

Viking Age Combs

Local Products or Objects of Trade?

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Abstract

Hair combs of bone and antler were commonly used personal items during the Viking Age (AD 800–1000). However, many specifics regarding their production and distribution are still unclear, and the discussion of local production or itinerancy has not been closed. In this paper, I argue that a combination of raw material analysis and empirical study of decoration can lead to new insights regarding local fashions and regional manufacturing. As a case study, an empirical analysis of comb material from three major Viking Age central places (York, Dorestad and Birka) is presented. The study suggests that although many decoration types occur on combs from all three sites, regional patterns can be distinguished that can be interpreted as indicators for local fashions as well as for itinerant comb makers.

Introduction

Hair combs are frequently found in early medieval/Viking Age (AD 800–1000) settlements. Often specific bone, horn and antler workshops can be identified, where apart from combs several other products were made, such as needles and spindle whorls. Yet it is often unclear whether these products were only produced locally or if they were transported and exchanged over a greater distance. It is also unclear whether the makers travelled with their finished combs, or if they were dependent on the market's hinterlands for raw materials and produced combs as itinerant craftsmen. In this article, I try to contribute to clarifying these uncertainties by comparing and analysing the combs that

have been found in three early medieval/Viking Age central places in northern Europe: York (England), Dorestad (the Netherlands) and Birka (Sweden). A special focus on raw material and decoration has provided some interesting insights regarding the distribution and origin of the comb material from these emporia.

Early medieval/Viking Age networks of exchange

Before introducing the comb as a commodity which could be exchanged, it is important to first get a grasp of the nature of trade and

exchange in the early medieval world. By the seventh century AD, a large and complex network existed in Europe through which goods were exchanged (Hodges 1982, 37). Goods could change owners through *gift exchange*, in which the political and social function of an object was more important than the economic value (Hodges 2012, 32). Because of this multifaceted aspect of exchanging goods, I prefer to use the broader term *exchange* instead of *trade*, which implies solely economic reasons for commodities changing owner. The nodes in this network of exchange are known as *emporia*, which are gateway communities and ports of trade, and often administrative and religious centres as well (Hodges 1982). The precise role and function of these emporia is widely debated, but recent research suggests that the exchange of bulk goods played a major role in the early medieval economy, and that this exchange took place not only in emporia but also for a large part in smaller towns (e.g. Verhulst 2002; Loveluck & Tys 2006; Skre 2008a; Hodges 2012; Loveluck 2013). Furthermore, scholars now assume that a much greater role could have been played by alienable exchange of commodities, free of any social obligation, between the sixth and ninth centuries, alongside socially embedded (inalienable) exchange, based on gift exchange and controller redistribution of goods (Loveluck 2013, 19). Artisans would have played a significant role in organizing this exchange of bulk goods, and were responsible for a large part of the production of bone and antler combs. A complex network of communication and transport would subsequently distribute some of these combs to different corners of early medieval north-western Europe (Sindbæk 2013).

Combs in their early medieval context

Combs are frequently found on early medieval sites. The Arab traveller Ibn Fadlan writes that the Volga Rus used combs every day as part of a daily cleaning routine (Frye 2005, 65). But combs were not just tools for cleaning and grooming, but also markers of social identity (Ashby 2014). We know from written sources that particularly elaborate combs circulated as gifts throughout the highest classes of Anglo-Saxon and Carolingian society (Sorrell 1996). Apart from these special status objects, finds from graves show that most combs were part of people's personal utensils and often carried on the body in a leather etui or in a special comb case made of bone or antler (Ambrosiani 1981, 14).

During the last century, extensive work was done to classify combs from the Viking Age and the Early Middle Ages (e.g. Wilde 1939; Jankuhn 1943; Tempel 1969; Davidan 1974; Tempel 1970; Ulbricht 1980; Ambrosiani 1981; MacGregor 1985; Ashby 2009). Such a classification involves a

fundamental simplification of patterning; it is this that allows one to find order in what would otherwise be a potentially endless continuum of variation ... only by studying patterning in traits relating to raw material use, methods of manufacture, and aesthetic treatment may we undertake interpretative discussion at a high level of resolution (Ashby 2011, 11).

This paper will focus mainly on the first and third trait suggested by Steve Ashby; raw material use and aesthetic treatment. The reason for this focus is the fact that both raw material and aesthetic treatment can be used as indicators of long-distance exchange of combs. As will be discussed in the next section, the sourcing of raw material

used for comb production can be especially valuable to trace combs made from non-local material such as reindeer antler. Aesthetic treatment can possibly provide us with an insight into different comb making traditions and give some clues about the network of comb makers. As discussed by Ingold (2000, 349 ff.), the distinction between art and technology is mostly a recent opposition. For ancient artisans, the act of decorating was possibly a part of the skill of creating an artefact, and specific comb makers or groups of comb makers possibly had their own set of decorative patterns.

The significance of raw material

The use of raw material studies in archaeology is evident. However, until the last couple of decades, archaeologists have been constrained by limited technology for sourcing materials

(Ashby *et al.* 2015). Recent developments of elemental, isotopic and biomolecular methods are increasing the range of materials that archaeologists can source (Henderson *et al.* 2005; Hull *et al.* 2008; Barrett *et al.* 2011; Ling *et al.* 2013).

