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FUR IN BIRKA
An examination of hair residue on penannular brooches

This article deals with the identification of hair found on Viking Age penannular brooches from Birka, Björkö parish, Uppland. The hair was covered with corrosion from contact with metal. The corrosion was dissolved using an EDTA solution. The results show the preserving effect of corrosion on ancient hair. The hairs were identified as to type by studying size as well as the shape of the outermost layer, the cuticle, and correspondance with recent reference material. Examination of the penannular brooches and the position of the hair residues show that the hairs most probably come from the borders of cloaks. All the surviving beaver hair is underhair which indicates that these cloak trimmings were made of pulled beaver fur, i.e. the fur had been finished off by pulling out the overhairs. Trade in pulled beaver fur is confirmed by written sources from the 9th and 10th centuries. Pulled beaver fur is interpreted as a status symbol: it might also have served as a symbol of rank.

Introduction

Methods for distinguishing between the hair of different animals have been in use by natural scientists since the 19th century. This expertise has come to good use within the textile industry where, moreover, quality demands have led to further refinements in this special science.

Although the methodology has been available, it has not been previously applied in archaeology in any consistent manner. This can possibly be attributed to the difficulty of transferring the accepted scientific analysis methods directly to prehistoric hair: analyses of recent hair are based on the study of intact overhairs where several different criteria can be used for identification, whereas the archaeological source material is often fragmentary and to an especially high degree this is true of organic remains. In cases where hair has been preserved, it has been a question of the odd section of overhair or underhair. Another great difference between recent hair and ancient hair is the type of dirt that coats the hair. Recent hair is mainly only in need of grease-removal (Teerink 1991:12). However ancient hair to survive is usually coated with corrosion caused by contact with metals, which requires a different type of treatment.

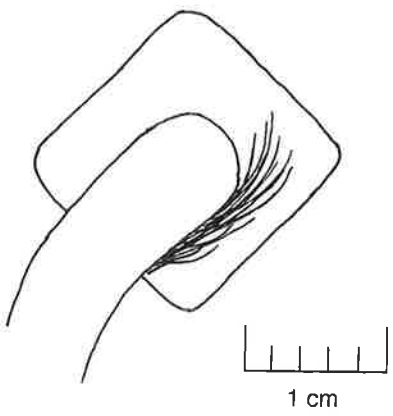

Fig. 1. On brooch Bj 605b the hairs were found underneath the end knob.

Material

The aim of my study was to find out whether or not it would be possible to identify, document and determine by species the hairs found on Viking Age brooches.

During examination using a hand magnifier, of the 73 available penannular brooches from Birka, I found that 23 of them carried hair or some similar fibre. Examination by microscope at 66× magnification, confirmed these as hair. On some brooches, the hair was found to be uncoated and fixed to the brooch only by being partly trapped in a layer of dirt or corrosion (fig. 1). On other brooches, a few hairs were wedged into the pin's coil. On ten brooches, the hairs were totally encased in corrosion. Hair samples were taken from a total of 13 penannular brooches and labelled by brooch number, which is the same as the inventory number of the source grave (table 1).

The study involved preparing and examining the hairs in a scanning electron microscope (SEM). The results were correlated with recent reference material, the major part of which consists of hair from species previously identified at Viking Age Birka. Finally the results of the

study were related to the penannular brooches on which they were found. Particular emphasis was placed on establishing the function of the hair in the dress.

Hair identification

General structure

A hair is made up of four structural units, three of which are keratin layers which can all be used for identification (fig. 2). The innermost layer, the *medulla*, is composed of rows of shrunken cells. Together with surrounding air-filled spaces, they form characteristic structures, typical for each species. The study of the medulla requires comprehensive preparation aimed at replacing the air-filled spaces with, for instance, paraffin. The work is difficult also because the medulla is often dark in colour, and since useful structures can be seen only in the widest parts of the hair (Teerink 1991:8).

Cortex is the main component of the hair and consists of a compact layer of oval cells which surround the medulla. Under the microscope, this part forms a homogeneous mass and its cell structure, as opposed to that of the medulla, is impossible to identify. On the other hand, its relative thickness is comparable with the total width of the hair.

The *pigments* of the hair are found in the cortex where they take various diffuse forms. In some cases, however, accumulations of granules are found which may be of value for identification (Hausman 1920:501), though more recent research has questioned this method since variations are considerable (Teerink 1991:8).

The outermost layer of the hair is composed of thin, colourless scales forming the *cuticle*. The scales have various sizes and forms which form the basis for classification and identification by reference to a comparative material.

The hair profile is divided into two sections with a thickening part towards the tip, called the shield, and a thinner part towards the base of the hair, the shaft (Teerink 1991:5).

Fur animals

The coat of fur-bearing mammals is made up of different types of hair which can be divided into two main groups. There are the long, straight overhairs, or guard hairs, which are often heavily pigmented, and a layer of underwool composed of fine, less pigmented hairs which moreover turn in the growth direction (fig. 3)(Day 1966:202).

Overhairs usually take three different forms depending on factors such as the proportion of the different sections to each other and the shape of the hair as a whole. Furthermore, the structure of the cuticle varies among the different hair types (Teerink 1991:5).

The underhairs are the dominating type of hair in the fur and are, like the overhairs, built up of the three keratin layers. Underhairs are considerably shorter and finer than overhairs, and their main outline is curved, with a less pronounced shield. The cuticle structure of the underhairs can be described as a simplified version of that of the overhairs (Hausman 1920:507; Day 1966:204).

