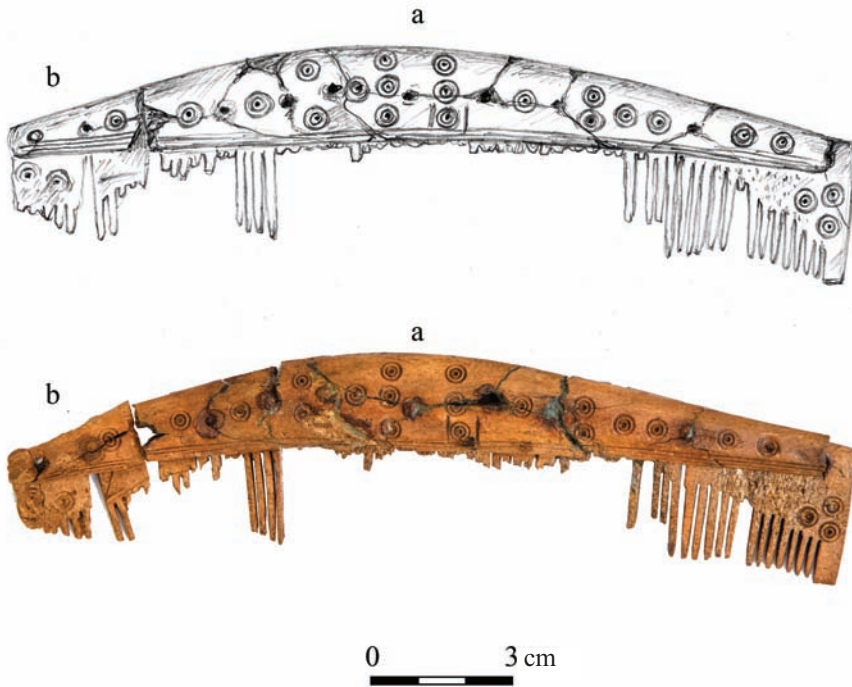


Fig. 11. Elk antler comb 3, found between skeletons VII and IX (SM 10602: 330 (a), 690 (b)). Drawing by Heidi Luik, photo by Reet Maldre.

curved lines, echoing the design of its connecting plates (Table 1: 2; Fig. 10). We do not know of any comb with similar decoration elsewhere. It is worth mentioning that this comb was found – together with the pattern-welded shears and the high-quality whetstone –, between the central skeleton XII (which probably represented a high-status individual), and skeleton XIII (see above).

Most of the combs also have edge lines close to their terminals (combs 1–2, 4–6, 8 and 9; Table 1: 1–2, 4–6, 8–9; Figs 9–10, 12–14, 16–17), and two combs stand out in that their endplates feature additional lines close to the tooththrow edge (combs 4 and 6; Table 1: 4, 6; Figs 12, 14: b). Several combs are also decorated along their back edges (i.e. the upper edges of the toothplates that are visible between the connecting plates). In two cases (combs 5 and 8), this decoration consists of triads of incised lines (Table 1: 5, 8; Fig. 16) and in one case pairs of lines (comb 10; Table 1: 10). Two combs have transverse lines and oblique crosses on their backs, while one also features badly preserved ring-and-dot motifs (combs 1 and 4; Table 1: 1, 4; Figs 9: a, 12). One loose toothplate has very rich decoration with transverse triads, oblique crosses, and four ring-and-dot motifs on its back edge (comb 6; Table 1: 6; Fig. 14: a). One loose endplate has only small oblique crosses (Table 1: 13).

