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Editorial

We thank all our readers and the members of the society for their constant support. It is a great pleasure to see that the many interesting articles published in ATN/ATR are widely used and quoted. We see that ATR fills an important gap in the line of academic journals.

In the beginning of 2017 issues 1-45 will be placed on the ATN homepage as free download pdfs, while three copies collecting issues 1-45 are available as a print-on-demand solution from the University of Copenhagen webshop. In connection with this long expected release two former editors share their memory of the early work with ATN.

Gillian Vogelsang-Eastwood, Director at the Textile Research Centre in Leiden, The Netherlands writes:

"The origins of Archaeological Textiles Newsletter lie in various informal discussions between John Peter Wild, Lise Bender-Jørgensen and myself, about the need to collect information on what was going on in the field of archaeological textiles. We all had the nagging feeling that something should be done! But done about what and how? More and more people were getting interested in archaeological textiles, but there was a lack of information about who was doing what, where and when. So the ATN was born in 1985, moulded and run from my home in Leiden.

The aim of the ATN was to provide up-to-date information – bearing in mind that this was in the period when computers were not widely available and the internet, as we know it now, simply did not exist. So information was sent to us via snail mail, sorted out into various topics, with telephone calls being made, and contacts persuaded to send in further details about excavations, museum collections, books, events, and indeed anything related to the subject. Gradually more and more people became involved in collecting information and if someone heard about something, they were sent out as 'roving reporters' to gather the all-important details. The ATN was designed to be a clearing house of information, rather than a journal of learned articles.

At first everything was written in columns on a simple typewriter, sent out to be checked, and mistakes covered with a slip of paper with the corrected information. There were line-drawings or black and white images to stick down on the correct pages and then down to the local printing shop to make enough copies to send around – again by snail mail. And it worked! The ATN became an essential tool for students and researchers wanting to build up a network and to learn what was happening in other parts of the world with respect to archaeological textiles.

After a number of years preparing and editing the ATN, it was clear that it was time for someone else to take it over and this task was given to Elizabeth Peacock in Trondheim. I still have the early proofs of the ATN, complete with paper corrections, and they bring a smile to my face as I think of the hard work, swearing, and fun involved in producing the early ATNs and how this newsletter was able to bring so many people together and set the stage for further research and contacts in the field of archaeological textiles."

And John Peter Wild continues the story:

"We took over ATN from Elizabeth Peacock in 1998 (ATN 27) on the understanding that it would be a low-tech publication – very low-tech by today's standards! All incoming text was retyped into two columns on our trusty Canon word-processor, and printed out. Strips of paper with the headers and footers were glued to each page by hand, as were the photographs and drawings submitted. Our print-shop scanned the document, printed it out page by page, and stapled each bundle. We found that colour photographs could be reproduced more successfully than black-and-white: the cost was initially greater, but dropped over the years.

We never needed to raise the subscription rate, though our postal costs on each issue became a problem. The other problem was finding a way for our subscribers to pay their subscriptions from abroad without incurring punitive bank charges. Since we regularly attended textile conferences transfer of cash by hand was an option; but otherwise posting bank notes in an envelope became the default method, and rarely failed!

ATN and ATR of course can only be as good as the articles they contain, and our authors literally made the newsletter! We shall always be grateful to them. However, there was rarely a consistent flow of suitable manuscripts into our hands, and pressing invitations were often issued when the editors got to hear of some new excitement! Two issues per year gave us the chance to keep readers abreast of the latest discoveries and ideas before they heard about them elsewhere; but it meant that there was no editorial closed season. Our final number was ATN 45 in 2007. Our word-processor must have known that its task was over; for after we had printed out the very last page, it broke down terminally. The age of low-tech was over!"

The next deadline for contributions is **1st May 2017**. Please also remember to send us any news of new projects, publications and conferences, so that we can continue to act as a hub for our growing archaeological textiles community.

We wish our readers a fruitful 2017 with many interesting textile finds to write about.

The Editors

Signe Groot Terkelsen and Vivi Lena Andersen

Red Heels

The Symbol of a Power Shift in 17th-Century Copenhagen

Introduction

Many people are aware of the massive popularity of the French designer Christian Louboutin's stilettos with their distinctive red heel and sole. They are the ultimate desirable item for fashion-conscious women (Semmelhack 2008, 66; 2011, 245). Some consumers even imitate the look by buying an ordinary pair of black stilettos and a can of red paint in pursuit of the admiration and cache so closely linked to this label of footwear (The Telegraph 2012). To protect the brand and its exclusivity, Louboutin has even trademarked his design, so that it is now controlled by law in the US (Milligan 2015). Today, this designer legally stands as the inventor of the red sole and heel design, enabling him, along with a high price tag, to secure the brand's exclusivity on the market and guaranteeing quality and originality for customers.

Fig. 1. Detail of bright red colour on stacked heel (Photo: Vivi Lena Andersen).

However, many are not aware that red heels and soles were also highly fashionable in Europe from the 17th century onwards, and a similar restrictive process took place at this early point. King Louis XIV of France often wore shoes with red heels and soles, and by regulation made them the preserve of the nobility, thereby making them into signifiers of authority, power, political privilege and wealth (Mansel 2005; Frisch 2013, 41). Their prestige was also linked to the high cost of red dyes at the time (Davidson 2011, 273). Evidence from portrait paintings of the time suggests that the social restriction concerning red heels and soles on shoes did not apply outside France (Swann 2001, 126-127), and recent excavations in Copenhagen reveal that the popularity of the red heels and soles was likely much greater than previously believed and could be found in a variety of social classes.