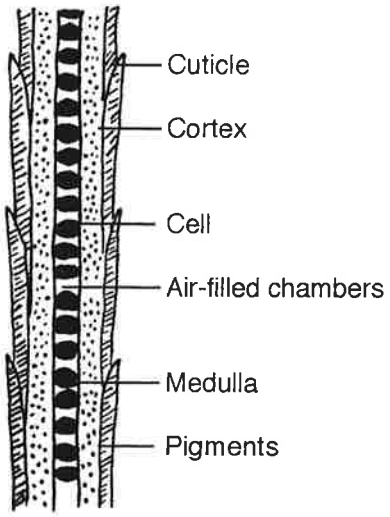

Fig. 2. Schematic representation of the components of the hair (Hausman 1920:524).

Some scientists maintain that an analysis of overhairs is the superior method since the underhairs are limited by their simple form and variation (Teerink 1991:12; Day 1966:204). Others are of the opinion that this very simplicity is an advantage to the study since the overhairs are dark in colour, more worn off, and often more difficult to work with (Hausman 1920:509).

The cuticle may show some minor variations. Structure is influenced by the position of the hair on the animal's body. The most distinct structure is observed on hairs from the body proper; hairs from extremities such as legs and tail often show simplified patterns. Examined hairs from young individuals show the same structure as hairs from adult animals, the only difference being that the structure is somewhat less distinguishable. It has not been possible to show any variations due to age, season, food or area of habitat (Day 1966:204).

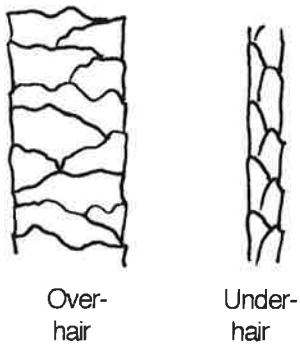

Fig. 3. The structure of the cuticle of the overhair and underhair of skunk. After Hausman 1920, p.524.

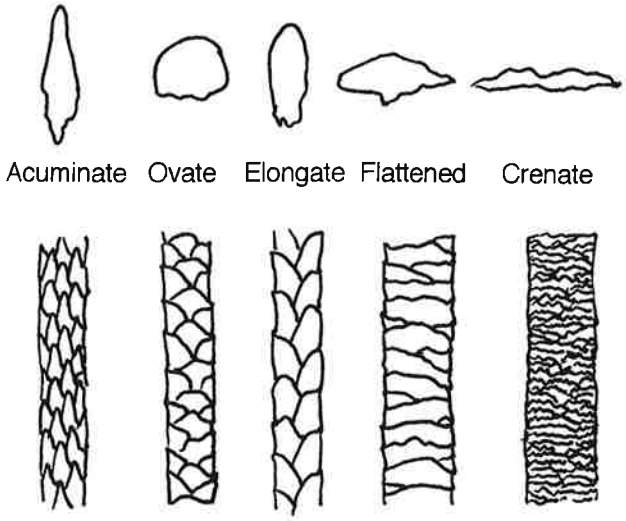

Fig. 4. The imbricate scales include hairs with scales arranged like fish scales.

Classification

In 1920, Leon Hausman published "Structural characteristics of the hair of mammals". This paper introduced the methods and terminology that later came to be generally accepted.

After analysis of the cuticle, the hairs were classified by Hausman under two main groups. The *imbricates* (fig. 4) include hairs with scales arranged like fish scales, i.e. overlapping each other in various ways. This group is divided into five subdivisions according to the form of the individual scale: the ovates (eggshaped), the acuminates (tapering to a point), the elongates (slowly tapering), the crenates (with crenulated edges) and hairs with flattened scales.

Most common are the crenates and the flattened scales. In both cases, the transverse axis is always greater than the longitudinal. The flat, uncrenulated (flattened) scale is somewhat higher than the crenulated one.

The second main type of scale is the *coronal* (fig. 5) which is common in small furred species such as bats and martens. In this type of scale, the hair is completely surrounded by petal or labiate-formed scales. Three subdivisions are determined by the form of the upper edge: simple, serrate and dentate.

A. B. Wildman further developed the grouping of the overall structure of the cuticle patterns, concentrating mainly however on a study of overhairs. The classification is based on a definition of the different field and wave patterns formed by the varying shapes of the scales (fig. 6). Cuticle patterns falling outside the defined types can also be assigned to their correct categories by a combination of attributes.

Cuticle structure is defined with reference to the visible edges of the separate scales and their distance apart which Wildman divides into three positions: close, distant and near. Scale pattern mosaics are also examined and classified according to regularity, i.e. regular mosaic or irregular mosaic.

Very useful are the many wave patterns. "Simple regular wave" describes a continuous wave pattern of uniform length and depth. "Interrupted regular wave" describes a wave pattern comparatively free from disturbances and interruptions, and "streaked wave" describes more irregularity with occasionally extremely large scales.

The wave forms show great variation and often have a characteristic appearance: the crests or valleys may form single or double chevrons, or comb-like forms of different sizes termed pectinate/lanceolate/petal.

Fur animals in the archaeological record

Since no useful reference material was available for analysis of the hairs under study it was necessary to compile one. Species selection is based on the data available on the occurrence of wild fur animal species at Viking Age Birka.

