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**The Sound of Bones**

**Proceedings of the  
8<sup>th</sup> Meeting of the ICAZ Worked Bone Research Group  
in Salzburg 2011**



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1999 – 2<sup>nd</sup> meeting – Budapest (Hungary)

Choyke A.M. / Bartosiewicz L. (eds.) 2001: *Crafting Bone: Skeletal Technologies through Time and Space – Proceedings of the 2<sup>nd</sup> meeting of the (ICAZ) Worked Bone Research Group Budapest, 31 August – 5 September 1999*. British Archaeological Reports, International Series 937. Oxford

2003 – 4<sup>th</sup> meeting – Tallinn (Estonia)

Luik H. / Choyke A.M. / Batey C. / Lougas L. (eds.) 2005: *From Hooves to Horns, from Mollusc to Mammoth – Manufacture and Use of Bone Artefacts from Prehistoric Times to the Present – Proceedings of the 4<sup>th</sup> Meeting of the ICAZ Worked Bone Research Group at Tallinn, 26<sup>th</sup>–31<sup>st</sup> of August 2003*. Muinasaja teadus 15. Tallinn

2007 – 6<sup>th</sup> meeting – Paris (France)

Legrand-Pineau A. / Sidéra I. / Buc N. / David E. / Scheinsohn V. (eds.) 2010: *Ancient and Modern Bone Artefacts from America to Russia. Cultural, technological and functional signature*. British Archaeological Reports, International Series 2136. Oxford

2003 – 7<sup>th</sup> meeting – Wrocław (Poland)

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edited by:

Felix Lang

Salzburg 2013

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# Horn and Hoof – Plastics of the Past

## The Use of Horn and Hoof as Raw Materials in the Late and Post-Medieval Periods in the Netherlands

Marloes Rijkelijhuizen

### Abstract

The use of horn and hoof is attested in historical and archaeological sources. Horn and hoof were important raw materials in the past and often used for object manufacture. However, horn and hoof are keratinous materials and degenerate much faster in the soil than bone or antler, and therefore our information on the trade in and craft of these materials is scant. These materials remain only in favourable, usually wet, conditions. For this reasons, the scale and character of the trade and craft in horn and hoof is largely unknown. In this paper, the evidence for horn and hoof working in the late and post-medieval period in the Netherlands will be discussed. Both historical and archaeological sources, such as objects made from horn and hoof, as well as waste fragments, were researched.

**Keywords:** horn, hoof, the Netherlands, medieval, post-medieval, trade, craft

### Identification of horn and hoof

Horn and hoof are both keratinous materials and can be identified by looking at both structure and morphology (Rijkelijhuizen 2008). The term horn is used for the complete outgrowths of, for example, cattle, sheep or goat, but also for the raw material used to manufacture objects for use. In general, we speak of ‘horns’ when we mean the complete outgrowths, consisting of a bone horn core with a keratinous sheath and of ‘horn’ when we mean the raw material which consists of the keratinous sheath only. For the manufacture of objects, the horn core was separated from the keratinous sheath and the latter was used and processed in many different ways.

Horn can be identified and distinguished relatively easily from other keratinous material such as tortoiseshell. Horn and tortoiseshell both consist of fine layers. However, the layers of tortoiseshell are more tightly packed together (Rijkelijhuizen 2010). These layers are the result of the growing process of horn. Horn is formed from the epidermis, which dies and forms into a hard (and dead) keratinous material at the base of the horn core. Although

horn is a dead material, new growth forms at the base of the horns, which continues throughout the life of the animal and therefore the horns can continue to grow. This results in different layers, but also in a fibrous structure, which is recognisable with the aid of a lens or microscope (Rijkelijhuizen 2008). This fibrous structure is absent in tortoiseshell.

Horn and tortoiseshell are easily distinguished, but the identification of hoof is more problematic. The hoof of an animal also consists of a bone, the third phalanx, with a keratinous sheath which covers the outer side of the hoof. Cattle are even-toed animals and have two hoofs on each leg. Horses are uneven-toed animals and have one hoof on each leg. Horse hooves are therefore bigger, and larger objects can be made. The properties and structure of horn and hoof are similar, and both materials cannot always be easily distinguished from one another. Hoof also has a fibrous structure, compared to that of horn.