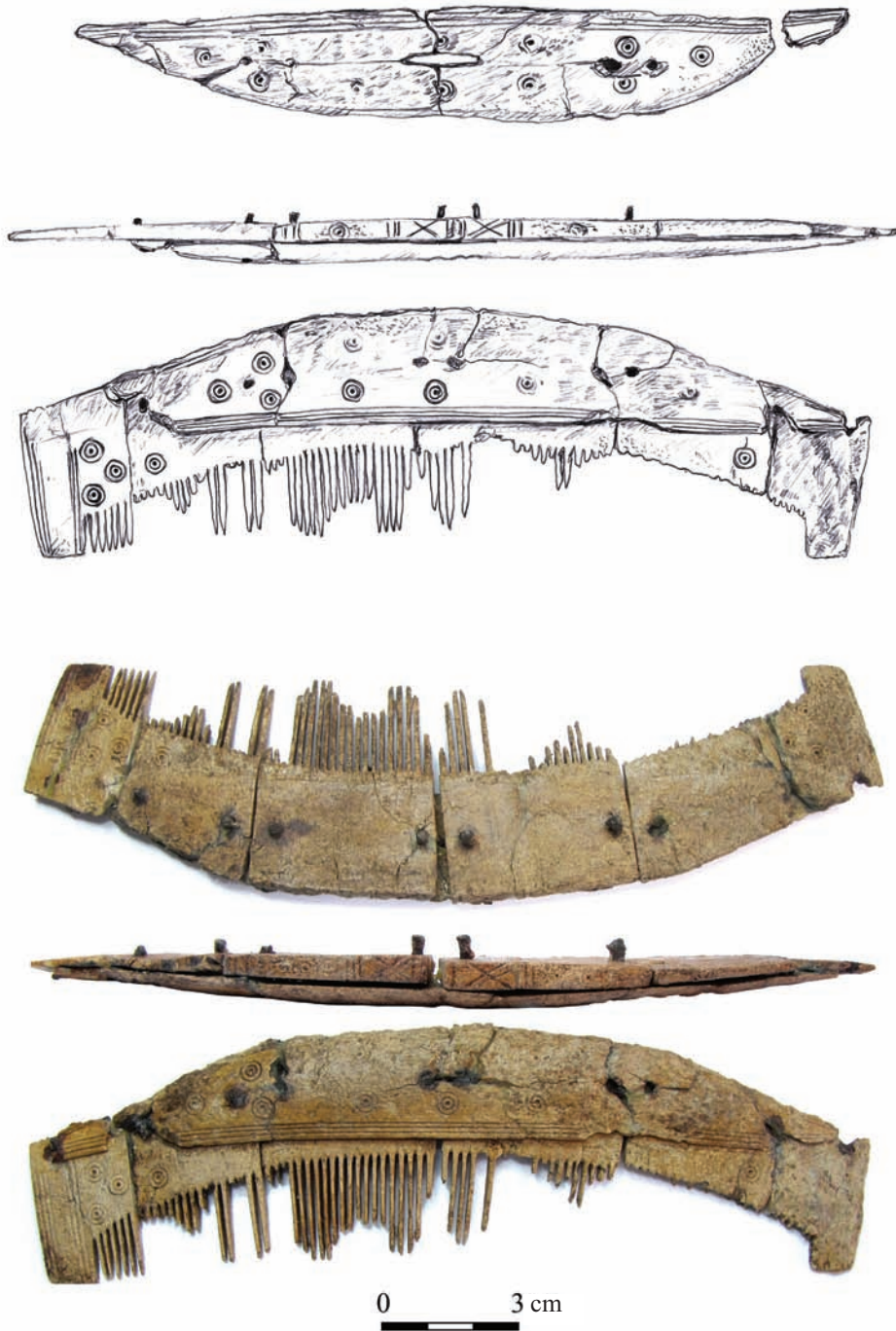


Fig. 12. Elk antler comb 4, found near skeleton VII (SM 10602: 450). Drawing by Heidi Luik, photo by Jaana Ratas.

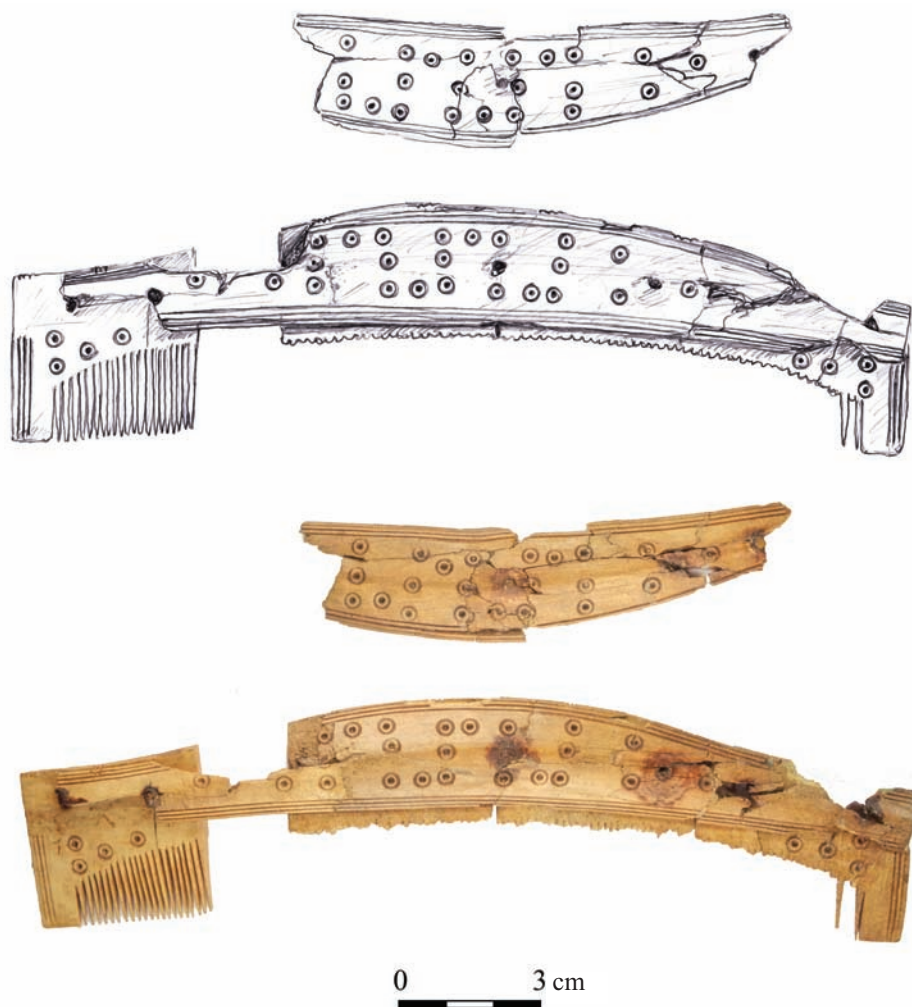


Fig. 13. Elk antler comb 5, found from the disturbed layer, probably belonged to skeleton XXXI (SM 10602: 219). Drawing by Heidi Luik, photo by Reet Maldre.

As is common with other combs from this period, all Salme examples have iron rivets. Some combs have rivets in the centre of toothplates (e.g. combs 7, 10 and 11; Table 1: 7, 10, 11; Figs 15, 18, 19), while in some cases they are placed on the edges (e.g. combs 2, 6, 8 and 9; Table 1: 2, 6, 8, 9; Figs 10, 14, 16, 17). One comb has rivets close to both ends of each toothplate, creating the impression of pairs of rivets separated by larger intervening gaps (comb 4; Table 1: 4; Fig. 12). In some cases, a combination of methods have been used (i.e. both through toothplates and at the edges) (combs 3 and 5; Table 1: 3, 5; Figs 11, 13), but all are consistent with production in Sweden or the east (compare the ‘alternating edge’ pattern that prevails in Britain, Ireland, and southern Scandinavia).



Fig. 14. Fragments of comb 6, found from the disturbed layer (SM 10602: 107 (a), 267 (b)). Photo by Reet Maldre.

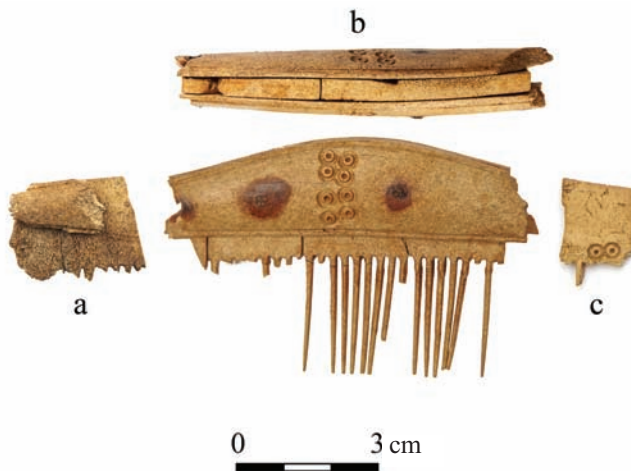


Fig. 15. Fragments of comb 7, found from the disturbed layer (SM 10602: 141 (a), 167 (b), 214 (c)). Photo by Reet Maldre.