Combs were produced by specialist artisans who also made other objects from bone or antler such as dice, needles and spindle whorls (e.g. Ambrosiani 1981). They could be made of wood, horn, bone or antler, of which the latter two are the most common categories (albeit partly due to preservation issues). Antler was the preferable raw material since it is less brittle and more flexible than bone (MacGregor 1985, 28 ff.). Fig. 1 shows the parts of an antler that were used for comb making and fig. 2 shows how these parts were worked and put together to produce a comb.

When antler was scarce, sometimes the connection plates were made of bone and only the tooth plates, which had to endure most

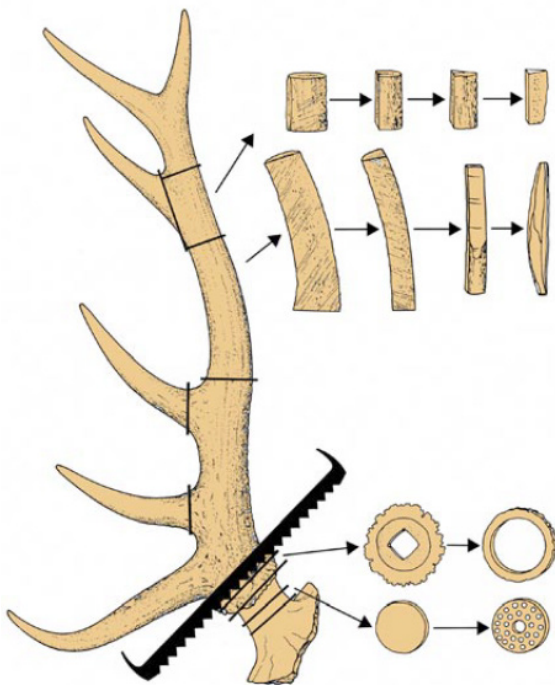


Fig. 1. How different parts of the antler were used for different artefacts. After Carlsson 2004, 4.

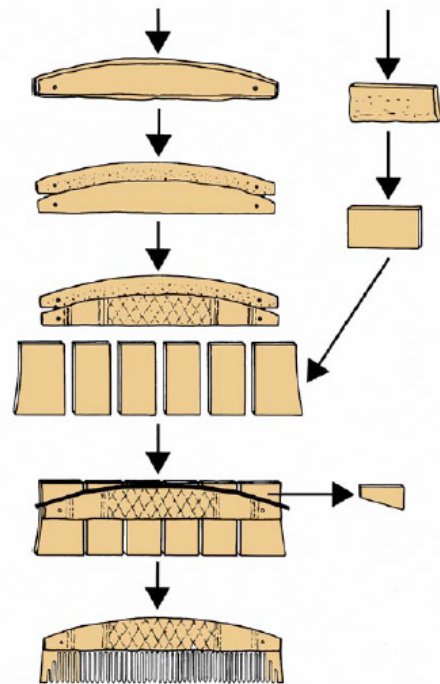


Fig. 2. The production process of a composite comb. After Carlsson 2004, 4.