Only one archaeological find, a comb from excavations in Amsterdam, could positively be identified as hoof (Fig. 1; Rijkelijhuizen 2004). In this





Fig. 1: Comb made of horse hoof excavated in Amsterdam, 17<sup>th</sup> century (inv.nr. ANJ-1-3). Collection: Office for Monuments and Archaeology, Amsterdam (BMA). Photograph: Anneke Dekker, University of Amsterdam.



Fig. 2: 16<sup>th</sup> century inkpot excavated in Middelburg. Photograph: Marloes Rijkelijhuizen.



Fig. 3: Horn spectacle frames from Amsterdam, 18<sup>th</sup>/19<sup>th</sup> century (inv.nr. NDK-2793-9). Collection: Office for Monuments and Archaeology, Amsterdam (BMA). Photograph: Marloes Rijkelijhuizen.

case, the tubules and lamellae, which are present on the inner side of a horse hoof, were visible. These features were flattened before this material was used (Rijkelijhuizen 2008).

When horn or hoof is not modified too much, and the shape and size is not altered, it is possible to identify species. In some cases, based on the size or shape of an object, some suggestions on the species or provenance of the material can be made. Largely modified horn objects cannot always be identified at species level.

### Properties and manufacturing techniques

Important properties of horn are its availability and the ability to process it by different methods. Dry, it can be cut, sawn and turned on a lathe. It is also thermoplastic, which means that it can be reshaped by using heat. The horn sheath, which is largely hollow except for the solid tip, can be cut open and flattened. The properties of hoof are less well-known, but to a certain extent it is comparable to the properties of horn. It can also be reshaped with heat, but apparently this is less easy than with horn.

Horn is a strong and flexible material and was processed into many items (Hardwick 1981; Schaverien 2006). A complete horn could be used as a tool; a blowing horn, powder horn, drinking horn or, with a few adjustments, turned into a tool which was used to apply decorations to pottery. The latter was found in Amsterdam from the post-medieval period (inv.nr. NDK-547-1; Rijkelijhuizen 2004). Guild horns or other ‘drinking’ horns are mostly present in museum collections, usually set in precious materials. A more common tool, which was made of a part of the horn, is the so-called shoehorn. These shoehorns still exist, and nowadays are made of plastic, but the name shoe‘horn’ still recalls the original raw material used to manufacture these items. A 17<sup>th</sup> or 18<sup>th</sup> century shoehorn has been excavated in Amsterdam (inv.nr. BLS-9; Rijkelijhuizen 2004).

The solid tip could be turned into small items, or used to make knife handles. With only little adjustment, the part of the horn including the solid tip and the hollow part could be used to make beaker-shaped objects. Inkpots, for example, were often manufactured from this part of the horn (Fig. 2). A unique find from Amsterdam is a horn spectacle frame (Fig. 3). Even nowadays, horn is used to manufacture items of use. The train conductor’s whistle is still made of real horn.

## Obtaining raw material

### Tanners and horn workers

Although horn could be obtained from butchers (Albarella 2003, 77), a connection between tanners and horn workers is often mentioned. Evidence that consisted of large amounts of excavated horn cores, or horn cores and foot bones is generally interpreted as tanner's waste. The horns, or part of the skull and/or the foot bones, were left attached to the hides to prove the species and age of the skinned animal. Those were removed before the skin was tanned. It is assumed that the horn worker could obtain the horn from the tanner, but it is difficult to find evidence to connect the two crafts.

Excavated Dutch and Flemish sites, which could be identified as tanneries by the excavated tanning pits, showed no direct evidence of horn working (Ervynck 2011; Ervynck et al. 2003; Prummel 1978; van Dijk 2006; Zeiler 2000). There are no sawing traces on the horn cores present, which could indicate the removal of the keratinous sheath for horn working, and there was no evidence that the horn was sold for horn working. However, removing the keratinous sheath by rotting or soaking it would leave no traces. Another feature of the excavated horn cores observed are holes or nails driven through the horns (Ervynck 2011; Ervynck et al. 2003; Prummel 1978; van Dijk 2006). It is possible that these holes were made for hanging the carcass or skin, but it was of no use to the tanner (Prummel 1978). These holes, however, would prevent the further use of the keratinous sheath.