Finds from Copenhagen

The Museum of Copenhagen in Denmark has in recent years carried out a number of large-scale archaeological investigations in Copenhagen's city centre. Many of the finds from the excavations were retrieved from the city's old moat, part of which was filled in around 1670 when the city walls were expanded and reinforced (Lyne and Dahlström 2015, 21). The favourable preservation conditions for organic material on these sites have resulted in a large number of organic finds, including shoes. As such, the finds have contributed substantially to the museum's collection of shoes and shoe parts in leather, wood and textile, the majority of which date to the 17th century (Andersen 2013, 9).

A close examination of a selection of footwear and fragments of footwear found at Rådhuspladsen in 2011 and 2012 have revealed a surprisingly high percentage of footwear with various shades of red colour on the

heels and/or soles (Fig. 1). Twenty-six of 46 stacked leather heels and 19 out of 43 soles in a sample analysis showed traces of red colouring (Terkelsen 2014, 4). The subsequent analysis of all footwear from Rådhuspladsen confirmed this unexpected high number of footwear with red colouring and showed that 20 percent of the finds containing stacked leather heels and soles have traces of red colour (Andersen 2015, 28). All in all 548 heels and parts of heels from shoes were registered from the Rådhuspladsen site. 483 of them were stacked heels while 65 heels were the type of heels that had a wooden core covered with leather. None of the wooden heels with leather covers showed any traces of red colouring. Therefor the following observations are based on footwear finds consisting of stacked leather heels.

Processing the finds

The registration of the footwear was based on principles defined by June Swann and modified by Vivi Lena Andersen for the Museum of Copenhagen (Swann 2001, 312; Andersen 2013, 14). All shoes and parts of shoes were measured and all heels and soles examined for traces of red colour. The description of the footwear included notes on dating, the gender of the wearer (based on length of sole, shape of toe and shape of heel), the age of the wearer (based on length of sole) and the use of the footwear, including traces of repair.

Identifying male or female shoes can be difficult, but there are some features that can be used as indicators of the wearer's gender. These are visible in contemporary art. A sturdy, square heel is most often seen on men's footwear during this period, while a slim heel and a more pointed toe is likely to be from a woman's shoe. Also, men's shoes are in general longer than women's shoes, although it can be difficult to distinguish between shoes worn by older boys and women. The examination showed that red colouring was more often, but not exclusively, seen on men's footwear, but also appeared on women's and children's shoes (Terkelsen 2014, 23). When looking at the material from Rådhuspladsen in its entirety, fewer assessments regarding the gender of the wearer could be made, but in general it can be seen that footwear with red heels and soles were worn by both genders, and by adults as well as children (Andersen 2015, 28-29) (Figs 2 and 3). Use wear analysis of the selected footwear further showed a notable difference between items with and without red colouring. Red coloured shoes had been repaired more often than shoes without red colour. In 19 of 25 heels with traces of red colouring, additional wooden pegs had been hammered into the heel after it was first constructed, indicating that the heel had been repaired one or more times. The same phenomenon was seen in only eight of 20 heels without red colouring. Another indication of repair more common in shoes with red colouring was the

Fig. 2. A woman´s mule with red heel. The shoe is worn out, has holes and traces of repeated repair indicating that this red-heeled shoe was worn by someone in humble circumstances before it was finally discarded (Photo: Mia Toftdal).

presence of large metal nails. These were present in 12 of 27 heels with red colouring and in no more than seven of 20 heels without red colouring. The nails were hammered into the heel from the top and, in cases where both sole and heel were present, the nail had been hammered through both parts, which is a clear indication that the nail was part of a repair rather than of the original construction. The larger number of wooden pegs and metal nails both suggest that repairs were more common in footwear with red colouring than in footwear without (Terkelsen 2014, 15). This observation was later supported when the entire collection of heels from the Rådhuspladsen excavation was examined.

A treasured object

When considering all the features examined one can imagine a typical 17th-century Copenhagener wearing red heels and/or soled shoes. This person was most likely a man and he often passed other men, and perhaps women and children, wearing the same type of shoes. But he may also have been in pain from treading on the large metal nails that were hammered into the back of his shoes in a last attempt to hold them together. Whether he was rich or poor is more difficult to assess. The quality of the leather and the craftsmanship of the shoes could be an indicator of the wearer's wealth, but so far it has not been possible to make any definite quality distinctions between footwear with red colouring compared to footwear without (Terkelsen 2014, 24).[1]

The one factor that may give an indication as to the wealth of the wearer is the repeated repairs. Most likely this feature is to be found in footwear belonging to less wealthy citizens like craftsmen, servants or perhaps the king's soldiers, but who appreciated the red soles and so took them to the cobbler more often than they otherwise would have done, or even made their own repairs before discarding them. It is also possible that this type of footwear had a much more complicated life cycle with more than one owner. No matter who wore the shoes with red heels, the many repairs can be seen as a sign that the last wearer did more to preserve them than the owner of footwear without this feature.

XRF analysis

In order to determine the components of the red colouring, 14 pieces of footwear with visible red colouring were selected for X-ray fluorescence analysis (XRF) at the Department for Conservation and Restoration at the National Museum of Denmark (Tauber 2014; Terkelsen 2014, 24) (Table 1). XRF analysis enables conservation specialists to detect if inorganic pigments are present as well as the concentration/composition of such pigments.