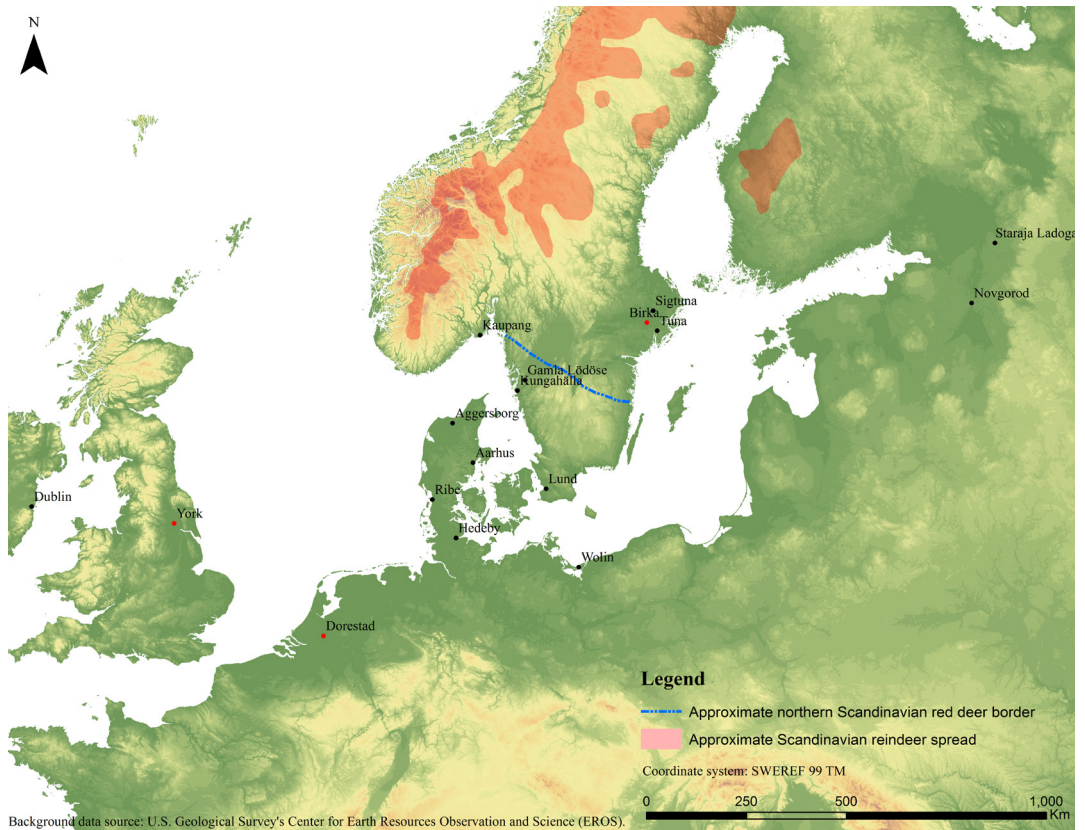


Fig. 3. Places mentioned in the text. Background map data provided by U.S. Geological Survey's Center for Earth Resources Observation and Science (EROS). Reindeer range based on Ashby *et al.* 2015 and Ulbricht 1978. Red deer border based on MacGregor 1985, 36. Map created by Sjoerd van Riel.

pressure, were made of antler (Rijkelijkhuisen 2008, 37, 43). A special category of combs which appears mainly in Anglo-Saxon contexts, but also in northern France and Ireland, consists of horn composite combs, which have been argued to be a possible indicator of Anglo-Saxon identity (Riddler *et al.* 2012).

Out of the available deer antler, the most commonly used are red deer (*Cervus elaphus*) and elk (*Alces alces*). Red deer lived in large parts of the north European lowland, whereas elk occurred in Scandinavia and around the Baltic, but were mostly absent in Denmark and southwards (Aaris-Sørensen 1988, 233). Reindeer (*Rangifer tarandus*) antler would be

the third major raw material source, although reindeer living areas were restricted to the circumpolar Arctic zone (Fig. 3 – Ulbricht 1978, 125; Ashby *et al.* 2015, 682).

The ratio of antler remains compared to other elements of deer suggests that shed antler was brought into the towns rather than the antler being taken from butchered animals (MacGregor 1985, 35). Furthermore, on many sites with large-scale antler working it has been observed that the assemblage is dominated by antler bases with natural ruptures at the burr, indicating that they were shed in the wild (Reichstein 1969; Ó Ríordáin 1971; Andersen *et al.* 1971; MacGregor 1978; Rytter 2001; Karlsson 2016, 61 ff.).

Evidence from Ribe suggests that shed antlers outnumbered those sawn from slaughtered deer by a factor of 4:1 (Ambrosiani 1981), and in Wolin in northern Poland the ratio was 3:1 (Müller-Using 1953). In Kungahälla the percentage of shed antler is as much as 91.7% (Vretemark 1991, 62). Interestingly, the town of Novgorod in present-day Russia shows a reverse pattern, where only 25% of the antler was shed (Smirnova 1997, 139). This difference should be explained not only by the natural occurrence of antler, but also through different social structures such as hunting restrictions, which are known to have existed in Scandinavia at least as far back as the 13th century (Karlsson 2016, 64).

In any case, given the fact that shed antler deteriorates rather quickly as it is gnawed on by small rodents as well as by deer itself due to the large amounts of calcium which it contains (Vretemark 1991, 63), collecting shed antler must have been a seasonal job carried out by people who had a considerable knowledge of local terrain and game (Christophersen 1980a). Red deer, which provided the majority of the raw material, cast their antlers over a period of two months in the late winter or spring. Elks cast their antlers around January, and reindeer between November and May (MacGregor 1985, 35).

Identifying bone or antler using macro- and microscopic zoological methods has proven to be difficult. When the surface layer or porous core is still intact, e.g. in waste material or half-finished objects, the species can sometimes be identified, but on highly worked finished products these approaches have had limited success (e.g. Ulbricht 1978, 20 ff.; Ambrosiani 1981, 102–109; von Holstein *et al.* 2014). A breakthrough in the research on combs has been the development of the ZooMS (ZooArchaeology by Mass Spectrometry) method, which allows species identification by analysing peptide fragments in the protein collagen (Buckley *et al.* 2009;

Buckley *et al.* 2010; Buckley & Collins 2011; van Doorn *et al.* 2011; Kirby *et al.* 2013; von Holstein *et al.* 2014). Studies on the use of ZooMS have shown that the method allows rapid analysis at a relatively low cost and has a higher success rate than traditional species identification analyses such as aDNA (von Holstein *et al.* 2014). Furthermore, it is relatively non-destructive and it works on very small samples of only 5–10 mg (Ashby *et al.* 2015). This is especially important for the use of this method on crafted artefacts, since it can be used to determine the raw material of not only complete products but also of fragmented production waste; which can provide valuable answers, for example, to the question whether merchants travelled with raw material or finished products. The method also has some limitations, such as the impossibility to distinguish between red deer, fallow deer and elk (Buckley *et al.* 2009; Buckley & Collins 2011; Kirby *et al.* 2013). However, red deer and elk can often be distinguished from each other based on visual analysis, and fallow deer can often be excluded on biogeographical grounds (Asby *et al.* 2015).