Did secondary use of horn take place at the tanners' sites? The raw material was dependent on the tanner's choice. The choice of the tanner could differ from the choice of the horn worker and this should be researched in more detail. A horn worker would prefer the larger horns from bulls, or especially oxen from breeds with long horns. Albarella (2003) states that horn was probably worked on a small scale, and was of less importance than hide working, but horn working is difficult to grasp. The horn worker could obtain the horn from a butcher or tanner, with or without the horn core, and could remove the horn core through rotting, which leaves no traces, or by sawing. Only in the last case is the horn working craft visible to archaeologists.

Although it is likely that the horn could have been obtained from a tanner, evidence for this assumption is lacking. It is not certain whether the horns were separated from the horn cores by soaking or rotting, which leaves no traces, or that the horn worker did not (always) obtain his horn from

the tanner. Perhaps horn working was not traceable, or not an important craft in certain periods of the Middle Ages.

### Trade

Apart from whether the horn was obtained from a butcher or tanner, the origin of the horn is another research question. The meat and/or hides could have been imported over shorter or longer distances. Importing meat 'on the hoof' happened on a large scale in Europe, and the importation of horn could have taken place in combination with that of meat and/or hides.

At the early medieval town of Dorestad, archaeozoological research provided evidence for the trade of goat hides to Dorestad. Large amounts of goat horns and a few cranial fragments were found, other post-cranial elements were absent (Prummel 1983). This is also known from other sites in Europe, such as in England (Albarella 2003). Apparently, a trade in goat hides existed in Europe, although the provenance of the goat hides and the scale of this trade is unknown. In order to find out more about different aspects of this trade, more research is necessary. The question of whether or not horn was used also remains unknown (Albarella 2003).

Besides locally obtained horn, or the use of secondary horn from short-distance trade in meat or hides within Europe, horn was also obtained from exotic places. A shortage of material or the lack of large horns could be overcome by means of long-distance trade. It is possible that hides from buffalo or other species were traded with the horns attached, but it is known that horn was also imported as a primary trading good. Buffalo horn was traded, for example, from Asia to Europe.

The importing of horn from Asia to the Dutch Republic probably started in the 16<sup>th</sup> century. The Dutch obtained it from Spanish or Portuguese traders. During this period, the Spanish and Portuguese traders dominated trade with Asia. From the end of the 16<sup>th</sup> century onwards, the Dutch started to trade directly with Asia and other regions, and they could obtain the horn directly from Asia without having to use the Spanish and Portuguese as intermediaries. Horn from the Asian water buffalo without horn core was traded to the Dutch Republic (Mohr / Hayen 1967). Because the horn core and horn sheath were separated before shipment to decrease the weight load, it is difficult to find evidence for this trade. Historical sources and occasional finds reveal this trade, but the exact scale is unknown. Some buffalo horn has been found in the North Sea (Fig. 4),



Fig. 4: Tip of a buffalo horn from the North Sea. Photograph: Marloes Rijkelijkhuisen.

but when the horn has been intensely modified and made into objects, it is difficult to identify species. Sometimes, very large objects of horn are found, which must have been made from the large horns of species that do not originate from the Netherlands.

However, not all the imported horn came from Asia. Historical sources also indicate an inter-European trade in horn. Cattle with large horns do not originate from the Netherlands, but several species with large horns breed in southern and eastern Europe. Horn was imported from Calis Malis (the island Cadiz, Spain) to Rotterdam, as is mentioned in an early 17<sup>th</sup> century document, although it is uncertain whether this was local horn or Asian buffalo horn. Nevertheless, finds of horn and horn cores that probably originated from southwestern European countries have also been found in the North Sea (Mohr / Hayen 1967). Apparently, horn and horn plates from England were sought after in Europe for their quality (Hardwick 1981, 13; Poller 1980). According to Schaverien, the English imported horn from all parts of the world and re-exported horn or horn plates within Europe (Schaverien 2006, 22; Hardwick 1981, 13). Inter-European trade also consisted of the re-export of horn and horn plates from Amsterdam to other European countries (van Nierop 1915). However, the exact scale of this trade, and which species were used remain unknown.