The analysis showed that all samples contained iron (Fe) as well as small amounts of calcium (Ca) and strontium (Sr). The presence of calcium and

Fig. 3. Child's shoe with red heel. Footwear with red heels was worn by adults as well as children (Photo: Mia Toftdal).

object number	analysis location	summary of results (elements with higher peaks)
FO238544	side	Fe, Cu
	sole	same
FO238813	side	Fe
	sole	same
FO238857	side	Fe, Cu, (Pb)
	sole	Fe, Cu, Pb
	rivet	iron
FO239788	side	Fe
	sole	Fe, Pb
FO241466	thread	Fe, Pb
FO241467	side	Fe
	sole	same
FO241468	side	Fe
	sole	same
FO241469	side	Fe
	red spot	Fe, Cu, Pb
FO241470	side	Fe
	sole	Fe, Pb
FO241471	side	Fe
	red spot	Fe, Pb
FO241472	side	Fe, (Pb)
	top	same
FO241473	side	Fe, (Pb)
	sole	Fe, Pb
FO241474	side	Fe, (Pb)
	sole	Fe, Hg, Pb
FO241475	side	Fe, (Pb)
	sole	same with a tiny bit more lead

Table 1. List of the XRF results of the 14 leather shoes. If the element symbol is underlined (*e.g.* Fe), a large amount was found. If only a small amount was present, the element symbol is shown in parentheses: (Pb).
The tests were undertaken by Michelle Tauber at the department for Conservation and Restoration at the National Museum of Denmark.

strontium likely stems from the wet soil in which the footwear was found. The iron could have the same origin, but could also stem from the metal nails hammered into some of the heels or an iron oxide colouring. These components are thus not indicative of the red pigment colouring only.
Ten pieces of footwear were found to contain lead (Pb) (Fig. 4). Lead is a component in the toxic red pigment called 'red lead'. The presence of lead could, however, also indicate the use of lead in glue or of a substance containing lead and oil that was applied to the heels and soles in order to make them waterproof. This component may thus be part of, but is not exclusive to, the red colouring.
One shoe also contained traces of mercury, a component used in the production of vermilion, an exotic and expensive red pigment (Lozier 2012, 129) (Fig. 5). The possible presence of both red lead and vermilion indicates that the red colour found on 17th-century footwear came from more than one kind of paint and that one of these was far more expensive than the other. In addition there is the possibility that a mixture of vermilion and red lead was used, a method of making the expensive vermilion go further or less likely to fade (Spring and Grout 2002, 57; Vadstrup 2006). An early example of how the two pigments differed in status can be found in the early Renaissance book *Il libro dell'arte.* Here the Italian painter Cennino Cennini warns his readers about buying ground vermilion as there is a risk of it having been replaced or mixed with red lead or ground brick (Cennini *et al*. 1942, 40).

New Luxury in a New Era
The second half of the 17th century was a period characterised by major political, social and economic upheaval in Denmark. The city of Copenhagen grew rapidly from about 30,000 inhabitants in 1650 to about 60,000 in 1710 (Feldbæk 1993, 81). In 1660, King Frederik III, with the backing of wealthy citizens and the clergy, was proclaimed absolute monarch. The nobility saw its power and privilege undermined while the citizens were able to gain influence and economic prosperity under the new rule. The old system of allowing privilege based on birth was breaking down, and ordinary citizens had a hitherto unknown chance to move up socially in this new absolutist society (Olden-Jørgensen 2011, 35).
During the 17th century a new type of luxury appeared in Europe, one that was available to a larger part of the population. The American historian Jan de Vries calls it 'new luxury', as

Fig. 4. XRF analysis showed that the colour on this heel contains lead. Lead is a component in the red pigment 'red lead' (Photo: Signe Groot Terkelsen).

Fig. 5. The red colour on this shoe contains traces of mercury, used in the production of vermilion (Photo: Signe Groot Terkelsen).

opposed to the nobility's 'old luxury', and describes a number of characteristics that define it: unlike 'old luxury' it is not unique, but produced in different qualities and price ranges; it is often made locally, imitates foreign and more expensive luxury goods, and is typically aimed at the domestic sphere and personal wellbeing (de Vries 2003, 51-52). De Vries describes this phenomenon in early 17th-century Netherlands and ties it to a booming economy in the increasingly powerful urban centres of Europe. Similar conditions were present in Copenhagen in the second half of the 17th century, and we believe it is possible that 'new luxury' could have emerged here too.

During the 16th and 17th centuries, a number of laws aimed at regulating the public appearance and behaviour of citizens were introduced in Denmark. The so-called 'luxury laws' dictated among other things what one should wear, how many guests one could invite to a wedding, christening or funeral, the splendour with which a church should be decorated and how many times the bells should toll for the dead – all depending on one's position in society. The aim of these laws was to solidify the existing social hierarchy and reinforce the differences between high- and low-ranking members of society (Jespersen 1997, 180). The luxury laws regulated what de Vries would call