A particularly interesting application of the ZooMS method for the study of combs is its ability to distinguish between reindeer and other types of antler (von Holstein *et al.* 2014; Ashby *et al.* 2015). Reindeer herding areas were already in the Viking Age limited to the circumpolar subarctic zone, including the Scandinavian highlands (Ulbricht 1978, 125; Ashby *et al.* 2015, 682). No reindeer occurred south and west of Norway and Sweden, and thus all artefacts made of reindeer antler in those areas represent some form of contact with the north. Reindeer antler burrs and other fragments have been found in, amongst others, the towns of Lund (Ekman 1973; Christophersen 1980a), Kungahälla (Rytter 2001), Sigtuna (Karlsson 2016), Birka (Karlsson 2016) and Gamla Lödöse (Lepiksaar

1965), which are located in modern-day Sweden, outside the reindeer range zone (Fig. 3), as well as Ribe in Denmark (Ashby *et al.* 2015). ZooMS therefore is not the first method to identify reindeer antler outside its naturally occurring area, but its revolutionary character lies in the fact that finished products and heavily worked samples can now also be identified.

Comb production in emporia: Dorestad, York and Birka

The emporia selected for this paper, to study the distribution and possible exchange of bone and antler combs are York, Dorestad and Birka (Fig. 3). The presence of imported goods shows that these places were part of an interregional network of exchange. In all three emporia, imported goods from the Rhineland such as pottery (e.g. *Badorf* and *Tating* ware) and glass have been found (e.g. Arbman 1939; MacGregor 1978; Clarke & Ambrosiani 1991, 165 ff.; Rogers 1993; Kemp 1996, 71 ff.; Willemsen & Kik 2010). The question is whether the combs belong to this category of goods that were shipped and exchanged over a large distance, or if they were produced for the local community. When we return to our emporia, we see that each of them yielded a large amount of bone and antler combs as well as production debris, which is an indication of local production.

Dorestad

Evidence of comb making in Dorestad consists of finished combs as well as production waste. A disproportionately large amount of production debris compared to finished products has been found in Dorestad, which has led scholars to believe that many finished products must have been exported (Roes 1965; Clason 1980; Prummel 1983, 9). Locations with a higher concentration of production

debris could indicate specialized production places (Prummel 1983, 15). These specialist artisans probably imported the raw material from the higher grounds of the Utrechtse Heuvelrug or Veluwe, which were very suitable for red deer (Prummel 1983, 17). As a means of accessing the raw material, Prummel (1983) suggested “import of antler, if any, from Schleswig-Holstein (Hedeby) or Scandinavia”. However, she hesitates to draw the conclusion that there was any import of red deer antlers from outside the Netherlands (Prummel 1983, 18). She also concluded that the town’s antler industry was not of great importance (Prummel 1983, 17). Her explanation for this conclusion was that combs in Dorestad were not exclusively made from antler but also from bone, whereas in towns such as Hedeby all the combs were made from antler. The reason for this difference can probably be sought in the lower lesser availability of antler in Dorestad (Prummel 1983, 17). It is disputable that the fact that fewer combs were made of antler meant that the comb industry was less significant. As Prummel herself concludes, also in Schleswig—the successor of Hedeby after the 11th century—most of the combs were made from bone rather than antler due to a lack of antler raw material rather than a less significant industry (Prummel 1983, 17 ff.).

The use of ZooMS has identified two combs found in a more recent excavation in Dorestad which were made of reindeer antler. Given the fact that reindeer only lived in Scandinavia, these combs must be made in Scandinavia, or at least the antler used for the combs came from Scandinavia (Esser *et al.* 2012, 515).

When Anna Roes (1965) published a study on the finds from Dorestad, she identified a decorative pattern on combs which she recognized from Frisia, Haithabu (Hedeby), Sweden, Scotland and Ireland. It was the lemniscate symbol (∞) which is characteristic of Ambrosiani’s type A2 (Fig. 5).

She provides a rather simplified explanation for the phenomena of similar looking combs over a geographically large area, namely that combs were “fashion objects” and that the comb makers imitated each other’s creations (Roes 1965, 60). However, as I will discuss further in this paper, her observation that the lemniscate symbol is one of the most eye-catching patterns on Viking Age combs could be significant.

York

The bulk of Anglo-Scandinavian material from York was excavated at the Coppergate and Fishergate sites (Rogers 1993; MacGregor *et al.* 1999). Already in a publication from 1891, it was noted that “a large series of combs of every shape and in every stage of manufacture” was found from “Danish workshops” (Raine 1891, 216 ff.). Later investigations on the Anglo-Scandinavian period of the town also yielded large amounts of finished combs as well as half-finished products and raw material, including horn, bone and antler (Rogers 1993, 1246 ff.; MacGregor *et al.* 1999, 1872 ff.). At the Fishergate site, a large majority, 79%, of the offcuts are made of antler, and the rest is made of bone (Rogers 1993, 1247). Raw material may have been taken from slaughtered deer, but the fact that few other elements of red deer were discovered from Anglo-Scandinavian deposits and the large number of burrs as opposed to pedicles suggest that the bulk of the deer antler was collected in the form of shed specimens (Rogers 1993, 1257; MacGregor *et al.* 1999, 1906). A clear preference for antler rather than bone as raw material for the tooth plates can be observed (31:7 ratio) because of its superior qualities in shock absorption and flexibility. However, the ratio for the connecting plates was more equal (25:22), which can be explained by the fact that the connection plates do not need to suffer as much stress and thus can be made of

“inferior” material (Rogers 1993, 1257).