Stable isotopes can be used to provenance archaeological finds and give insight about trading routes. This research was conducted on a very long horn core found in Rotterdam, and the results showed that the animal lived in a central European alpine region. It is possible that this horn was traded with the hide, but the horn was undoubtedly used for object manufacture (Kootker et al. 2010). This research provides archaeological evidence for the inter-European trade in hides and/or horn. However, many questions still remain on the transportation, scale and routes of this trade.

## Craft and industry

### Combined craft – Evidence of craft in the medieval period

Evidence from medieval horn working is scarce, and this craft only leaves traces for archaeologists to find when a horn was sawn from the skull or worked when the horn core was still attached. From the late middle ages a case study of Deventer is presented.

At the Burseplein excavation in Deventer, several sawn horn cores from the 9<sup>th</sup> to 10<sup>th</sup> century AD were found. These sawn horn cores can give some insight into past manufacturing techniques, but the finished objects are decayed. At this site, combs were made, probably by one artisan using several different raw materials. It is possible that he also made other items. Objects were found that dated to the 9<sup>th</sup> and 10<sup>th</sup> century: an antler container (Rijkelijkhuisen 2011b), composite bone and antler combs (Rijkelijkhuisen 2011a), a bone knife handle, a bone skate and a few small items made of bone. Horn objects were not found due to the unfavourable soil conditions.

Primarily, the first stage of horn working could be reconstructed. At this site, waste fragments of bone, antler and horn working have been excavated. The site was situated on a river bank, a place where tradesmen and craftsmen were probably established. Waste fragments from bone working were found in contexts from the 9<sup>th</sup> century AD until probably the 14<sup>th</sup> century AD. The antler and horn core waste fragments date to the 9<sup>th</sup> and 10<sup>th</sup> centuries AD. These finds provide a small window into this medieval craft.

Sawn horn cores of cattle, goat and sheep have been excavated. In order to receive more information on the possibility of goat hides and/or horns having been imported to this location, further zoo-



Fig. 5: Sawn cattle horn core from Deventer. Collection: Archeologie Deventer. Photograph: Marloes Rijkelijkhuisen.

archaeological research needs to be done. The sawn horn cores merely show the craftsmen's raw material and the working method. Most of the fragments came from cattle horn cores (eleven out of seventeen). Besides four larger parts of the horncores, two sawn tips and two fragments from the proximal end of the horncore with part of the skull attached (Fig. 5), three rectangular pieces were present. These fragments show the primary stage of horn production. First, the horns were sawn from the skull at the base of the horn core (Fig. 5). The horn layer at the proximal end is very thin and was not used; the horns were sawn above this thin horn. At the next stage, the horns were divided transversely into different parts. The solid tip was removed and could have been used for small items. The middle part of the horn was then divided into rectangular pieces without removing the horn core, which resulted in rectangular sawn pieces of horn core left over as waste fragments (Fig. 6). The size and shape of the obtained pieces of horn are apparent, the pieces measured between 7.5 to 8.5cm in length and 2.5 to 3cm in width.

At this site, besides the cattle horn core fragments, two sawn sheep horn cores were found, two of goat (Fig. 7) and one horn core fragment could be identified as sheep or goat. Although it is obvious that sheep and goat horn were processed, it was probably less important than the horn of cattle. Cattle horn is much larger and sheep horn is less practical because of the deep grooves. Goat horn is quite smooth, but much smaller than cattle horn. Horn cores of goat with saw marks have been found at other medieval sites as well, such as Dorestad (Prummel 1983), but also at post-medieval sites, for example at excavations in Amsterdam (Rijkelijkhuizen 2004).