In connection with Agnes Geijer's examination of textile remains, hairs from six graves were analysed and species determined under microscope as follows: beaver in graves Bj 539, 619,956, 968, squirrel in Bj 507 and marten in Bj 557. Hairs found in another three graves were identified with some uncertainty as beaver or marten in Bj 838, bear in Bj 845 and beaver in Bj 987 (Geijer 1938:157–186). Inga Hägg identified beaver fur in grave Bj 543 (Hägg 1974:91).

Hjalmar Stolpe's work on the Birka material mentions a great number of animal species. As regards wild fur animals, bones occured from lynx, elk, reindeer, beaver, marten, wolf, fox, hare and squirrel (Stolpe 1873:56–59). During the excavation of the harbour area of the Black Earth at Birka in 1969–71, 1500 kg of animal

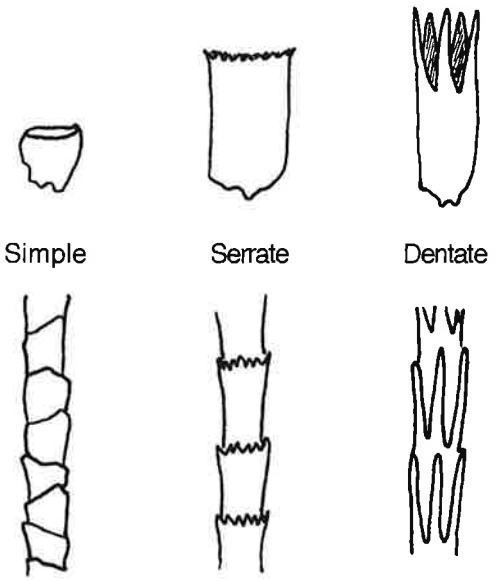

Fig. 5. The coronal scales completely surround the hair.

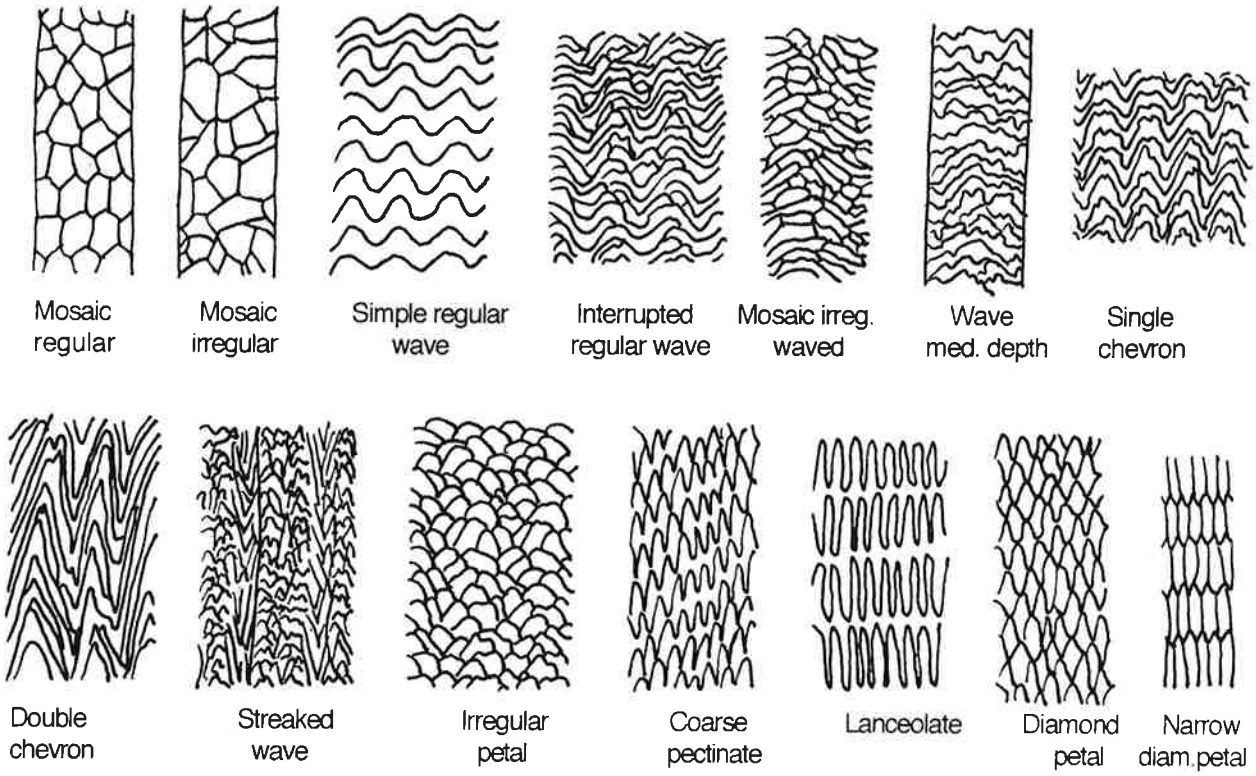

Fig. 6. Wildman's classification of the different scale structures of hair.

bones were found. The wild animal species were determined by the osteologist Elisabeth Iregren who found, in addition to the species identified by Stolpe, bones from ermine, badger, otter and wolverine (Ericsson et al. 1988:84).