According to MacGregor *et al.* (1999, 1939), the combs from York accord closely with those from other Viking Age sites throughout the United Kingdom as well as central and northern Europe.

Birka

Most of the combs excavated in Birka come from graves that were excavated in the late 19th century (Arbman 1940, Taf. 159–165; Ambrosiani 1981, 58; Hyenstrand 1992, 32 ff.). This means that they are from a significantly different context than in Dorestad and York, where most of the combs were found in deposition layers and not in closed contexts such as graves. For Birka it is possible to analyse the combs in relation to other objects found in the graves, which can possibly tell us more about the network of the owner. However, this is outside of the scope of this article. Apart from the combs from grave contexts in Birka, a part of the material comes from the “Black Earth” settlement area which has been under excavation since the 1870s (see e.g. Wigh 2001, 20 ff. for a summary of the excavation history).

Two combs with bronze connecting plates are known from Birka, which have parallels in Frisia, Gotland and Haithabu (Hedeby). On the latter site, moulds for the connecting plates were found, indicating that the bronze connecting plates were produced locally in Hedeby (Ambrosiani 1981, 68 ff.). Production debris from the “Black Earth” mainly consists of elk antler (67%). The remaining part consists of red deer (21%), and reindeer (12%) antler, neither of which was native to the area of Birka (Fig. 3 – Karlsson 2016, 126 f.). This relatively large share of imported antler can be attributed to the function of Birka as an interregional trading place. The finds of production waste from imported material can be seen as an indication of itinerant craftspeople taking raw materials with them,

as well as of local craftspeople working with imported raw materials (Ambrosiani 1981, 36 ff.; MacGregor 1985, 36).

Decoration on combs: Dorestad, York and Birka

The combs from the three emporia investigated for this article show many similarities. In all three places, single-sided composite combs (combs made of separate parts with teeth on one side – Fig. 2) are the dominant category. Combs with handles are not unusual. These observations correlate perfectly with Ambrosiani's conclusion that combs found throughout northern Europe show "remarkably similar developments in both form and decoration" which she interprets as "clear evidence for close contacts within that region" (Ambrosiani 1981, 55). However, this idea has been challenged by Ashby, who argues for the existence of local fashions and regional manufacturing traditions that problematize the idea of a uniform comb culture (Ashby 2015, 260). These regional differences can be explained, in Ashby's view, as representing a different *habitus* through technological traditions (Ashby 2013, 195). According to Ashby, "the implications of the work of Ingold, Lemonnier and others are that combmaking is best understood in terms of tradition, and that this tradition reflects the negotiation of social and practical concerns through engagement with the local environment (including materials, tools, the provision and organization of working space)" (Ashby 2013, 195). An example of such a technological tradition determined by *habitus* might be the riveting of a comb (Riddler *et al.* 2012; Ashby 2013), where we can see different trends in riveting techniques in England and Scandinavia. Supposedly the choice of riveting techniques for individual comb makers was unconscious and a consequence of the tenets

by which the artisans were working (Asby 2013, 201). Decoration, on the other hand, could tell us something about the consumer the comb was made for. Possibly each artisan produced combs according to a range of templates to meet the demands of consumers with different aesthetic preferences (Ashby 2013, 204).

In the following section the results of a short literature-based empirical study will be presented in the form of a scatter chart (Fig. 4). I have looked at combs from publications about Dorestad, York and Birka and categorized the combs according to their decorative patterns. For this I have followed the categories created by MacGregor *et al.* (1999, 1935 ff.) for their analysis of decorated combs from the Coppergate site in York. Reading the diagrams, one must bear in mind that a decorative analysis of combs from the Viking Age is problematic for several reasons. As I discussed earlier, classification requires a fundamental simplification of the data at hand. Most combs are decorated quite lavishly with a mix of different styles, which means that it is difficult to assign the comb to one specific decorative category. For my analysis, I have categorized the combs in the decorative group which is most prominent on the comb. When two decorative patterns are equally prominent on the comb, I have assigned the comb to both groups. When a comb carries more than two prominent decorative patterns, I have assigned the comb to the "mixed" category. As a result, the number of samples used for the analysis (N) is not necessarily equal to the absolute number of combs. A second problem with this kind of quantifying analysis is the level of fragmentation of the combs. Since a comb could carry different types of decoration, broken fragments could give a misleading image. Ideally, one should only include complete combs in this type of analysis, but since this would leave us with a much smaller sample assemblage, all