This method of sawing the horn while it was still attached to the horn core is also known from later periods. At a 16<sup>th</sup> century site in Groningen, the horns were sawn transversely and divided into several parts, comparable to some of the finds from Deventer. However, rectangular pieces were not present, and some of the horn cores from Groningen still had the keratinous sheath attached (Wieringa et al. 2001). At several other sites in Europe, this method was also used, for instance at the medieval town of Schleswig. The horn cores were also divided into transversely sawn parts, and no rectangular pieces have been excavated. The horn tips were regarded as waste and were also found at the site. It is assumed that the finished products were combs. Horn of sheep and goat were probably also used as a raw material (Ulbricht 1984). Another example is

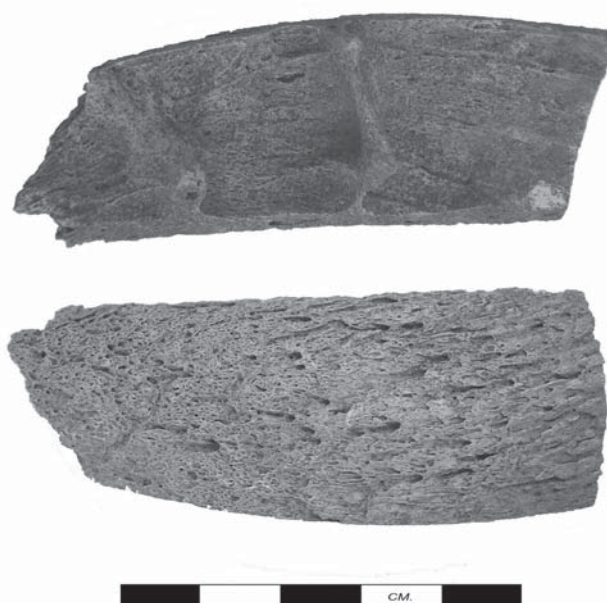


Fig. 6: Rectangular piece of cattle horn core from Deventer, 900-925 AD. Collection: Archeologie Deventer. Photograph: Marloes Rijkelijkhuizen.



Fig. 7: Sawn goat horn core, excavated in Deventer, 850-900 AD. Collection: Archeologie Deventer. Photograph: Marloes Rijkelijkhuizen.

the sawn horn cores found at Anglo-Scandinavian York. These have been found together with waste fragments from bone and antler working. At this site, another method present was to remove the horn from the horn core. The horn was sawn, but the horn core was not completely sawn, only grooved circumferentially (MacGregor / Mainman 1999).

Horn could have been used in the medieval period for the manufacture of combs, as suggested for the Schleswig finds. Horn combs could be made of one piece or as composite combs. The first type is difficult to trace archaeologically, the second only if it has been made of different raw materials. Ashby describes composite combs made of a horn tooth plate with bone or antler side plates, which is common from the 10<sup>th</sup> to 12<sup>th</sup> centuries (Ashby 2011, type 4). A few of these bone or antler side plates have been found in the Netherlands (at Vlaarding and Rotterdam; unpublished), but their occurrence



Fig. 8: Horn comb, excavated in Amsterdam, 17<sup>th</sup>/18<sup>th</sup> century (inv.nr. WLO-327-15). Collection: Office for Monuments and Archaeology, Amsterdam (BMA). Photograph: Anneke Dekker, University of Amsterdam.



Fig. 9: Horn waste fragment from a knife maker in Den Bosch. Collection: Bouwhistorie, Archeologie & Monumenten 's Hertogenbosch. Photograph: Marloes Rijkelijhuizen.

has not yet been fully researched. Another possibility is the use of horn for window and lantern panes. Horn has been used since Roman times for this purpose, and it was cheaper than glass (Schaverien 2006, 228-238). Archaeological evidence for this use is difficult to find, and historical evidence only comes from later periods (see below).

Although it was probably a raw material commonly used in the medieval period, probably no large-scale craft activities in horn working existed in the Netherlands and it was a combined craft. No specialised 'horn worker' existed, but horn was

worked together with other materials, such as bone and antler. As a raw material, it seemed less important than antler, but this cannot be confirmed, because the lack of evidence from horn working could be the result of unfavourable conditions in the soil and the method of separating the horn core from the keratinous sheath. The exact products manufactured still remain unknown, but horn could have been used by comb makers. Towards the end of the Middle Ages, specialised crafts evolved, but there is presently no evidence for late medieval guilds or 'horners' combining forces in this region, as 'The Horners' Company' in England did (Hardwick 1981, 164; Schaverien 2006, 10). More research is necessary to establish when specialised crafting of these materials began. From the post medieval period onwards we have more archaeological finds of horn objects and additionally historical sources are present. Crafts developed into specialisation and industrialisation.