In the osteological material examined by both Hjalmar Stolpe and Elisabeth Iregren, bones from squirrel and fox dominate. This is confirmed also by the osteological material from more recent investigations at Birka (pers. comm. Bengt Wigh).

The reference material

Bear, wolf, lynx, fox (fig. 7a). The hair from larger prey differs from that of other species by diameter. The underhair of bear measures c. 30 μm and of lynx c. 20 μm (Hausman 1920:499). The structure of the cuticle in these species belongs to the fish-scale group, the imbricates, where the form of the scales is elongated and pointed, elongates and acuminates. Somewhat smaller hairs are those from fox measuring c. 10–15 μm. The scale structure of fox underhair, save for the first part of the shaft, is formed in the same characteristic manner with pointedly elongated scales.

Marten (fig. 7b), **sable** (fig. 7c), **ermine, otter** (fig. 7d), **polecat, badger.** The underhair in the marten family is finer, except for that of badger which is c. 45 μm in diameter (Wildman 1954:160). The underhair of the other species of the same family are c. 10–15 μm and the structure of the cuticle can be defined as roughly serrated (dentated) scales – coronal/dentate. The size of the underhairs can be compared with the overhairs of the otter (which, on the widest part of the shield, may measure up to c. 160 μm), with the overhair of the marten (150 μm) and with that of the ermine and the weasel (110 μm) (Teerink 1991:39).

Squirrel (fig. 7e), **beaver** (fig. 10b), **hare.** The underhair of both the squirrel and the beaver measures c. 15 μm in diameter, which can be compared with the overhair of the squirrel (c. 60–70 μm) and that of the beaver (c. 80–90 μm). The cuticle on the squirrel's underhair consists of even, horizontally elongated (flattened) scales on the upper part of the hair whereas the lower part is characterized by pointed, vertically elongated scales (acuminates). The cuticle of the hair belongs to the main group of imbricates.

The underhair in beaver fur measures c. 10–15 μm and consists of two different types. In addition to the general type of underhair, which is in the majority, there is also a somewhat coarser hair, the tip of which ends with a sickle-shaped shield, hence referred to as "sickle-tipped" (Wildman 1954:163). Both these forms of underhair are composed of simple coronal scales which develop a simple wave form along the hair (cf. "single chevron"). The edges sometimes have occasional dents. The distance between the edges of the scales falls into the middle position (near). The hair of the hare also measures c. 15 μm, and its structure, like beaver hair, forms a simple wave shape but of considerably greater depth (Wildman 1954:151).

Sheep (fig. 11b). A study shows that the size of sheep hair varies considerably. The variation is not only one of

quality but can also be observed along each separate hair (Wildman 1954:60). Wool hairs previously measured at Birka show a variation between 10 and 80 μm, concentrating on 30–50 μm (Geijer 1938:183). The cuticle on the hair of finer wool shows an irregular wavy mosaic pattern, called "irregular waved mosaic". The scale edges are even and their distance apart falls into a middle position (near).

Method

As previously mentioned, the purpose of cleaning recent hair is the removal of grease from the surface layer of the hair. This is achieved by washing and rinsing the hair in tepid water. In some cases ethanol is used. The hair can be dried by dipping it into pure ether or chloroform (Hausman 1920:518).

The contamination on the samples, in addition to grease and other dirt, was made up of a corrosion coating which wholly or partly covered the cuticle (fig. 8). The first cleaning attempts were made with tepid water, ethanol and ultrasound without visible results. Further attempts were made using a 4% EDTA (ethylenediaminetetracetate) solution with neutral pH. EDTA together with a phosphate buffer attacks the corrosion product without harming the object being treated (Klockhoff 1989:35). The method, which was developed by Birgit Arrhenius at the Archaeological Research Laboratory and has previously been used to clean corroded textiles among other materials (Hägg 1974:4), proved effective also in the treatment of corroded hair. After heating the EDTA solution to approximately 40°C, the hairs were left immersed in the solution for 60–90 seconds, 30 seconds of which, under the influence of ultrasound. The hairs were finally rinsed in distilled water and dried.

The treatment was most successful on hairs that had been in contact with bronze and thus coated with *verdigris*. Iron corrosion generally requires a rougher treatment which is accomplished by using a more concentrated EDTA solution for a considerably longer period of time. An attempt was made to treat a layer of rust, that had remained unaffected after the first effort, for an extended period of five minutes. As a result, the whole rust layer was dissolved and, with it, the cuticle of the hair (Bj 958). After this, no further attempt was made to extend the duration of treatment.

All the hair specimens, except Bj 958, showed some form of visible cuticle after cleaning; some hairs were completely free from coating, were softer and showed a clear structure. Other hairs showed less elasticity and a more diffuse structure. In some cases, the coating had broken up into flakes and showed a very distinct cuticle (fig. 9). This circumstance illustrates the preserving effect of corrosion on hair (cf. Körber-Grohne 1988:74).

After cleaning, the hairs were mounted on a slide holder, coated with gold and examined in a scanning electron microscope. When the cuticle showed subtile structures, photographic documentation was made and the results compared with recent reference material.

Results

Scanning electron microscope analysis shows that the hairs can be divided into two groups according to size. The hair samples Bj 60b, 477, 478, 736, 918, 954 and 956 have diameters of 15–20 μm while samples Bj 587, 605b and 1074 measure 20–30 μm in diameter. Three hair samples (Bj 727, 830 and 958) could not be identified, due to their poor condition.