Comparative analysis

Given the significance of the Salme skeletons as likely foreign visitors on Estonian soil, and the biochemical difficulties in precisely determining the origin of the deceased individuals found within, the combs offer an important opportunity for comparative analysis. While it has long been claimed that Viking Age combs were heterogeneous in form and ornament ‘between Dublin and Staraja Ladoga’ (Ambrosiani 1981, 32 ff.), this assumption has been disputed on material and technological grounds (e.g. Ashby 2011, 2013; Ashby et al. 2015), and it has



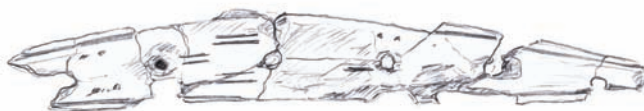
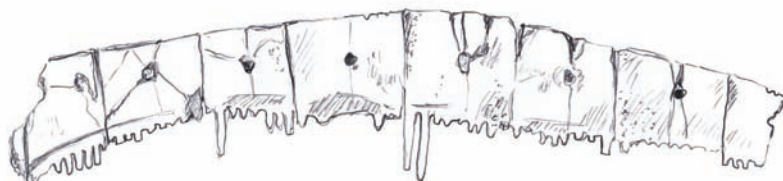
Fig. 16. Reindeer antler comb 8, found near skeleton XXXIII (SM 10602: 844). Drawing by Heidi Luik, photo by Reet Maldre.

certainly not been demonstrated for the Pre-Viking Period. Thus, there is much to be gained from a close-grained analysis of form, ornament, technology, and raw materials. One of us (Ashby 2011) has already published a broad survey of the northern European distributions of combs, but in this case there is a need for a more detailed analysis, where regional variations below the type level are taken into account.



0 3 cm

Fig. 17. Reindeer antler comb 9, found near skeleton XXXIII (SM 10602: 894). Photo by Reet Maldre.



0 3 cm

Fig. 18. Reindeer antler comb 10, found near skeleton XXX (SM 10602: 581). Drawing by Heidi Luik, photo by Reet Maldre.



Fig. 19. Elk antler comb 11, probably associated with skeleton XII (SM 10602: 685). Photo by Reet Maldre.



Fig. 20. Fragmentary comb 12, found near skeleton XVIII (SM 10602: 742). Photo by Reet Maldre.

The most likely contexts for the production of the combs in Salme are the regions surrounding the eastern Baltic. Before the find of the Salme ship burials, only a few single composite combs had been found in Estonia, and combs pre-dating the Viking Age are particularly rare (Luik 1998, 21 ff., figs 7–17, pl. I; Aun 2009, 93, fig. 14: 1). Presumably these combs were not made locally, but brought from elsewhere, most likely from Scandinavia (Luik 1998, 139 ff.).

Several combs have been found in the cemetery in Grobiņa (regarded as a Vendel and Viking Age colony of Gotlanders) in the western coastal area of Latvia. These belong to types which were used from the beginning of the 7th century, and have parallels in Gotland and central Sweden (Nerman 1958, 118–126, 150 ff.). Comparison of the combs from Salme with those from Grobiņa is complicated by the generally fragmentary remains of the latter, which mean that their form and (particularly) size are difficult to determine. Nonetheless, the multiple edge lines and ring-and-dot motifs characteristic of the Salme combs are also represented on those from Grobiņa, and at least in some cases it seems likely that they might have had a curved back (e.g. Nerman 1958, pls 11: 67, 24: 137, 29: 163, 47: 319, 50: 351, 51: 363). A better preserved comb from Grobiņa, the size of which can be estimated, is smaller than combs from Salme and has different decoration. It is not clear if it had a curved back. Presumably this comb dates from the 2nd half of the 7th century (Nerman 1958, 154, pl. 39: 235).

Antler combs are numerous in Gotland and central Sweden (Mälars region) (Fig. 1), and there are several publications about combs from different periods (e.g. Nerman 1935; 1947; 1969; Ambrosiani 1981; Thunmark-Nylen 1991; Brynja 1998). Comprehensive studies are available for combs from central Sweden dated to the Roman and Migration Periods (Brynja 1998), as well as for later Viking Age combs (Ambrosiani 1981). There is no study of Vendel Period combs for the whole of central Sweden. However, Bo Petré has dealt with combs in several books about grave fields on Lovön island in Lake Mälaren, in which he has analysed the characteristic features of combs, and compiled chronologies accordingly (Petré 1984a; 1984b; 1999; 2000; 2011). Combs from several other cemeteries have also been published (e.g. Lamm 1962; Holmqvist 1970; Waller 1996; Sander 1997; Melin & Sigvallius 2001), and these sources provide the basis for the discussion that follows.

Earlier, Migration Period combs from Gotland and central Sweden are quite different from the Salme combs. They are much shorter, and usually feature wedge-shaped connecting plates and single edge lines. Earlier combs were often decorated with semi circles and semi-ring-and-dot motifs; complete circles are rather rare (e.g. Nerman 1935; Brynja 1998).

According to Bo Petré, characteristic features which enable the dating of the combs are the cross-section of toothplates and connecting plates, the back contour of the comb, the number of edge lines, and the shape and placement of ring-and-dot motifs (Petré 1984b, 71 ff.; 1999, 188 f.; 2011, 299 ff., 331 ff.).

Characteristic features of combs from Salme (with reference to Petré's scheme), are their 'curved' (concave/convex/concave) back contour, toothplates of straight cross-section, and connecting plates of plano-convex cross-section. According to Petré, such features are characteristic of the 7th–8th centuries (Petré 1984b, 75 ff.; 2011, 331 ff.). By around AD 700, connecting plates of plano-convex cross section were also dominant in Gotland (Nerman 1947, 115, fig. 5; 1958, 120; Nørgård Jørgensen 1999, pls 108: 14, 110: 4). Wolf-Dieter Tempel dates combs with curved backs from Sweden and Norway to the 8th century (Tempel 1972, 58, pl. 7: 3, 4). Combs with 'rounded' backs (i.e. with connecting plates tapering evenly toward the ends), were used simultaneously with combs with 'curved' backs (e.g. Brynja 1998, figs 37, 51; Petré 1984b, 71, 78), but became the exclusive form in the 9th century (e.g. Arne 1934, 59, pls III: 10, IV: 4, 5, VII: 1; Tempel 1972, pl. 8: 8, 9, 11; Ambrosiani 1981; 1984; Hyenstrand 2018; Sörling 2018).