the 'old luxury', one that enabled the old aristocracy to display its wealth and power and set it apart from others (de Vries 2003, 41). 'New luxury', on the other hand, emerged in the urban centres and was available to a much larger number of people, who used it to communicate new and more dynamic relations rather than maintain old hierarchies. The emergence of 'new luxury' thus enlarged the risk of social confusion and confronted established hierarchies (de Vries 2003, 43). Might shoes and boots with red heels have been part of this 'new luxury'? An argument in favour of this interpretation is the fact that coloured footwear is far from rare. It is seen in 20 percent of finds containing stacked leather heels and soles from the Rådhuspladsen excavation. Further, it seems that this type of footwear was more frequently repaired than other footwear, indicating that the wearers were more preoccupied with preserving the footwear with coloured heels than other footwear. The XRF analysis also suggests that this fashion was available to more people than just the very rich. One heel had been painted with vermilion, while the others were more likely painted with red lead and/or iron oxide – different kinds of red colour that came at very different prices. Finally, the shoes and boots analysed are likely to have been locally-made products (Andersen 2015, 50) and one can easily imagine how it would disturb social codes when men and children from all social classes walked the increasingly crowded streets of Copenhagen in footwear otherwise associated with the most powerful monarch in Europe, the Sun King of France.

The use of red heels in 17th-century Copenhagen presented here is different from what is seen in collections and findings in other countries, where red-heeled footwear was a part of local footwear history. Therefore, it would be interesting to see the study of these shoes unfold further by comparing the finds with material from, say, England and Ireland where other strong political and social agendas were at play. This would add to our growing understanding that in this context, red colour was much more than a simple pigment.

Notes

1. As an experiment, a number of shoes and parts of shoes were also examined by master shoemaker Kenneth Elsgaard from Copenhagen, who found no difference in the way footwear with and without red colouring was produced and no noticeable differences in the quality of the leather. The work done by Kenneth Elsgaard is described in detail in Terkelsen 2014.

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Karina Grömer

Liturgical Vestments of the 16th to the 18th Century in Austria

Introduction

In addition to architecture, sacred objects, paintings and statues, textiles play an important role in the sign system within rituals in the Catholic Church. They can be consecrated objects serving as official dress of the priests or covering and wrapping sacred objects. The vestments also carry messages that are reflected in specific colours and symbols. During the liturgical year, vestments in different colours have to be used, and they mark specific periods, *e.g.* the time before Christmas and Easter (Advent and Lent – violet), specific ceremonies (*e.g.* feast of Our Lord's Passion, feasts of martyred saints – red; Gaudete and Laetare – rose), high festivities of the liturgical year (*e.g.* Easter and Christmas – white) or mourning (black) (Braun 1907, 728-760; Legg 1882). Especially the design of historical, mainly baroque vestments is strongly orientated towards pictorial and symbolic connotation. The level of meaning distinguishes these special historical textiles from other fabrics of the time. Liturgical vestments in monasteries, churches and museum collections have been the subject of many different approaches. They are a valuable source for researchers with a focus on costume history, textile craft and art history (*e.g.* Fortescue 1934; Johnstone 2002; Stauffer 2001), but even if detailed descriptions of vestments are published, these descriptions differ from that needed for archaeological inquiry. Usually the cut of the garment, the patterns and iconography of the fabrics used and other details are emphasised, while there is rarely any detailed description of yarn qualities or thread counts. Such technical analysis is, on the other hand, more common when describing archaeological artefacts, but the ideal is of course to use both. The following article focuses on liturgical textiles in Austria of the 16th, 17th and 18th centuries.

Archaeological finds: graves of priests

For many centuries, Catholic priestly burials were equipped with liturgical vestments to emphasise the identity of the deceased. That was not only a common habit of specific parishes or for highly valued persons, but was prescribed in church laws from 1590 (although reaching back to the 9th century) and published by the Vatican as the *Rituale Romanum* in 1620. The formal objectives of the burial, the sequence of events and the gifts of a Catholic funeral are described in detail with a specification for the funeral clothing of a deceased priest:

> *sacerdos, aut cuiusvis ordinis clericus, defunctus, vestibus suis quotidianis communibus usque ad talarem estem inclusive, tum desuper sacro vestuitu sacerdotali, vel clericali, quem ordinis sui ratio deposcit, indui debet; acerdos quidem super talarem vestem amictu, alba, cingulo, manipulo, stola, et casula, seu planeta violacea sit indutus*
>
> A deceased priest or cleric of any stage of consecration must be dressed from the inner side in his robe and in his ordinary everyday clothes, above that with the priestly or clerical vestments, which demonstrate his rank. A priest shall above that be robed in the cassock, alb, girdle, maniple, stole and chasuble or violet cope [*pluviale*] (*Rituale Romanum VI*, 1.12-16).

This general Vatican law had to be followed from the early modern period until the middle of the 20th century. It was replaced in the 1960s with the Second Vatican Council (1962-1965) containing new regulations.

Fig. 1. Zwettl, grave of a priest with chalice, paten and textile fragments (Photo: Verein Archäologie Service).

Excavation, preservation and analysis

Catholic priestly graves can often be identified in archaeological excavations in early modern churchyards, Catholic cemeteries and crypts as a result of finding cloth fragments from chasubles, stoles and maniples (*e.g.* Bravermanová 2010; Cybulska *et al.* 2013, Fig. 1; Grupa 2015; Mittelstrass 2003, 138). Such archaeological contexts can have a variety of preservation conditions. The organic finds in graves buried in the soil in a graveyard are usually very fragmented. Parts of garments usually only survive when attached to metal objects. The analysis of such finds follows the general mode of textile analysis from archaeological contexts using microscopy analysis and Scanning Electron Microscopy for fibre identification, description of microstratigraphy and the like.