Variation in cuticle structure and scale shape is slight and mainly comprises two types. The scales in Bj 60b,

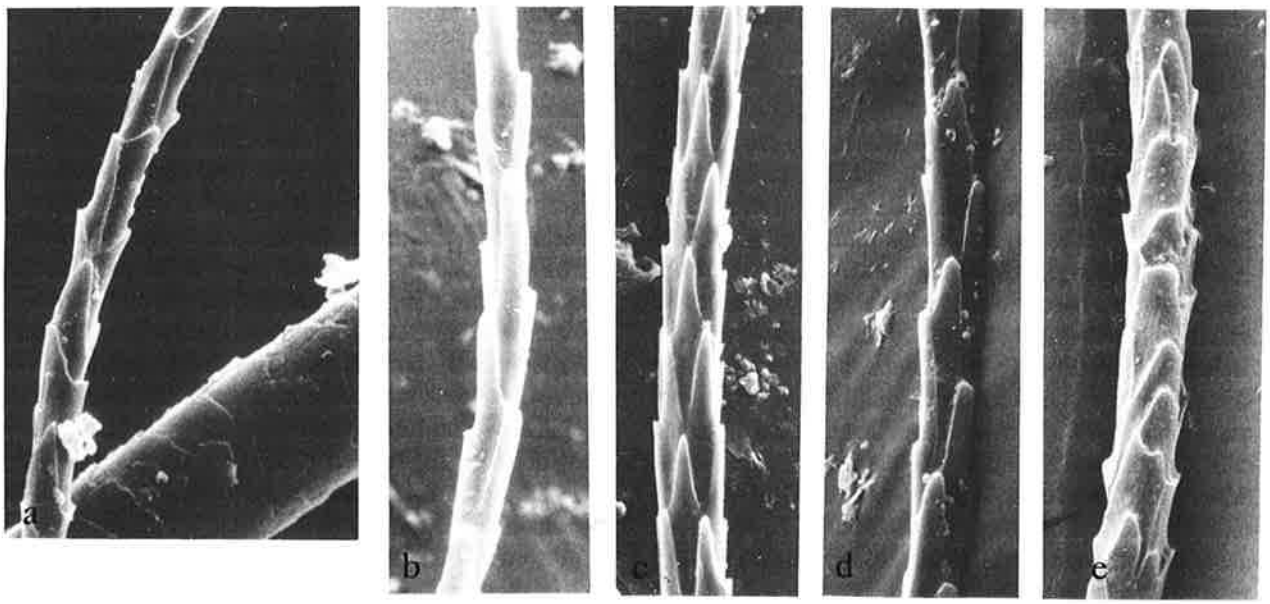

Fig. 7. Underhair from (a) fox, (b) marten, (c) sable, (d) otter, and (e) squirrel (700×).

Table 1. The 13 penannular brooches from which hair samples were taken (listed with identifications) and the remaining 10 brooches carrying hair/fibres (no samples analysed). Due to the poor condition of three samples, no identification was possible to make.

Brooch	Identification of hair sample
Bj 60b	beaver, underhair
Bj 477	beaver, underhair
Bj 478	beaver, underhair
Bj 587	sheep, wool
Bj 605b	sheep, wool
Bj 727	—
Bj 736	beaver, underhair
Bj 830	—
Bj 918	beaver, underhair
Bj 954	beaver, underhair
Bj 956	beaver, underhair
Bj 958	—
Bj 1074	sheep, wool

Examined, but no samples taken:

Bj 58a, Bj 567, Bj 588, Bj 771, Bj 855, Bj 860a, Bj 909, Bj 954, Bj 985, Bj 1062

477, 478, 736, 918, 954 and 956 are coronal. The edges are sometimes simple and smooth and sometimes of a simple wave-like form with occasional dents or depressions. These hairs correspond both in their size and form with the underhairs from beaver (fig. 10). The scale structure in hair samples Bj 587, 605b and 1074 is of an irregular wave-like form (irregular waved mosaic) where the scale edges are characterized by occasional peaks. These hairs are the same as in sheep wool (fig. 11).

Discussion

The diameter of the penannular brooches studied, varies between 36 (Bj 830) and 80 mm. The median value for the 13 brooches analysed is 62 mm. For all the 23 brooches examined, the median value is 63 mm. This size range can be compared with that of the 1314 penannular brooches from Viking Age Gotland, where the median value of the total number of brooches is 50 mm and of those dating back to the 10th century, 27.5 mm (Carlsson 1988:87). Eleven of the penannular brooches found at Birka belong to the group with faceted end knobs, the median value of which is 68 mm. This type of brooch may be compared with the same type on Gotland, the median value of which is 44 mm.

Out of Birka's 115 penannular brooches, 50 were found in their original position. Most of them (27) were placed at the right side of the body, 15 at the center, and only 8 at the right side of the body. The same applies to the Gotlandic brooches (Carlsson 1988:85). Of the Birka brooches analysed in this study, five were placed at the right hip, four at the right knee, three at the right shoulder and one at the neck.

Eight of the hair samples are taken from underneath the pin where they were found in the coil – Bj 477, 587, 727, 830, 918, 954, 956 and 958. On two brooches the hair was found on the tip of the pin – Bj 60b and 478. In a further two cases, hair was also found underneath the end knobs – Bj 605b and 1074. On one of the brooches, the hair covered almost the entire pin; here hair samples were taken 31 mm from the tip of the pin (Bj 736).