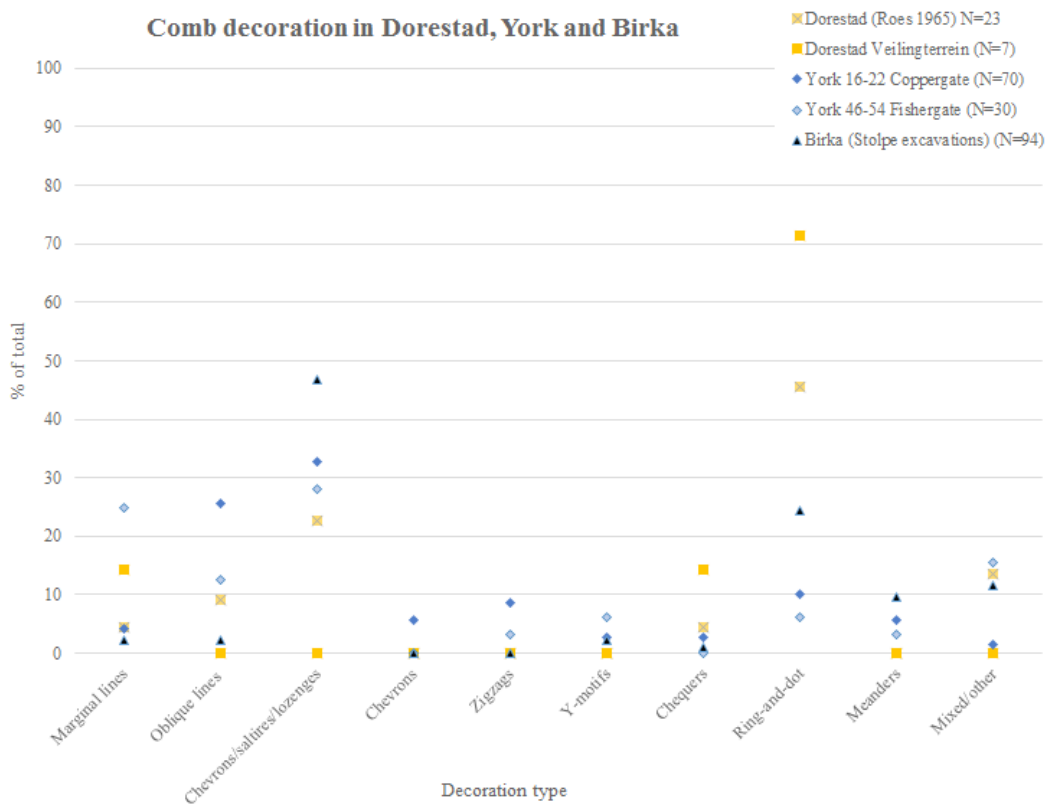


Fig. 4. Scatter chart showing the comb decoration in Dorestad, York and Birka, based on Arbman 1940, MacGregor et al. 1999, Rijkelijkhuisen 2012, Roes 1965, and Rogers 1993. Created by Sjoerd van Riel.

decorated fragments of connection plates have been included in this study. Although end plates also frequently carry decoration, they have not been included in this study.

Most decoration types occur on combs from all sites, which is in line with claims of a uniform comb culture that was subjected to “fashion” (Roes 1965, 60; Ambrosiani 1981, 55). However, a few trends can also be deduced from the graph. Decoration consisting of incised lines created with a single- or double-bladed saw (predominantly marginal lines, oblique lines, chevrons/saltires/lozenges), which were among the most important tools used in the working of bone and antler material (MacGregor 1985, 55), is more common in York than in Dorestad and Birka. A second

observable difference is the larger amount of ring-and-dot decoration in Birka and especially Dorestad compared to York. Although this motif is also rather common in York (Rogers 1993, 1404), the ratio in Birka (1:4) and Dorestad (1:2) is much higher. These motifs were made with centre-bit or scribing tool, and given the occasional irregularity of the ring-and-dots also by freehand (MacGregor 1985, 60). A particularly eye-catching motif which occurs in almost identical form in both Dorestad and Birka, but not in York, is that of an incised double line border with a pattern of ring-and-dots in the middle (Arbman 1940, Taf. 160; Roes 1965, Fig. XXVII, 204, 206, 207, Fig. XXVIII, 208; Rijkelijkhuisen 2012, comb no. 19, 22, 23, 24). This type has been identified