Compared to finds from the soil, burials in churches (in a sarcophagus, crypt etc.) display much better preservation conditions. Sometimes, even complete garments survive under dry conditions. Nevertheless, such finds are brittle and their conservation is a challenge.

Recent examples from the Czech Republic and Poland (Bravermanová 2010; Grupa 2010; 2015) have given good overviews of the conservation processes of finds from crypts and the possibilities of making them accessible to the public. Attempts were also made to make virtual reconstructions of such garments by means of computer graphics (*e.g.* Cybulska *et al.* 2013). Two priests' graves from Austria have recently been excavated that serve as examples for what can be achieved by analysing liturgical textiles from an archaeological approach: Zwettl and Hollenburg.

Textiles from the Zwettl graveyard (c. AD 1500)

An archaeological rescue excavation took place at Zwettl in Austria in a graveyard that was used between AD 1500 and 1850. Graves of men and women were identified by means of metal dress elements such as eyelets and hooklets attached to textile layers containing coarse linen fabrics as well as fine silk taffeta and damask (Grömer 2015). It is, however, not easy to decide to which garments they belonged as a result of the degree of fragmentation.

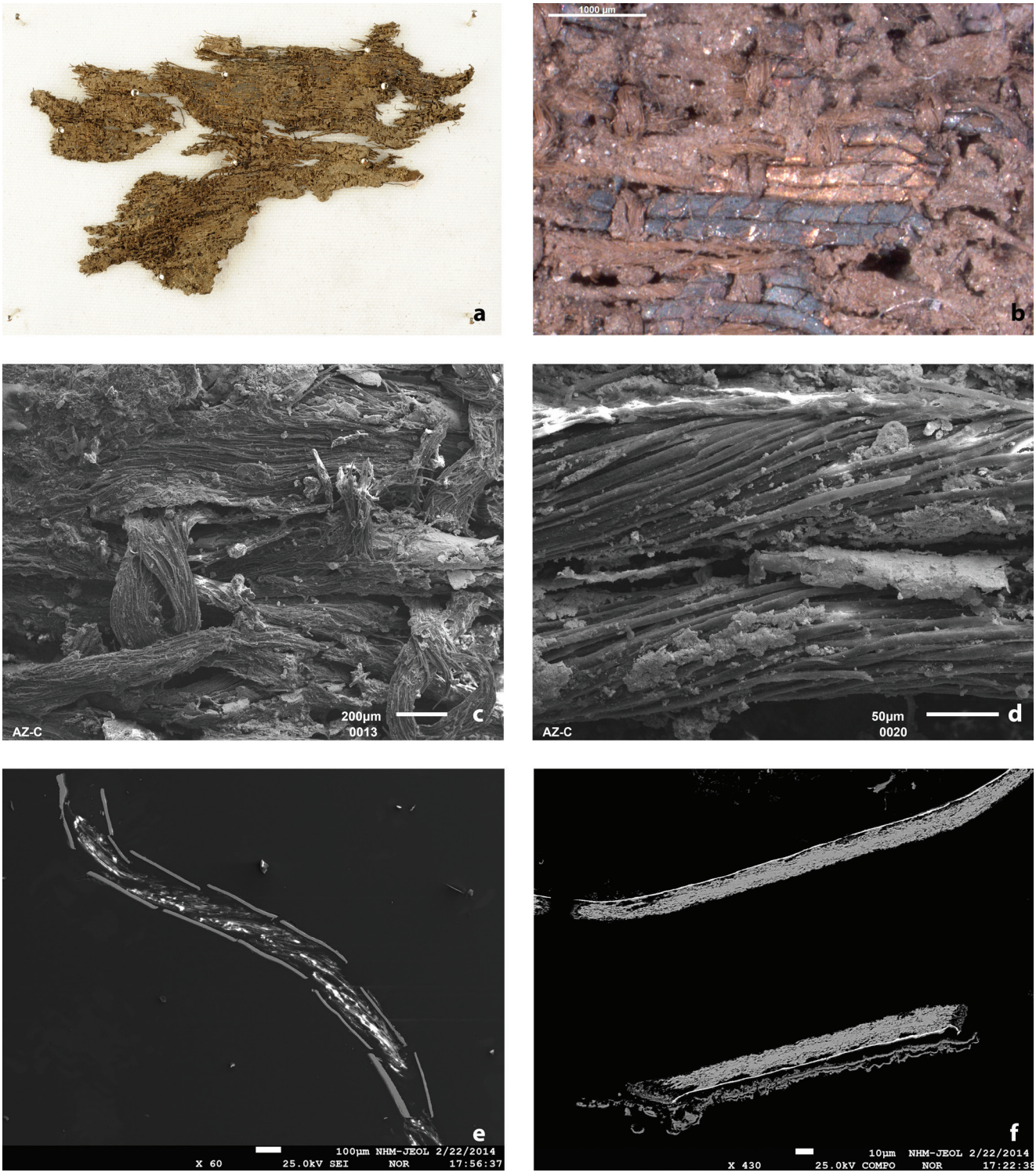


Fig. 2. Zwettl, grave of a priest: a-b) fabric of silk and gold threads; c-d) SEM pictures of weave and silk fibres; e-f) cut through gold thread (Photos: A. Schumacher, A. Kroh and D. Topa).