Decorative features characteristic of the Salme combs are single or triple edge lines; none of the combs from Salme features double edge lines. In the Mälars region and Gotland, single edge lines were used from the Roman Period onward, with triple lines being introduced in the 6th century. However, in combination with morphological features similar to the Salme combs, they occur primarily between the late 6th and 8th centuries (Petré 1984b, 75; Nørgård Jørgensen 1999, pls 108: 14; 110: 4, 20; 131: 12). Double edge lines, used on connecting plates of plano-convex cross-section, came into use in the 2nd half of the 8th century and are typical of the Viking Age (see in particular Kristina Ambrosiani's A-combs: Nerman 1947,

115; 1958, 120; Ambrosiani 1981; Petré 1984b, 75 ff.; 2011, 331 ff.; Thunmark-Nylén 1991, 115, fig. 1).

It is instructive that semicircles are not present in the decoration of the combs from Salme; such decoration was common in the Roman Period, but used less frequently in the Migration and Early Vendel Periods (Petré 1984b, 76; see also Nerman 1947, 115; 1958, 120). Double ring-and-dot motifs – as can be seen on three combs from Salme – were more typical for earlier periods, and were used primarily on combs with connecting plates of wedge-shaped cross-section. Such decoration occasionally appears on connecting plates of plano-convex cross-section (e.g. Petré 1984a, A 115: 3; 1999, A 4: 7, A 46: 14), but ring-and-dot motifs with single rings are much more common on these objects. Groups of ring-and-dot motifs are typical of combs of the 7th to 8th century (Petré 1984b, 76 ff.; 2011, 331 ff.).










The connection of double ring-and-dot motifs with curving lines seen at Salme (comb 2; Fig. 10) has quite a close parallel in a Vendel Period grave in Spelvik (south-west of Stockholm) (Lamm 1962, fig. 9: B) and Löta in Bettna (SHM Inv. No. 13974). Patterns of ring-and-dot motifs with connecting lines forming rhombs (like comb 8; Fig. 16) are also known on the combs from Lovön Island (e.g. Petré 1984a, A 11: 5, A 78: 5, A 118: 6; 2011, A 4, A 9, A 17). Similarly decorated combs are known from 8th- to 9th-century contexts in northern continental Europe (between Germany and north-west Russia), but these examples lack the ‘curved’ back contour so characteristic of the combs from Salme (e.g. Tempel 1979, fig. 25; Davidan 1992, 19, figs 3, 53; Sörling 2018, 154 f., No. 655).

The decoration of comb back edges is a feature of the Late Migration Period and Vendel Period (5th–8th centuries) (e.g. Nerman 1969, pls 37: 398, 40: 417; Brynja 1998, 58, 71, e.g. combs Nos 143, 144, 164, 166, 173, 178, 180; Petré 1999, A 24: 3, A 48: 5, A 41: 3; 2011, A 72), though occasionally it does occur on later combs (e.g. Thunmark-Nylen 1991, 118; Smirnova 2005, 17 ff., 52, 54, figs 3.3, 3.4, 3.33: A 144, 3.36: A 335; Sörling 2018, 144–178).

Turning to technological traits, the material and placement of rivets (Table 1) does not help to precisely date the combs from Salme. The Salme combs are characterized by iron rivets, but these were common until the 10th century (when copper alloy began to take over as the key material for the production of comb rivets in Scandinavia: Ambrosiani 1981, 72, 90; 1984, 167). The placement of rivets has also been used for dating. For example, Lyuba Smirnova notes that combs from the earlier layers at Novgorod are more commonly fixed through toothplate centres, but that from the end of the 10th century, rivets were more usually placed at the junctions between plates (Smirnova 2005, 37 f.). Nevertheless, these patterns relate to a later period, and probably to the particular social dynamics of Novgorod; it seems clear that across Viking Age Europe, several styles of riveting were simultaneously in use (Ashby 2006, 38, fig. 2.15; 2009, 16 ff., table 3, fig. 5; cf. Nordby & Ramstad 2015).

In summary, the characteristic features of combs from Salme can be dated as shown in Table 2. The combs from Salme are most satisfactorily dated to the 8th century, which fits well with the burial’s established date of c. AD 750, based on

Table 2. Characteristic features of combs from Salme

Characteristic feature		Dating
(a) 	(a) curved (concave/convex/concave) back	6th–8th century
(b) 	(b) connecting plates with plano-convex cross section	From the 2nd half of the 6th century, prevailing from the 8th century
	(b) toothplates with straight cross section	From the 2nd half of the 6th century
(c) 	(c) full ring-and-dot motifs	Prevailing from the 7th century
(d) 	(d) double ring-and-dot motifs	Mostly 6th–8th century
(e) 	(e) single edge lines	From the Roman Period until the 9th century, but rare in the late 6th–7th century
	(f) 	(f) triple edge lines
(g) 	(g) decorated back edges	Mostly 5th–8th century
(h) 	(h) decoration composed of groups of ring-and-dot motifs with connecting lines	8th–9th century
	(i) 	(i) iron rivets

radiocarbon dates and the typology of other artefacts (Konsa et al. 2009, 61 f., fig. 9; Peets & Maldre 2010; Peets et al. 2011, 29, 34 ff., table 1; 2013, 57; Price et al. 2016, 1022, 1032 ff.).

Raw material analysis

The combs from Salme are made of antler. In the case of such finely worked objects, it is rarely possible to confidently identify the species of deer from which the antler was taken (for a discussion of the problems of material identification see Ashby 2006, 83 ff.; 2013, 208 ff.).