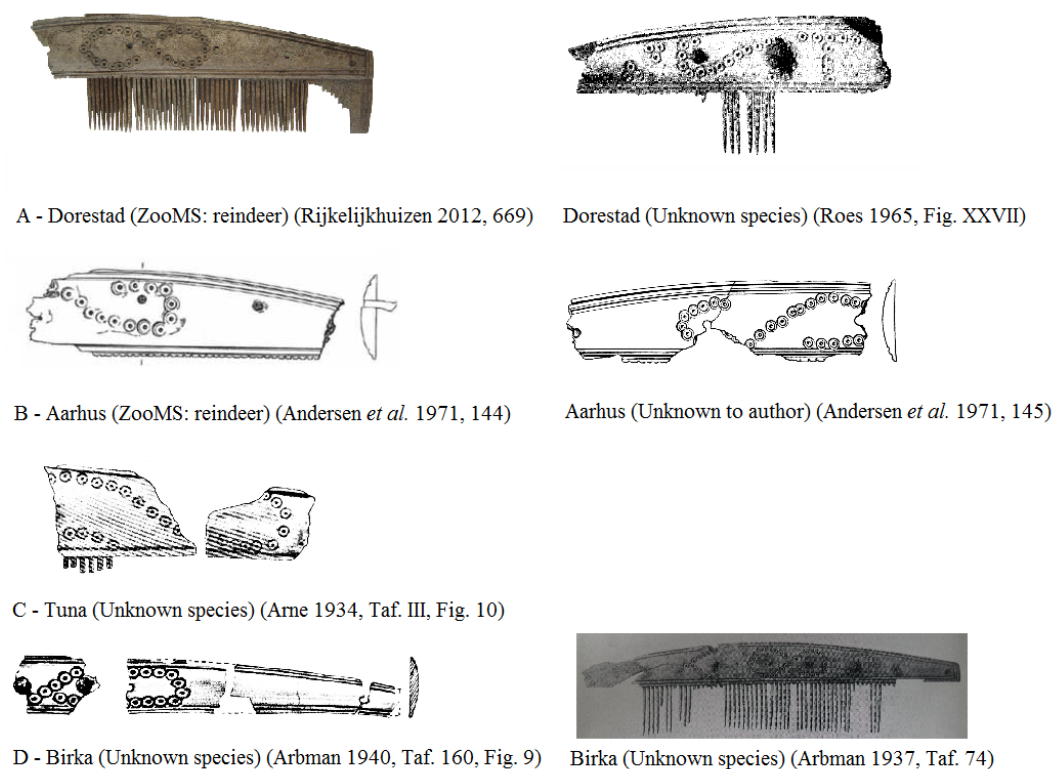


Fig. 5. Ambrosiani A2 combs with lemniscate (∞) decoration from north-west European and Scandinavian settlements.

by Ambrosiani as the earliest comb type in Birka, dating from the 9th century into the first half of the 10th century (Ambrosiani 1981, 21 ff.). Its distribution ranges from Staraja Ladoga in the east to Dublin in the west (Ambrosiani 1981, 22). Within this type the lemniscate (∞) is a commonly used motif. This has been recognized by scholars dealing with Viking Age combs, and the traditional interpretation has been that these combs originate from Frisian areas (Arbman 1937, 238; Wilde 1939, 76; Jankuhn 1943, 154; Hübener 1953, 186; Andersen *et al.* 1971, 144). However, with the help of ZooMS some of the lemniscate combs have been identified as made of reindeer antler (Fig. 5 – Rijkelijkhuizen 2012, 669; Ashby *et al.* 2015, 689) which makes a Frisian origin for these combs unlikely. On the contrary,

this new evidence supports Ambrosiani, who argued that type A combs are of Scandinavian origin. Arguments for this interpretation are a supposedly long Scandinavian tradition in form and ornament of the A1 and A2 combs. Furthermore, it has been argued that the flat and broad shape of the comb's connecting plates is a natural consequence of the use of elk antler, which is flatter than antler coming from red deer. Finally, in England type A combs have only been found in the north, which could suggest that they were brought to England from Scandinavia rather than the continental coast area (Ambrosiani 1981, 32 ff.).

Discussion and conclusion

In order to trace networks of interaction and the role of artefacts therein, archaeologists must deal with the “black-box” problem: knowing only inputs and outputs (at best), are we able to reconstruct the components and composition of a network hidden in between (Sindbæk 2013, 76)? For the study of combs, this is especially true. Based on construction method and decorative patterns, it is extremely difficult to point to a certain origin for a comb. Furthermore, unlike the finds from Birka, most combs are not found in graves but in deposited cultural layers, which makes it almost impossible to reconstruct the social biography of the comb.

Based on the raw materials and decorations studied for this article, a uniform “comb culture” seems to have existed on a certain level in the Viking Age. In all three of the emporia, the most easily available antler—red deer for Dorestad and York and elk for Birka—was the raw material of choice, since it was superior to bone in terms of material characteristics. Decoration was carried out using the same techniques and using a large variation of roughly the same geometrical patterns. However, some trends in decoration can be identified, which could indicate local traditions (Ashby 2013). In York, the use of incised lines in various patterns is a more dominant decoration, compared to ring-and-dot; whereas in Birka and especially Dorestad, it is the opposite (Fig. 4).

A new opportunity of analysis is the use of ZooMS to identify the raw material of combs. The use of this method has provided interesting results, especially with the identification of reindeer antler on combs that have been found far outside the natural environment of reindeer herds in the Viking Age, e.g. Ribe, Aggersborg, Aarhus and Dorestad. In Aarhus and Aggersborg it was found that no less than one in four combs

was made of reindeer antler (Ashby 2015, 694). Perhaps more importantly, ZooMS has identified reindeer antler waste fragments in Ribe, where no reindeer occurred in the natural surroundings (Ashby *et al.* 2015, 688). So far, the use of reindeer antler seems to be especially prominent among combs of Ambrosiani’s type A, with the incised double lines along the edge and a ring-and-dot pattern in the middle. A special category within the type A combs are the lemniscate combs, whose supposed origin from Frisia seems to be rather unlikely since at least two of them have been identified as reindeer antler (Fig. 5).