All the penannular brooches, save for Bj 567, were found in richly furnished chamber or coffin graves. Weights for beam balances suggest graves of a merchant aristocracy – Bj 477, 736, 855, 860, 956, 1074. The

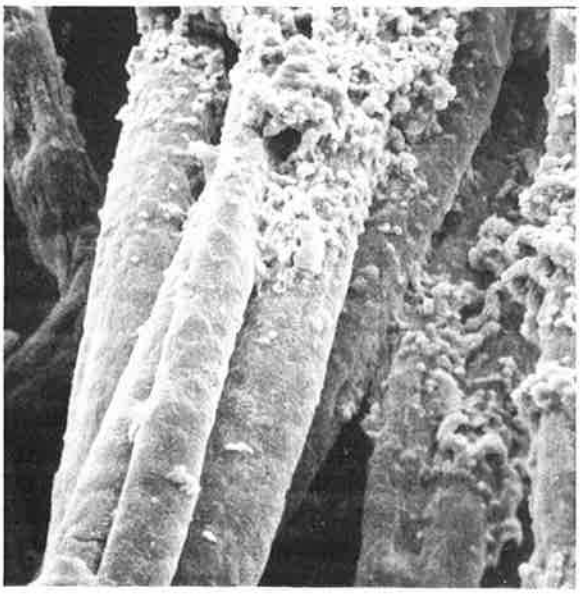

Fig. 8. Hair sample Bj 477 before cleaning (700×).

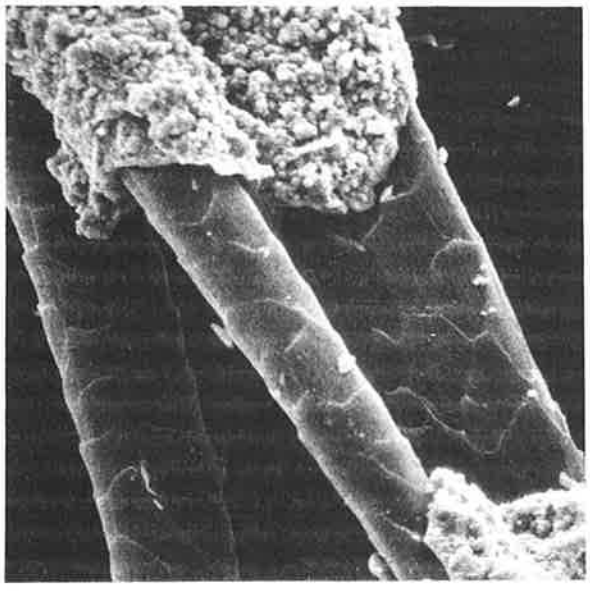

Fig. 9. Hair sample Bj 605b after cleaning (700×).

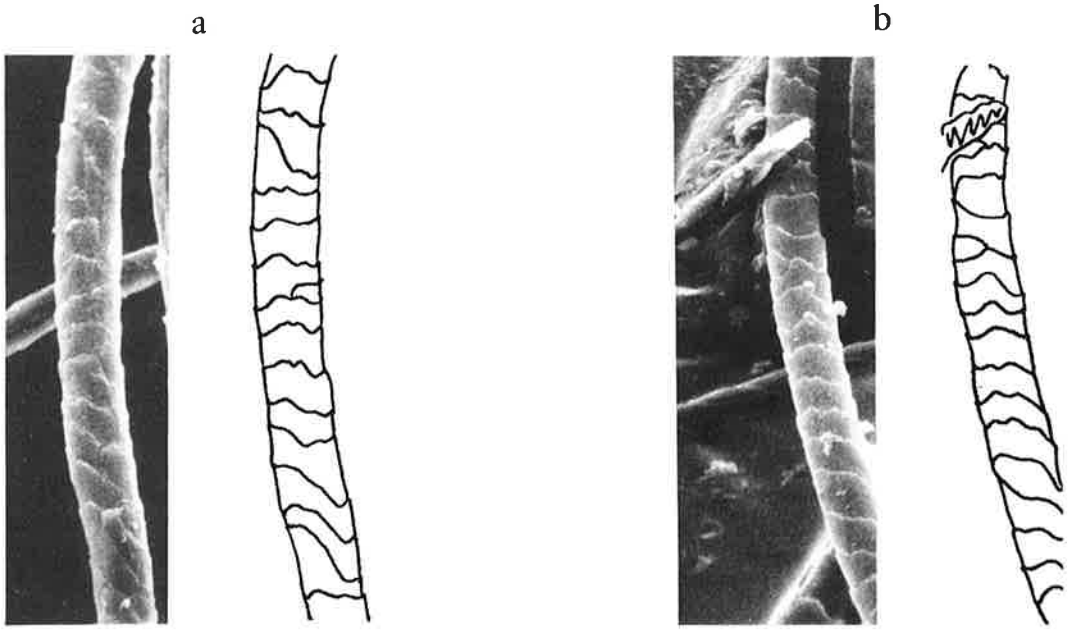

Fig. 10. The structure of the cuticle (a) in hairs from Bj 60b, and (b) in recent underhairs from beaver (700×).

dead have been arrayed in costly garments and the men's graves often include weapons – Bj 477, 605b, 727, 736, 830, 855, 909, 958, 985, 1074.