It has been assumed that combs from the Mälär region were made from elk (*Alces alces*) antler (Ambrosiani 1981, 34 ff.; Petré 1984b, 70); of the species whose antlers could be used, elk dominated completely in the Mälär region during the time period under consideration (e.g. Ashby et al. 2015, fig. 3). In Denmark, red deer (*Cervus elaphus*) populations were naturally available, and most combs from there appear to have been made from *C. elaphus* antler (e.g. Ulbricht 1978; Ashby et al. 2015). Considering the size and shape of the combs from Salme, elk antler seems more likely to have been used in their manufacture than red deer, but such determinations are based on assumption rather than observation, and thus at risk of error.

To identify precisely which species were used in the manufacture of the combs found at Salme, nine samples from eight combs (combs 2–5, 8–11) were taxonomically identified using collagen peptide mass fingerprinting (ZooMS) in the BioArCh laboratories at the University of York (Table 1: 2–5, 8–11). All samples were comb teeth, with the exception of one comb, for which both a tooth and a fragment of connecting plate were analysed (comb 10; Table 1: 10). Approximately 10–20 mg of material was sampled from each comb, and underwent collagen extraction and matrix-assisted laser desorption/ionization time-of-flight (MALDI-TOF) mass spectrometry following the method described in Buckley et al. (2010) and modified as per Rodrigues et al. (2018). Briefly, the comb samples were demineralized in 0.6 M hydrochloric acid, gelatinized, then digested with trypsin overnight. The collagen was purified using a C18 resin ZipTip pipette tip (EMD Millipore) and each sample was run in triplicate, along with a calibrant, on a Bruker ultraflex III MALDI TOF/TOF mass spectrometer. Mass spectra from each sample were averaged, and species were assigned based on the *m/z* markers presented in Buckley and Collins (2011) and Kirby et al. (2013).

According to the ZooMS analyses, four samples (from three combs) were identified as reindeer (*Rangifer tarandus*) (combs 8, 9 and 10; Table 1: 8–10; Figs 16–18), and five samples were identified as red deer/elk/fallow deer (combs 2–5 and 11). Since it is not possible to distinguish between these species with ZooMS analyses (on ZooMS see e.g. von Holstein et al. 2014; Ashby et al. 2015), we subjected these samples to ancient DNA analyses, targeting a 122 bp fragment of the 12S ribosomal RNA gene in mitochondrial DNA which is capable of

distinguishing between cervid species (Speller et al. 2014). Ancient DNA extraction was undertaken in the ancient DNA laboratory at the University of York following published protocols to avoid contamination from modern sources (Poinar 2003). DNA was extracted from a separate subsample of the combs using a silica spin-column method (Yang et al. 1998), following the methods described in Speller et al. (2014). All five samples were successfully amplified and sequenced using forward and reverse primers; consensus sequences from the five samples were uploaded to the GenBank NCBI database under accessions MN810315–MN810319. BLAST searches against the NCBI Genbank nr/nt database displayed identical matches with published 12S sequences from elk (*Alces alces*), while phylogenetic analysis of the sequences with published cervid 12S sequences truncated to the same 122 bp fragment confirmed the species identity of elk for all five combs (combs 2–5 and 11; Table 1: 2–5, 11; Figs 10–13, 19). None of the samples were identified as either red deer or fallow deer antler.

ZooMS analysis of one comb fragment from I ship (comb 1d; Fig. 9: d) had been previously undertaken (by Krista McGrath and Eve Rannamäe), also in the BioArCh labs. The ZooMS identification for this sample was the same as the aforementioned five combs found from II ship – red deer/elk/fallow deer (Table 1: 1). It seems likely that the I ship sample may also be made from elk antler, however aDNA analysis was not undertaken on this sample and as such, the identification is only tentative.

Reindeer did not live in the Mälars region, so either the raw material or complete combs must have been imported from elsewhere in Scandinavia. Today, wild reindeer are primarily associated with Norway and northern Finland, but they were once very common over vast areas of northern Scandinavia, where they were subject to large-scale hunting (e.g. Ekman 1922; Ashby et al. 2015, fig. 3; Røed & Hansen 2015, fig. 4; Lindholm & Ljungkvist 2016; Pilø et al. 2018). Combs made of reindeer antler have been reported across large areas of Norway, Sweden, Denmark, Orkney and the Faroe Islands (e.g. Ulbricht 1978; Hansen 2005, 159, 271; Ramstad 2010; Ashby et al. 2015; Nordby & Ramstad 2015; Røed & Hansen 2015). For example, at Ribe, Denmark, reindeer antler was used in manufacturing from at least the 780s and became more common throughout the Viking Age, with examples of reindeer antler combs now definitively recorded from Århus and Aggersborg (Ashby et al. 2015). Work at Haithabu is ongoing. Some of the early combs from Ribe are made of reindeer antler, suggesting the existence of trade and travel connections from early in the 8th century (Ashby et al. 2015, 687, fig. 4: 1, o). Although it is possible that reindeer hunters were also craftsmen, and manufactured combs from reindeer antler (e.g. Christensen 1986; Rosvold et al. 2019), it is also possible that antler was brought to the Mälars region as raw material for local comb makers. In the case of Salme, the similarities in the form and ornament of combs made from elk and reindeer antler may support the latter suggestion, though this is a complex issue that cannot be covered in detail herein.

It is worth mentioning that alongside combs, other osseous artefacts are known from the Salme burials, and some of these are made from bones of species not native

to either central Sweden or other countries around the Baltic. These are gaming pieces of whale bone and walrus tusk, and a die probably made from a sperm whale tooth (Peets & Maldre 2010, 10 ff.; Peets et al. 2013, 47).

It would be interesting to establish whether morphological, ornamental, or technological differences between combs relate in any way to the use of different materials. As has been already mentioned, the back contour and connecting plate cross-section are similar in all combs, and the riveting technique is not consistently patterned in relation to species (Table 1). But can we also find differences in the decoration of combs of elk and reindeer antler where the raw materials have been definitively identified? Regarding edge lines, we can observe that triple lines and double ring-and-dot motifs are found only on elk antler combs (combs 2–5; Table 1: 2–5; Figs 10–13), whereas the combs of reindeer antler (combs 8–10) have single edge lines on their connecting plates (Table 1: 8–10; Figs 16–18), and both examples decorated with ring-and-dot have plain, single rings (combs 8 and 9; Figs 16–17). One comb of reindeer antler (comb 8), however, has triple lines at the edges of its endplates, as well as groups of three transverse lines on the back, although its connecting plates still have the expected single edge lines (Fig. 16). Nonetheless, neither single ring-and-dot motifs nor single edge lines are exclusive to the reindeer combs, and occur on those of elk antler (comb 5; Table 1: 5, Fig. 13; comb 11; Table 1: 11, Fig. 19). Finally, one comb of reindeer antler (comb 10) features a different style of decoration: it is not decorated with ring-and-dot motifs, but instead with small rectangular dimples and pairs of short horizontal lines (Table 1: 10; Fig. 18). Overall, though, generally the combs of each material are stylistically quite similar. Though the sample size is small, there does not appear to be a direct relationship between biogeographic provenance and aesthetic form or technological choice.