Perhaps the most significant contribution of ZooMS will be to the old discussion of itinerancy versus locality. The dominant interpretation following Ambrosiani (1981, see also Christophersen 1980b) argues for travelling comb makers due to the relatively small amounts of production waste on most sites; while new research pioneered by Ashby (2015, 259 ff. for a summary) challenges this idea based on the supposed existence of local fashions and regional manufacturing traditions, as well as practical arguments against itinerant comb making (Ashby 2015, 260; Rijkelijkhuisen 2011, 204). Part of this debate concerns the question of whether comb making was “surely in professional hands and therefore demanded a year-round supply of raw materials” (MacGregor 1978, 46) or a part-time activity (Ulbricht 1978, 138). Other scholars have argued that interpretations based on absolute amounts of production waste are insignificant—because a large part of the material gets lost due to post-depositional factors—and that we should instead focus on the presence, or absence, of stages in the manufacturing process (Tweddle 1990, 37 f.).

So, what is more likely—are combs local products or objects of trade? And if they were traded, were they finished products taken by

merchants, or were the merchants and artisans working and selling their products in different places? If combs were produced locally, one would expect concentrations of debris from (semi-)permanent workshops (Ambrosiani 1981, 40). For both Dorestad and York, small amounts of production waste are found all over the towns (Tweddle 1990, 38; van Es and Verwers 2015, 334 ff.), suggesting a more itinerant production of combs (Ambrosiani 1981, 40). Furthermore, the finding of combs made of reindeer antler in Dorestad suggests they were produced by comb makers from Scandinavia who took the raw material with them. However, given the strong connection between Dorestad and the north it is just as likely that a northerner travelled to Dorestad and lost his or her comb there.

Several practical concerns have been raised that would argue against itinerant comb making. Travelling over long distances is deemed to make “little ergonomic sense”, and impose a high value on an individual comb. Furthermore, the need to acquire raw material on a market and spend up to one day per comb on manufacturing the combs seems hardly profitable (Ashby 2015, 260). Moreover, Ashby proposes that comb making might have been tied to the estate of elite magnates and kings, and that the artisans might not have enjoyed unlimited mercantile freedom (Ashby 2015, 260; cf. Cnotliwy 1973, 320). However, I think that the widespread distribution of production waste related to bone and antler craft in virtually every Viking Age town argues against this supposed connection between bone and antler craft and elite estates, at least in north-western Europe and Scandinavia. Other critiques against itinerancy include the fact that comb makers would need water for soaking the antler, and that the artisan would need to bring their tools and a supply of raw material with them (Rijkkelijkhuizen 2011, 204). In my opinion, these arguments are easily dismissed; water is

available virtually everywhere, and the tools of a comb maker can easily be brought in a bag, especially when travelling by boat or with a draught animal. Raw material could also be packed or acquired at a market. So even though bringing tools, purchasing raw material locally and spending some time on the spot for creating the combs might not seem the most economically efficient, Ashby’s argument that social and symbolic considerations might be equally important as efficiency could also be used in favour of itinerancy (Ashby 2013, 198).

To further advance research on the nature of comb making and the distribution of combs, more research is needed in a broad north-west European perspective. Furthermore, the potential of ZooMS should be utilized not only on a larger scale, but also with different research questions in mind. Examples from Aarhus, Dorestad and other places have already shown that combs made of reindeer antler are present far outside the natural environment of wild reindeer. This can easily be explained in the frame of our knowledge, regarding the Viking and early medieval European world. A network of emporia connected large parts of northern Europe, and nodes like Dorestad would have had dozens of visitors from Scandinavia and other parts of Europe.

To truly build new knowledge, ZooMS should be used not only on complete combs but also on production waste and half-finished combs. This has been done recently on material from Ribe, Aggersborg and Aarhus in Denmark, and resulted in the identification of reindeer antler waste material consisting of tine tips, burrs, as well as part-worked blanks in Ribe (Ashby *et al.* 2015, 688). This is a significant discovery, since it strongly suggests that reindeer antlers were brought to Ribe as complete antlers for working. Moreover, strontium isotope analysis has recently shown that as much as 87% of the analysed red deer

antlers in Hedeby were probably imported (Becker & Gruppe 2012, 258). Considering that most of the imported antlers there have elevated $^{87}\text{Sr}/^{86}\text{Sr}$ isotopic ratios which indicate north-to-south trade, the authors suggest that these red deer specimens were imported from the Scandinavian area (Becker & Gruppe 2012, 258). Towns like Kaupang in southern Norway were in the vicinity of the subarctic highlands and could have functioned as hubs for raw materials from the north, such as soapstone, furs, iron and possibly also red deer and reindeer antlers (Skre 2008b, 353).

A final suggestion for future research is to always analyse and publish riveting techniques. Previous research has suggested that riveting can be interpreted as a technique heavily influenced by local traditions (Riddler *et al.* 2012; Ashby 2013), and therefore combs should be analysed for riveting techniques; a good example is the classification developed by Ashby (2009) and applied in one of the more recent publications from Dorestad (Rijkelijkhuisen 2012, 653 ff.). If archaeologists publishing their comb material will maintain the standards and new approaches to analyse this classic artefact, a clearer picture should emerge regarding the nature of Viking Age comb making.

Acknowledgements

Thanks to Peter Norris assisting with English language revision and Paulina Blaesild for her advice and support during the writing process. Thanks also to Dr Arno Verhoeven from the Amsterdam Centre for Ancient Studies and Archaeology (ACASA) for giving me the opportunity to work with combs from the Netherlands during my B.A. thesis; this sparked my interest, without which I would not have been able to complete this article.

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