#### Towards specialisation – post-medieval craft

As the process of urbanisation and the development of a market economy continued, specialised crafts developed. The emergence of specialised crafts already started in the Middle Ages, and progressed in the post-medieval period. The most common article made from horn in the post-medieval period is the comb (Fig. 8). The hollow part of the horn was cut open and flattened by using heat. Warm water and presses were probably used to alter the shape of the horn into a flat sheet. Two comb makers in 17<sup>th</sup> century Amsterdam took on an apprentice especially for the flattening of horn plates, while other apprentices made combs of various raw materials such as ivory, tortoiseshell and horn (van Dillen 1974). Hoof is never mentioned in historical sources as a raw material for comb makers during this period, but at that time the word 'horn' was used to describe both horn and hoof. Therefore, hoof is rarely mentioned in historical sources. Only in early modern historical sources is hoof specifically mentioned. In 19<sup>th</sup> century books and documents, the use of hoof for the manufacture of combs has been described. Hoof was used for this purpose in the Netherlands, but also in other European countries (Bleekrode et al. 1854; Unknown writer 1841; Weiland 1802).

Specialised comb makers in the 17<sup>th</sup> and 18<sup>th</sup> centuries still used several raw materials to make their combs. Some of them specifically called themselves ivory comb makers, but others used horn (and hoof) besides their primary materials of ivory and

wood (Rijkelijhuizen 2009). This also accounts for knife makers, who principally used ivory and wood, but also bone and horn. A 16<sup>th</sup> century knife maker from Den Bosch seemed to have produced almost exclusively horn and wooden handles; no other raw material was found, only a few bone waste fragments. In his cesspit, waste fragments and semi-finished products of wood and cattle horn and horn cores have not been found! Knives manufactured in Den Bosch were famous, and during this period, knives from this city were exported internationally (Rijkelijhuizen 2010; van Genabeek 2012).

In this knife maker's cesspit, fragments of cattle horn, but also of cattle hoof, were excavated. Only the keratinous layer of the cattle hooves were found, the bones were absent from this context. Hoof could be used to make plates for plate handles, but not for solid knife handles, which were made out of the solid tip of horn. The hoof fragments showed no traces of manufacture, in fact, some of the keratin hoof layers were complete (Fig. 10). It is unknown whether the knife maker used hoof for his handles and disposed of these hoof fragments as unsuitable, or if he was swindled by a salesman and found hoof at the bottom of a sack of horn. Another possibility is that the knife maker did not use hoof for knife handles, but for hardening the iron blades. For this purpose, the hoof (or horn) was burnt and mixed with other ingredients into some sort of paste. This paste was put on the iron blade and heated. Then, the whole was cooled down with water, vinegar or urine. Through this procedure, carbon and nitrogen were absorbed by the iron, and it became less flexible and stronger (pers. comm. P.De Rijk; Rijkelijhuizen 2010; Smith / Gnudi 1959; Theobald 1984; van Genabeek 2012).

One of the specialised crafts which evolved was the profession of horn breaker. A horn breaker produced 'broken' or split horn sheets. The horn was flattened and split into several natural growth layers. The result was a translucent thin sheet of horn. These were used as panes for lanterns. Horn was used for lantern panes for a long period of time, because it was less expensive than glass. This profession is known from historical sources, and horn breakers are mentioned in the notary archives in Rotterdam. After one of the horn breakers died, a supply of 'raw' horn and lantern sheets in his workshop was documented, which confirms the usage of 'broken' horn for the manufacture of lantern sheets. The horn sheets could also have been used for so-called horn books. A horn book consisted of a wooden plate with a piece of paper attached to it, upon which the alphabet was written. The paper was



Fig. 10: Cattle hoof from a knife maker in Den Bosch. Collection: Bouwhistorie, Archeologie & Monumenten 's Hertogenbosch. Photograph: Marloes Rijkelijhuizen.

protected by a thin horn sheet (Schaverien 2006, 205-214).