It is noteworthy that two of the combs made from reindeer antler (combs 8 and 9) were found in the bottom layer of burials, and one in the third row of the 2nd burial layer (comb 10). From the first row of the 2nd layer, all combs that could be identified to species (i.e. four of five combs – combs 2–4 and 11), are made from elk antler. This may suggest that these individuals were from a particular place or group.

Summing up, both identified materials point to Scandinavia: reindeer antler to the upland areas of present day Norway and northern inland Sweden, and elk antler primarily to Sweden. However, areas further east – such as parts of present-day Finland – cannot be excluded as potential sources, particularly as there is good evidence for large-scale hunting in the Iron Age in these areas. Future developments in archaeogenomics may allow the origin of the reindeer antler used in the Salme combs to be more accurately determined; the potential of aDNA in this field of research has been demonstrated in a recent pilot study on Norwegian material (Rosvold et al. 2019).

However, the absence of red deer antler at Salme is noteworthy. In more southern regions around the Baltic, such as Denmark and Germany, combs were most

commonly made in red deer antler (e.g. Ulbricht 1978; Ambrosiani 1981, 98 f.; MacGregor 1985, 35, fig. 28; Ashby et al. 2015). The fact that this material was not identified in any of the combs from Salme makes such a western origin unlikely, and on the basis of probability, central Sweden seems the most likely place of manufacture. As outlined above, this is consistent with many other finds from the Salme ship burials.

Methods of manufacture and the skills of the comb-maker

Although analysis of the practice and organization of comb-making is not the aim of the present paper, some details indicating differences in the competence of different comb-makers can be noted (for more on methods and quality of manufacture, see e.g. Ashby 2006, 68 ff.).

As has been mentioned already, these combs were constructed from three layers: a group of tooth- and endplates, secured by connecting plates on either side, all fastened together with rivets. The manufacture of such artefacts required certain experience and practice, and was most likely undertaken by specialists. Making and decorating combs required special tools, including saws with extra fine blades (and possibly saws with two parallel blades for sawing comb teeth), as well as tools for adding decorative elements (e.g. pronged drills for ring-and-dot ornament, and engraving tools for producing parallel edge lines) (e.g. Ambrosiani 1981, 113 f.; MacGregor 1985, 55, 60 f., figs 33, 38; Hansen 2005, 181). Incised ornament was also filled with pigment: most frequently this seems to have been a mixture of beeswax and soot (e.g. MacGregor 1985, 70; Lobisser 1999, 266 f.). A dark pigment is preserved in the ornament of one of the Salme combs (comb 2; Figs 10, 22: b).

Although most of the Salme combs are made with great skill and carefully finished, there are some exceptions. One observed flaw in craftsmanship is a fault in the ornament of a comb, where an attempt has been made to rectify the incorrect placement of a ring-and-dot motif by drilling a new motif partly over the first attempt (comb 7; Fig. 21). In other respects, the comb has been made as skilfully as most of the other specimens.

However, as mentioned above, one comb (comb 3) stands out as having been produced with considerably less care and skill (Fig. 11). While the general appearance of the comb is beautiful and elegant – if a little asymmetrical – on closer examination, a number of flaws become apparent. First, the maker of this comb has not succeeded in engraving the edge lines on the comb. While the other combs feature edge lines on each edge, this example has such lines only on the lower, straight edge. Neither are edge lines present at the edges of the endplates (Fig. 11). Where present, the lines are not regular and parallel, as is the case on other combs of this type (e.g. comb 2; Fig. 22: b). In some places they are closer to each other, and in some places the interval is larger. In some places there are three lines, in others there are only two, and the lines are also of uneven thickness (Fig. 22: a). It seems that the maker of this comb did not have at hand the tool necessary for the

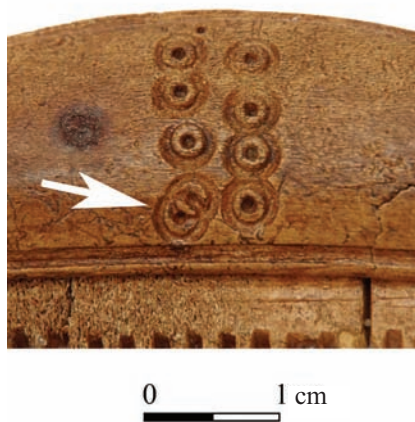


Fig. 21. Comb 7 (SM 10602: 167), detail of ornament. A new motif has been drilled to correct a fault in the ornament of the comb. Photo by Reet Maldre.



Fig. 22. Edge lines. a – comb 3 with irregular and uneven edge lines (SM 10602: 330), b – comb 2 with regular triple edge lines (SM 10602: 416). Photo by Reet Maldre.

engraving of this staple of 8th-century comb ornament. This may also explain why the edge lines have not been engraved on the curved back of the comb, where such parallel lines would have been even more difficult to engrave without the proper, specialized tool.

On the other hand, the manufacturer of this comb clearly did have access to the tool needed in the production of double ring-and-dot motifs. Nevertheless, a certain irregularity can be observed in ring-and-dot motifs: on one side of an endplate the motifs stand in a triangular group, whereas on the other side they are placed in a curved line (compare Figs 11 and 23: b). Finally, sawing the teeth seems to have also been problematic. While most of the comb teeth are very even, regular, and carefully finished (e.g. combs 5 and 2; Fig. 23: a, c), the preserved teeth from the endplate of this comb have been sawn quite unevenly, and the finishing process has not been completed (Fig. 23: b).