Among the graves was also one of a priest, and although most organic material was decomposed, his identity and status is clear from the liturgical objects in the grave: a chalice and a paten. The man was between 30 and 50 years old when he died. The shape of a vessel that covered and protected the chalice can be dated to c. AD 1500. Textile remains with gold threads were found lying in the region of the right forearm, and especially under this, which was detected during the excavation when the radius and ulna were removed (Fig. 1/right). The fabric belongs to a precious silk cloth (a composite weave with yarns 0.2 mm in diameter), patterned with small and larger lozenges. Due to the small size of the fragments, and the change of the colour to various shades of brown, an identification of the pattern is not possible (Fig. 2 a-b). In the late Middle Ages and early Renaissance, mainly Italian luxury silks, most likely from Florence, were exported all over Europe. The Italian silks are distinguishable on account of their imaginative patterns of flora and fauna (Geijer 1979, 141-153; Stolleis 2001, 20). Unfortunately, detailed statements on the provenance of the silk textiles from Zwettl cannot be made, since the fragments are too small and damaged.

The decorative gold threads were made on a still-existing thread wrapped with fine gold wire (see Barker 1980, 5-8; also Wincott Heckett 2015, Fig. 23.3). High-resolution SEM images indicate that it was made of a streaky-cut, thin, gold-coated silver metal (silver: 20 µm, gold: 5 µm) (Fig. 2 e-f). The gold wire was wound in S-direction around the silk carrier threads. Due to the corrosion of the silver the threads now appear dark (Fig. 2b).

It is not entirely clear to which part of the liturgical vestments (maniple, stole, chasuble or cope) the silk-gold textile fragments once belonged. The position of the fabric in the abdominal region under the arms indicate a chasuble. It is, however, interesting that so few pieces have survived. Comparable chasubles of such silk damask with gold threads would not be limited to such a small area, asymmetrical on the body, but would be spread throughout the whole area of the garment. Even if the silk had not survived, the gold threads should have been present in the grave, especially at the back of the body which represents the visible side of the garment and was usually designed more magnificently than the front (Stolleis 2001, 16-17). As the silk-gold textile was found at the right arm, it might thus derive from a maniple (a decorated band of silk or similar fabric that when worn, hangs from the left arm, Fig. 8b). Maniples are only used within the context of Holy Mass and are of the same liturgical colour as the other vestments.

Textiles from Hollenburg church (c. AD 1700)

During renovation works in a small church in Hollenburg, rescue excavations had to be carried out (Leib 2007). Under the floor of the *presbyterium* the graves of two priests were found, along with other burials. From the early Modern until the Baroque period, it was a privilege of the clergy and rich elites to be buried within the church. Laypeople had to be buried outside the church in the graveyard. Grave 2 (Fig. 3), dated to c. 1700, is the burial of an adult male. Since the bones are poorly preserved, the exact age cannot be determined. A wooden coffin grave was dug into the soil instead of being placed in a sarcophagus, so the garments are also in this case in a very bad condition. Nevertheless, the Hollenburg archaeological textile evidence is much clearer than the small fragments from Zwettl, and larger parts of the various garments are still visible. As the specific layers of the vestments of a Catholic priest are well known (compare Fig. 8b; Braun 1907; Fortescue 1934), it was easy to identify a cassock, an alb, a cingulum, a chasuble, a stole and a maniple in the grave.

Fig. 3. Hollenburg, priest's grave found in church (Photo: ASINOE).