The size of the penannular brooch is usually proportional to the weight of the dress and to the coarseness of the cloth (Thunmark-Nylén 1980:171). With the exception of the three smallest brooches, Bj 830, Bj 771 and Bj 954 – diam. 36, 44 and 45 mm respectively – the examined brooches are larger than what is believed normal for a penannular brooch. Their size suggests that they should be regarded primarily as cloak brooches.

The position of the penannular brooches in the graves also indicates that they have been pinned to cloaks. The concentration of brooches at the right shoulder and hip in men's graves would seem to indicate that the cloak was pinned together on the right side in order to leave the "sword arm" free (Müller-Wille 1987:53). In his description of the *rus*, Ibn Fadlan writes: "They have neither jackets nor caftans but the man wears a dress that covers one side of the body and leaves one arm free" (Wikander 1978:63, my transl.). The position at the hips may also indicate that the brooches have been worn on a livery (Hägg 1986:68).

The hairs were found mostly on the brooch back or various places on the pin. The most common position is near the base of the pin at its coil. Provided that the brooch is pinned on a cloak which opens at the top, the brooch comes into contact with the dress on its underside, and pin tip and coil. This indicates that the hairs belong to fur-trimmings. Previously analysed hairs were found on dress fragments, and in some cases these hairs are believed to be remains of fur-trimmings (Hägg 1986:65).

Conclusion

The analysis of the hair on penannular brooches Bj 587, 605b and 1074 has led to the assumption that these hairs are from sheep. In grave Bj 1074, wool surviving on bronze buttons has been interpreted as stemming from some form of livery or a caftan (Hägg 1986:66). The penannular brooch in the same grave may have been worn on a wool trimming or even a sheepskin coat, but the size of the brooch and its position at the neck imply rather that the hair stems from the woollen fabric of a livery.

The hair on seven penannular brooches is believed to be hair of beaver. The size of the brooches and their position mostly at the right shoulder and hip indicate that these beaver hairs may have been part of cloak trimmings. Beaver fur was regarded as an exclusive fur. The Lapp tax, which is the oldest tax we know from a Nordic area, was paid entirely in skins. In the accounts of 1553 from the Lapland areas the value of different skins is given as follows: 1 beaver skin = 3 marten skins = 120 squirrel furs. In comparison, the value of a bear skin, using the same conversion table, is: 1 bear skin = 2 marten skins = 80 squirrel furs (Storå 1977:91).

Beaver was caught in the Viking Age mainly by the Saami (*Lapps*) in northern Scandinavia who curried the hides and probably also processed them. A comparison with wild fur animals in the osteological material from Viking Age Birka shows that beaver is relatively rare. Instead, bones mainly from squirrel and fox dominate. This corresponds with the situation at medieval Sigtuna, where a comparatively great proportion of bones is made up of phalanx bones from fox and squirrel (Jonsson

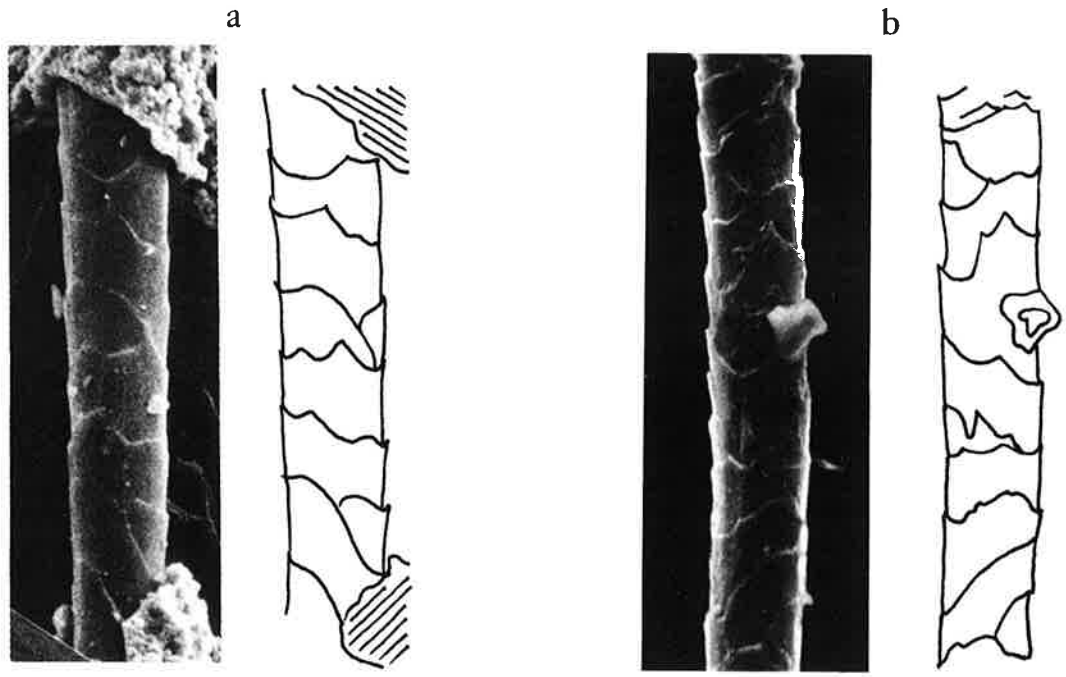

Fig. 11. The structure of the cuticle (a) in hairs from Bj 605b, and (b) in recent sheep wool. (700×).