These apparent differences in skills suggest that the combs were purchased from different craftsmen. Perhaps the owners of the combs acquired their combs from several comb-makers' workshops in different sites. Alternatively, they could have been made and sold by a number of itinerant craftsmen visiting a smaller number of sites (e.g. Ambrosiani 1981, 40, 161; MacGregor 1985, 49 f.; Ashby 2006, 273;



Fig. 23. Comb teeth. a, c – even and regular teeth, combs 5 and 2 (SM 10602: 219, 416), b – uneven teeth, comb 3 (SM 10602: 330). Photo by Reet Maldre.

2015; Hansen 2015, 157–203), or by agents collecting combs from various sources in various regions. It is not possible, on the balance of evidence presented here, to choose between these scenarios.

Conclusions

The combs from Salme have features characteristic of the 7th–8th centuries, so their dating fits well with the burial's established date of c. AD 750, based on radiocarbon dating and typological study of other artefacts. On the basis of parallels, most of the combs from Salme most likely come from the Mälars region in central Sweden, where combs most similar to them are found. The material of three combs (reindeer antler) suggests the possibility that either these combs, or the material used for making them, was obtained from upland areas in the territory of the present-day Norway or more northern regions of Sweden. It is also noteworthy that products made from skeletal parts of species from a wide geographic spectrum have been used to make objects found in the Salme ship burials. In addition to elk and reindeer antler, whale bone, walrus ivory and bear teeth are present in the artefactual assemblage. This suggests access to a wide network of travel and trade.

In terms of general appearance, particularly regarding size and form (shape of the back, and cross-section of connecting plates), the combs are quite similar. Some differences can be observed in patterns of decoration and in raw material use. While most of the combs have been made by a skilled hand, one of them was evidently made by a less skilled individual. Considering these differences, we may suggest that the combs were commissioned or purchased from different craftsmen, which may have implications for our understanding of the mobility of such artisans.

The general distribution of combs in the Salme ship burials is uneven, and potentially socially informative. Only one comb was found in Salme I. In the Salme II ship, combs were completely absent in the 1st burial layer and in the second (middle) row of the 2nd burial layer. It seems likely that almost every buried person in the first row of the 2nd layer had a comb, and all identifiable combs in this row were made from elk antler. In the bottom layer, a smaller number of skeletons were buried with combs, and both examples found *in situ* in the bottom layer were made from reindeer antler. At least one comb, also of reindeer antler, was buried with a skeleton in the third row of the 2nd layer. It is remarkable that the presence or absence of combs does not seem to relate to the richness of personal grave goods, and thus need not be a direct indicator of social status.

Combs were very common grave goods in the Mälars region of central Sweden, as well as in other regions of Scandinavia. Across this region, combs were frequently incorporated into the burials of individuals of different age, gender and social status. It is thus an intriguing question why so few combs were deposited in the Salme mass burials. In contrast, weapons – especially swords – are extremely rare in Pre-Viking graves from middle Sweden, but are numerous in the Salme ship burials. It is also remarkable that cremation was

the dominant mortuary tradition in Pre-Viking Scandinavia, but at Salme the dead were buried as inhumations. Presumably both phenomena – the use of inhumation, and the unusual deposition of grave goods – were connected with the specific character of these burials as a mass grave of warriors killed in battle in a foreign territory.

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**SALME LAEVMATUSTE SARVKAMMID: LEIUKONTEKST,
PÄRITOLU, DATEERING JA VALMISTAMINE**

Resüme

Laevadesse paigutatud massmatuste ja skandinaaviapärase esemetega unikaalne rauaaegne kalmistukoht asub Eestis Saaremaal Salme aleviku põhjaservas. Kahe matuseleava (Salme I ja Salme II) jäänused avastati ja neid uuriti aastatel 2008 ning 2010–2012 (jn 1–2). Arheoloogiliste kaevamiste käigus leiti koos relvade ja isiklike esemetega maetud vähemalt 41 sõdalase jäänused ning arvukalt loomaluid. Peale rikkalike panustega massmatuste teeb leiukompleksi eriti unikaalseks selle samaaegsus, millele osutavad nii esemelise materjali ja matmisviisi suur sarnasus kui ka inimluude radiosüsinikanalüüside, DNA-uuringute ning hambaemali isotoopanalüüside tulemused. Tõenäoliselt pärineb matusekompleks ühest umbes 750 pKr toimunud traagilisest “sündmusest”, mille käigus relvakokkupõrkes langenud sõdalased-meresõitjad sängitati mererannale kahte laevasarkofaagi. Maetute hambaemali isotoopanalüüside põhjal ei olnud mehed kohalikud, vaid olid sündinud Kesk-Rootsis Mälari piirkonnas, inimluude DNA-uuringud osutavad aga nende põlvnemisele väga lähedastest esivanematest.

Salme kahest laevmatusest leiti kümme kammid sarvest kammi, millest osa on säilinud peaaegu tervikuna, osa aga väikeste katketena (kammid 1–12; tabel 1; jn 3–20). Artikli eesmärgiks on anda ülevaade kammide leiukohtadest ja võimalusel siduda neid konkreetsete luustikega. On kirjeldatud kammide kuju ja ornamendi, mille abil on püütud kindlaks teha nende päritolu ning neid dateerida. Samuti on uuritud kammide valmistamisega seotud küsimusi, nagu kasutatud materjal ja kammivalmistajate oskused ning vilumus.

Kokku on Salme kahest laevmatusest leitud vähemalt 12 kammi katkeid. I laevast saadi ainult ühe kammi fragmente, kõik ülejäänud leiti II laevast. Seega oli

Salme I laevas üks kamm sealse seitsme maetu kohta. II laeva 34 luustiku kohta on 11 kammi, st kamm on olnud umbes kolmandikul maetutest. Märkimisväärne on, et Kesk-Rootsi samaaegsete matuste puhul on kammid kõige tavalisemateks hauapanusteks, mis on asetatud peaaegu igasse hauda.