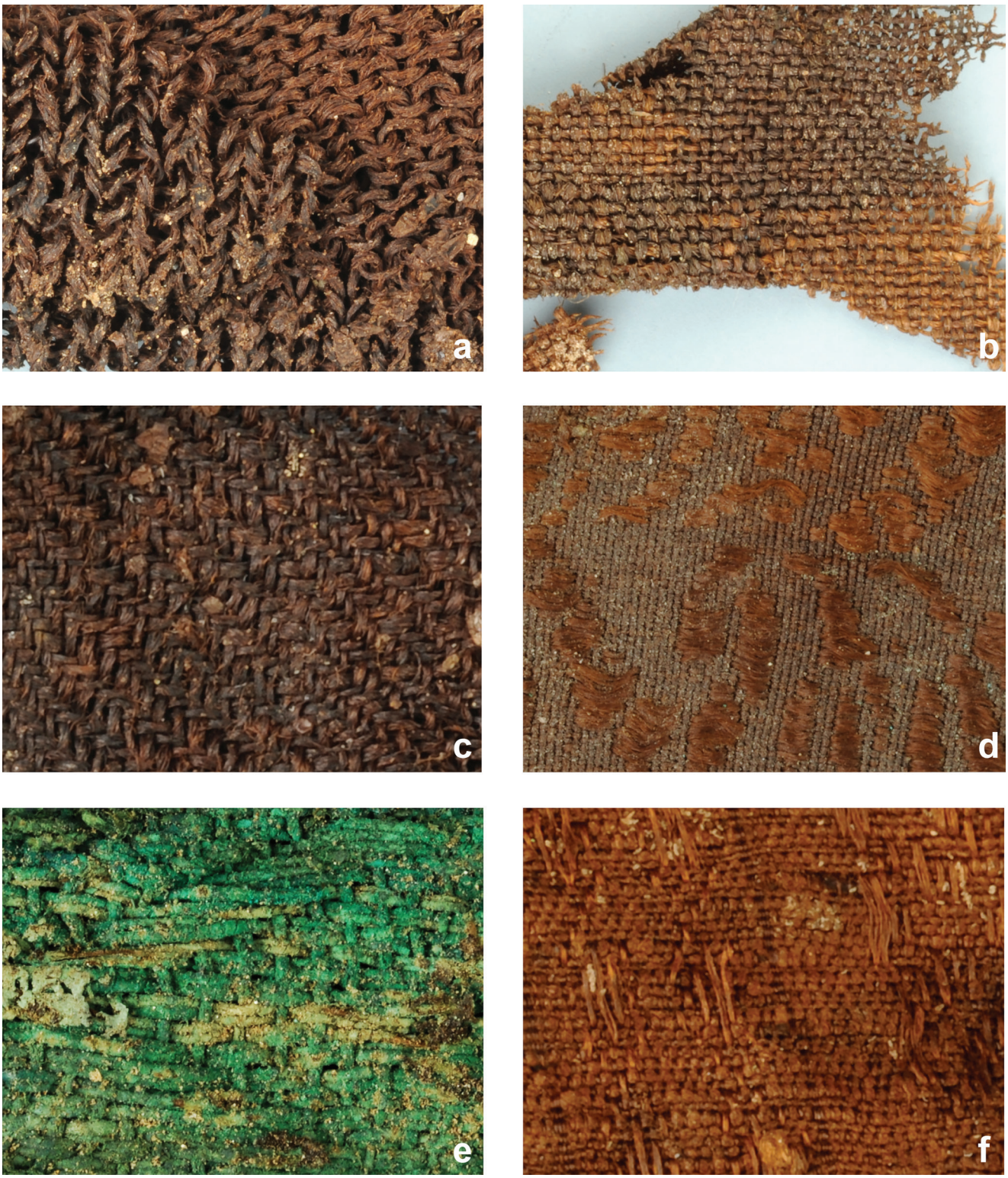


Fig. 4. Hollenburg, fabrics found in priest's grave: a) knitted stockings; b) linen tabby of the alb; c) wool twill cassock; d) silk of the maniple; e) metal lace: f) silk of the chasuble; all samples are 2 cm wide (Photos: A. Schumacher).

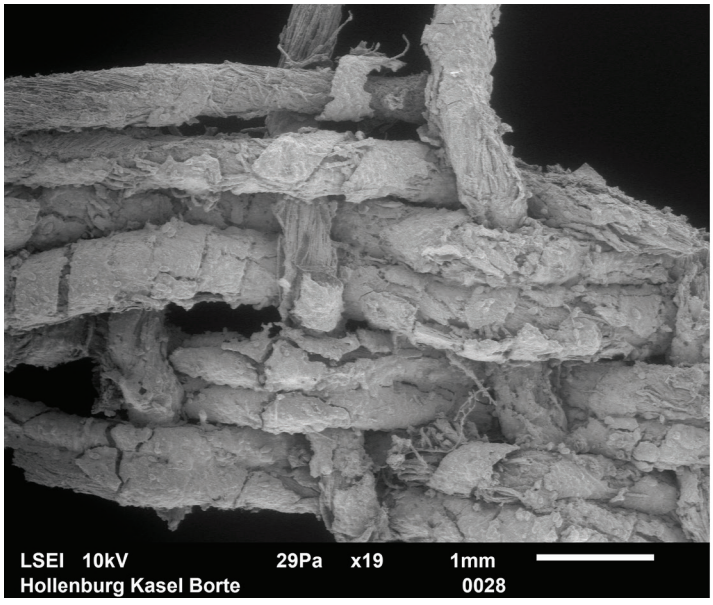
The priest was placed on a mattress covered with a medium-quality twill fabric (0.3-0.4 mm z-yarn; 18-20 threads per cm) and filled with wood shavings. He wore knitted stockings of a now brownish hue (Fig. 4a). Closest to the body the remains of a cassock were identified, made of a wool 2/2 twill of medium quality (0.3 mm z-yarn; 22 threads per cm) (Fig. 4c). Over the cassock the priest wore an alb, as prescribed. This consisted of a medium fine linen tabby (0.4-0.6 mm z-yarn; 20 threads per cm) of even and dense structure (Fig. 4b).

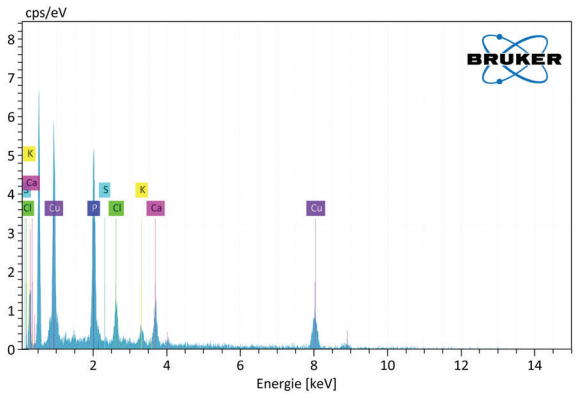
The maniple was made from a fine patterned silk with about 70 threads per cm; the visible colour is still purplish-brown (Fig. 4d). The decoration consists of stripes or zones with a stylised floral pattern (lancé on taffeta). The maniple was also decorated with metal lace braids (Fig. 4e) that form a cross and frame the ends of the maniple in a trapezoidal shape. To make the ends of the maniple stiff, it was lined with a very coarse and stiff open-weave tabby made of plant material (0.3 mm z-yarn, 10 threads per cm), which was glued onto the silk. Wool tabby was used as an additional lining for the maniple.