1989:56). Finds of phalanx bones suggest that the hides were curried on the spot.

All the hair samples are underhairs which indicates that the cloak trimmings were made of pulled beaver fur, i.e. that the fur was finished off by pulling out the overhairs. The Saami, presumably the first to handle the hides, probably delivered them in pulled condition. This explains the modest representation of beaver in osteological material in the Mälar Valley. Beaver fur, which is rather rough at first, becomes smooth and sleek when pulled and gives a silky impression. The trade with pulled beaver fur is confirmed by several Arab sources from the 9th and 10th centuries. The Arab writer Nizami writes: "Loaded on donkeys came the shiny beaver, and the black sable as well..." (Steckzén 1964:134, my transl.). The often quoted Ibn Khordadbeh writes: "Regarding the route followed by the tradesmen to the ar-Rus, who are of the same kind as the as-Saqaliba, they carry hides of al-Hazz (beaver) and black fox and, in addition, swords from the most distant parts of the Saqaliba country to the Rum-see..." (Birkeland 1954:11, my translation from the Norwegian). Al Ishari an Ibn Hauqal also mention trade with al-Hazz (Birkeland 1954:28, 50). The Arab word *al-Hazz* actually means "silky skin" and has been interpreted by translators as meaning beaver (pers. comm. Ingmar Jansson, Stockholm University).

The dress from Birka contains several exclusive elements with "oriental" touches such as tablet-woven braid and metal thread appliqué edgings around sleeves of tunics and caftans. These features of dress correspond with those that during Late Antiquity were regarded by contemporaries as signifying rank. Inga Hägg interprets such dress as belonging to those most prominent in society, most probably signifying court dress or official dress (Hägg 1984:213).

The beaver fur hair interpreted as cloak trimmings occur together with the rank-determining features suggested by Hägg at three different graves: Bj 478 – with tablet braids of gold thread, Bj 736 – metal thread appliqué and silver threads, Bj 956 – tablet woven braids of silver threads. In addition to the significance of pulled beaver trimmings as a status symbol, its position on the cloak may thus have served as a symbol of rank.

References

Birkeland, H. 1954. Nordens historia i middelalderen etter arabiske kilder. *Skrifter utgitt av det norske videnskaps-akademi*. Oslo.

Carlsson, A. 1988. *Vikingatida ringspännen från Gotland*. Stockholm Studies in Archaeology. Stockholm.

Day, M.G. 1966. Identification of hair and feather remains in the gut and faeces of stoats and weasels. *J. Zool. 148:201–217.*

Ericsson, P., Iregren, E. & Vretemark, M. 1988. Animal exploitation at Birka. *Fornvännen* 83.

Geijer, A. 1938. *Birka III. Die Textilfunde aus den Gräbern*. Uppsala.

Hausman, L.A. 1920. Structural characteristics of the hair of mammals. *American Naturalist* 54.

Hägg, I. 1974. *Kvinnodräkten i Birka. Livplaggens rekonstruktion på grundval av det arkeologiska materialet*. Aun 2. Uppsala.

Hägg, I. 1984. Birkas orientaliska praktplagg. *Fornvännen* 78.

Hägg, I. 1986. Die Tracht. *Birka II:2. Systematische Analysen der Gräberfunde*. Stockholm.

Jonsson, L. 1989. Massfångst av sjöfågel och pälsdjursjakt. *Avstamp – för en ny Sigtunaforskning. 18 forskare om Sigtuna*. Sigtuna Museer. Sigtuna.

Klockhoff, M. 1989. Fornfynd i laboratoriet. *Arkeologi i fjäll,*

skog och bygd 2. Järnålder–medeltid. Fornvårdaren 24. Jämtlands läns museum. Östersund.

Körber-Grohne, U. 1988. Microscopic methods for identification of plant fibres and animal hairs from the prince tomb of Hochdorf, southwest Germany. *Journal of Archaeological Science* 15. Stuttgart.

Müller-Wille, M. 1987. *Das wikingerzeitliche Gräberfeld von Thumby-Bienebeck (Kr. Rendsburg-Eckerförde). Teil 2.* Offa-Bücher 62. Neumünster.

Steckzén, B. 1964. *Birkarlar och lappar: En studie i birkarleväsendet, lappbefolkningens och skinnhandelns historia.* KVHAA. Stockholm.

Stolpe, H. 1873. Naturhistoriska och archaeologiska undersökningar på Björkö i Mälaren, II. Redogörelse för undersökningarna år 1872. *I Öfversigt af Kongl. Vetenskaps Akademiens Förhandlingar 1873, N:o 5.* Stockholm.

Storå, N. 1977. De ryska klostren och Kola-samernas rätt till jakt och fiske. Instituttet for sammenlignende kulturforskning. Forelesninger 28. Oslo.

Teerink, B.J. 1991. *Hair of West-European mammals.* Cambridge.

Thunmark-Nylén, L. 1980. Dräkt och dräktsmycken på Gotland under vikingatiden. *Gutar och vikingar.* Statens Historiska Museum. Stockholm.

Wikander, S. 1978. *Araber, vikingar och väringar.* Lund.

Wildman, A.B. 1954. The microscopy of animal textile fibres. *Wool Industries Research Association.* Leeds.