I laeva kammi katked (kamm 1) olid kaablikraavi kaevamisel algsest asukohast eemale sattunud ja neid ei ole võimalik ühegi luustikuga seostada. Salme II laevas leiti vähemalt kolme kammi katkeid (kammid 5–7) ülemistest, osaliselt segatud kihtidest, kuhu osa neist oli sattunud laeva läbivate kaablikraavide kaevamise käigus (jn 3). 1. matusekihis, samuti 2. matusekihi teises reas ei olnud ühtki kammi. Seevastu 2. matusekihi esimeses reas oli kamm peaaegu iga luustiku kohta (kammid 2–4, 11 ja 12; jn 4: 2–4, 11, 12). Üht kammi (kamm 10) võib seostada 2. matusekihi kolmanda rea luustikega, millest kaablikraavi kaevamise tõttu on algses asukohas säilinud ainult jalaluud (jn 4: 10). Kõige alumisest, 3. matusekihist saadi kaks kammi (kammid 8 ja 9; jn 4: 8, 9), tõenäoliselt pärineb sealt veel üks kamm (kamm 5), mis kaablikraavi kaevamisel oli sattunud ülemisse kihti (jn 3: 5).

Kõik kammid on ühe piireaga ja kokku pandud otsa- ja piiplaadikestest ning neid ühendavatest ühendusplaatidest (jn 9–20). Kammid, mille pikkust saab kindlaks määrata, on 19–21 cm pikkused ja keskosas 4,5–5 cm laiused. Neile on iseloomulik kaarjas seljakontuur ja lamekumera läbilõikega ühendusplaadid. Viimaste servas, sageli ka otsaplaatidel, on ühe- või kolmekordsed kontuurjooned. Enamik kamme on kaunistatud silmakestega, st ringikestega, mille keskel on punkt, mõnel juhul ümbritsevad punkti kaks kontsentrist ringjoont. Silmakesed paiknevad vertikaalsete või horisontaalsete ridadena või rühmadena, mis võivad olla joonte abil ühendatud. Mitmel kammil on kaunistatud ka ühendusplaatide vahel nähtav piiplaadikeste seljaosa.

Ühe piireaga kammid on Eesti ala leiuaaineses haruldased, viikingiajast varasemaid kamme oli enne Salme leide teada vaid mõni üksik. Salme kammidega kõige sarnasemad on Rootsist, näiteks Ojamaalt ja eriti Kesk-Rootsist Mälari järve piirkonnast, leitud kammid. Salme kammidele iseloomulikud tunnused (seljakontuur, ühendusplaatide läbilõige ja ornamendimotiivid) olid levinud 6.–9. sajandil, osa neist on tüüpilised pigem 6.–8. sajandile, teised aga 8.–9. sajandile (tabel 2). Seda arvesse võttes võib kammid dateerida 8. sajandiga, mis sobib ka Salme matustest leitud teiste esemete ja samuti ¹⁴C dateeringutega.

Kammid on valmistatud sarvest, kuid sedavõrd viimistletud esemete puhul ei ole võimalik loomaliiki määrata. Mälari piirkonna kammid arvatakse olevat põdrasarvest, ka Salme kammide suuruse ja kuju põhjal tundus põdrasarv kõige tõenäolisem. Liikide määramiseks analüüsiti Yorki ülikoolis üheksat Salme II laeva kammidest võetud proovi, mis pärinesid kaheksast kammist (tabel 1: 2–5, 8–11). ZooMS-analüüsiga tehti kindlaks, et neli proovi (kolmest kammist) on põhjapõdrasarvest (kammid 8–10). Ülejäänud viie proovi (kammid 2–5 ja 11) tulemuseks saadi punahirv/põder/kabehirv, sest neid liike ei ole võimalik ZooMS-i abil üksteisest eristada. Kõigi nende puhul selgus vana DNA analüüsiga, et tegu on põdrasarvega. Juba varem oli ZooMS-analüüs tehtud ühele Salme I laevast leitud kammikatkele (kamm 1d), mille tulemus oli samuti punahirv/põder/kabehirv.

Põhjapõdrasarvest kammid või nende valmistamiseks kasutatud materjal on saadud nendest Skandinaavia piirkondadest, kus põhjapõdrad elasid. Punahirvesarvest kammide puudumine viitab sellele, et ilmselt ei pärine Salme kammid Läänemere lõunakalda maadest (Taani, Saksamaa), kus enamasti tehti kamme seal elava liigi, punahirve sarvedest.

Täheldada võib erinevusi kamme valmistanud meistrite vilumuses. Enamik Salme kamme on valmistatud meisterlikult ja hoolikalt viimistletud. Ühel kammil (kamm 7) võib märgata viga ornamendis: üks silmakestest on algul tehtud valesse kohta ja seejärel püütud mustrit uue silmakese abil parandada (jn 21). Teise kammi puhul (kamm 3) esineb mitmeid puudusi: kontuurjooned on kohati kolme- ja kahekordsed ning jooksevad mõnes kohas viltu (jn 22), ka silmakeste asetus on ebakorrapärane: otsaplaadi ühel küljel paiknevad need kolmnurgana, teisel kaarja reana. Lisaks on selle kammi piid saetud ebakorrapäraselt ja jäänud viimistlemata (jn 23).

Kokkuvõttes võib kammid tüpoloogia põhjal dateerida 8. sajandiga, mis sobib Salme ¹⁴C dateeringute ja teiste esemetüüpide vanuse ning matusekompleksi ülddateeringuga. Kõige tõenäolisemalt pärinevad kammid Kesk-Rootsist Mälari järve piirkonnast. Kolm kammi on põhjapõdrasarvest, mis pärineb tänapäeva Norra territooriumilt või Rootsi põhjapoolsematelt aladelt. Kammide paiknemine Salme matuste juures on erinev: mõnes matustereas on kamm peaaegu iga luustiku kohta ja mõnes puuduvad kammid sootuks. Samas ei ole kammide olemasolu või puudumine seotud muu leiumaterjali rikkalikkusega. Mälari piirkonnas olid kammid väga tavaliseks hauapanuseks, sõltumata maetu vanusest, soost ja staatusest. Seetõttu tekib küsimus, miks on Salme kammid ainult osa luustike juures. Relvade, eriti mõõkade puhul on aga vastupidi: Mälari piirkonna selleaegsetes matustes on relvi vähe, Salmes aga arvukalt. Kesk-Rootsis domineeris vastaval ajaperioodil põletusmatus, kuid Salmes on surnud maetud põletamata. Need erinevused võivad seotud olla matmispaiga spetsiifilisusega: tegu on võõral territooriumil lahingus langenud sõjameeste ühishaudadega.