Horn 'leaves' were probably produced in England from the 14<sup>th</sup> century on. Lantern panes were exported from England to the rest of Europe (Schaverien 2006, 234-235). It is not clear when the production of lantern panes in the Netherlands began, but this profession is mentioned in 17<sup>th</sup> century historical sources. At this time, it was a specialised profession that existed in several towns, and the craftsmen took on apprentices. Schaverien suggests that the horn workers in England formed a close community through their association with the guild (Schaverien 2006, 19). The horn breakers in Rotterdam were in close contact and testified for each other. They also had connections with horn breakers in London (Notarial Archives Rotterdam). Nowadays, a 'Hoornbrekersstraat (Hornbreakersstreet)' still exists in Rotterdam. In other cities, horn breakers were established as well, but it was a profession that was only practised in towns.

According to Hardwick, buffalo horn was not used for lantern sheets because of its colour and because it is difficult to split (Hardwick 1981, 20). Hardwick mentions ox horn for the manufacture of lantern panes (Hardwick 1981, 77). The production

of lantern panes is probably closely connected to the inter-European trade in horn and was dependent on the import of large, clear-coloured horn from abroad.

The production of horn sheets was well established in England among the horn workers. It is not yet known when this production started in the Netherlands. At a certain point, the specialised craft of horn breakers also developed in the Netherlands. The horn breakers 'broke' or split the horn for the production of lantern panes. The horn breakers were in close contact with each other, and family bonds probably existed. However, to support these conclusions, more research on this craft and these craftsmen is necessary.

## Conclusions

Although an intensive use of horn as a raw material probably existed during all periods, degeneration in the soil makes the archaeological evidence scarce. Craftsmen could hypothetically obtain the raw material, horn, from the butcher or tanner. The question of whether or not tanners provided craftsmen with raw materials is difficult to prove from archaeological sources. Horn from cattle was mainly used, but sawn horn cores indicate that goat and sheep horn also could have been used for object manufacture.

Much research needs to be done in order to obtain more information on trade in horn (products). Horn trade during the medieval period is largely unknown, although it was probably a secondary product in the meat and/or hides trade. The development of a market economy and the emergence of Dutch trading companies increased trading distances and the specialisation in one raw material, for example the import of buffalo horn as a main product instead of horn as a secondary product of the hide trade. Long-distance trade is known from the post-medieval period, and archaeological and historical sources, and stable isotope research shows that inter-European trade also existed. The importation of horn is difficult to prove, because it was often traded without the horn cores and thus leaves no evidence. Hitherto, the scale and trading routes during this period are also unknown.

Horn can be processed in many ways, because of its thermoplastic nature. Different working methods existed, and the craftsmen used the properties of the raw material to best advantage. Techniques in the medieval period can differ from post-medieval working techniques, but they probably remained largely the same, as sawn horn core finds illustrate.

Evidence from Deventer showed that the horn was cut up with the horn core still attached. However, because medieval horn objects are rarely found, and if the keratinous sheath was removed from the horn core by rotting or soaking, not much evidence of this craft remains. In Deventer, different kinds of horn, bone and antler were probably worked by the same craftsmen, and, possibly, mainly combs were manufactured. The 'horn worker' as a specialised craft did not exist in the medieval period, but rather it was a combined craft.

The process of urbanisation and the development of a market economy in the medieval period were responsible for the development of specialised crafts. Professions such as comb makers or knife makers emerged, craftsmen who were specialised in (mainly) one specific object. Some of them also specialised in a certain raw material, but others used different raw materials in their workshop. They specialised in objects and/or raw materials, although the division was not as strict. Comb makers and knife makers also sold other small products.

It is uncertain when the transition to specialised horn workers in this region evolved. Specialised horn workers who produced semi-manufactured objects are called 'horn breakers'. These show the ultimate specialisation in raw material and semi-fabrication. 'Broken' horns were used as lantern panes, for which the different layers of horn are split to obtain thin translucent sheets. Obviously, horn breakers were a closely connected group, but this needs to be researched in more detail.

The evidence for the use of hoof in the manufacture of objects is scarce, but it was used to make combs in the post-medieval period. A single archaeological find from Amsterdam forms the only archaeological evidence. Hoof was described as horn in historical sources, which makes it even more difficult to trace. Horn and hoof were also used for industrial purposes, such as the production of glue, the hardening of iron and several other industrial purposes. Slowly, new semi-synthetic and synthetic materials replaced the natural raw materials. The flexible horn combs are now made of synthetic materials, but colours and patterns are still used to imitate real horn.

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