The arrangement of the metal lace braids can be clearly identified as linings and trimmings of a chasuble of the 'fiddleback' shape (compare Fig. 3 and Fig. 8b), which was developed in the late 1500s when heavy material and ornate embroidery made the chasuble very stiff. To accommodate the priest's movement, the front was cut away from the arms giving it the distinct fiddle-like appearance (for the development of the chasuble, see Braun 1907, 149-239). The same lace was also used to decorate the maniple (cross and frame). The fabric used for the chasuble (the sample was taken from the shoulder region) is a fine silk of purplish-brown colour and striped floral decoration (lancé on taffeta) (Fig. 4f). It does not exactly match the fabric of the maniple, so two different silks were used for these two items.

The threads of the laces consist of a metal filament wound around a silk core. SEM analysis and Energy Dispersive X-ray (EDX) analysis proved that it was copper (Fig. 5), and no traces of silver or gold could be found. For the Baroque style, silver or gold laces were common for vestments with the liturgical colours violet and black, but copper laces are not (see *e.g.* Sporbeck 2001, 112). The coloured appearance of the metal threads is now greenish due to the high content of copper, which changed by corrosion to the elements phosphorus, potassium and calcium (Fig. 5 right).

All of the fabrics now appear more or less brownish or blackish due to the decomposition of the human remains, and maybe also the degradation of the natural dyestuffs used for the silks. Due to church regulations we know that the alb must have been





Element	Ord. Z.	Lin. Ser.	Netto	Gew. [%]	Masse Norm. [%]	Atom [%]	abs. Fehler [%] (1 sigma)	abs. Fehler [%] (2 sigma)	abs. Fehler [% (3 sigma)
phosphor	15	K-Serie	4178	14,58	20,80	31,76	0,65	1,31	1,9
sulfor	16	K-Serie	36	0,14	0,20	0,30	0,05	0,10	0,1
chlorine	17	K-Serie	1030	3,89	5,55	7,41	0,22	0,44	0,6
potassium	19	K-Serie	426	2,31	3,29	3,99	0,17	0,34	0,5
calcium	20	K-Serie	1084	6,98	9,96	11,75	0,35	0,69	1,0
copper	29	K-Serie	1310	42,19	60,19	44,79	1,94	3,89	5,8
			Sum	70,11	100,00	100,00			

Fig. 5. Hollenburg, detail of metal lace, copper filament wound around a silk core (SEM pictures and EDX analysis: D. Topa).

Fig. 6. Storage facilities for liturgical vestments in Göttweig monastery (Photos: K. Grömer).

white in its original state (*albus* – white), a garment that symbolised cleanness and purity. The chasuble, stole and maniple were all violet, as prescribed in the *Rituale Romanum* (note the dye analysis of chasubles and stoles from Gniew in Poland: Grupa 2015, 194).
After examination and sample-taking, all remains from the grave, including the vestments, were reburied according to the wishes of the parish.

Historical liturgical vestments in Austria

Austria is a Catholic country with a rich Catholic tradition. Most of the churches founded before 1900 own different sets of historical vestments. After the 1960s and the *Sacrosanctum Concilium* (the Second Vatican Council), a modernisation of how the Holy Mass took place and the style of liturgical vestments began. Today it is the choice of the priest whether to wear modern vestments or the old, historical ones. In the Catholic Church the paraments also belong to the holy inventory of the church, along with chalices, holy statues etc. Since the *Sacrosanctum Concilium* it has also been forbidden to throw away liturgical vestments, even if they are not used anymore (SC 126). This is why historical liturgical vestments are still stored in churches.
As liturgical vestments are ritually important but also fragile objects, there is in the churches a special focus on their conservation and restoration (Jägers 1998). As most garments are brittle, they should under ideal circumstances be stored in a horizontal position in a dark drawer. Many churches have such facilities in the sacristies for chasubles or stoles (Fig. 6). Larger items such as mantles (*pluviali*, copes) are usually stored hanging in cupboards, which in a long term perspective can cause great damage.
In most Catholic churches in Austria the priests today use modern liturgical garments, but especially for High Festivities in cathedrals and in monasteries the historical vestments are often still in use. For example, the Gothic St. Stephan's Cathedral in Vienna (the main cathedral in Austria) has a parament treasure consisting of c. 2500 individual items. The oldest objects date to the 16th century while most are from the Baroque period (17th and 18th centuries) (Inventory St. Stephan 2003). A valuable vestment is the so-called 'Kleiner Breuner Ornat' (Catalogue St. Stephan 1997, 218-220), consisting of a chasuble, stole, maniple and dalmatic. The precious fabric of the outer coat is red silk damask from Italy dating to between 1500 and 1540. In 1647 new vestments were made, using these 'old' fabrics. Such a 'reuse' of valuable textiles, which were given to the church, is a well-known phenomenon. Particularly female members of royal families and the elite donated precious textiles to be made into liturgical vestments. Some chasubles are stored in St. Stephan's which were made from the wedding gowns of different members of the Habsburg family (*e.g.* Eleonorenkasel) (Catalogue St. Stephan 1997, 238 and 253). These precious vestments are exhibited (Fig. 7), but are taken out of the displays and worn for one specific Holy

Fig. 7. St. Stephan's Cathedral, exhibition of the cope from the 'Großer Breunerornat' (Photo: K. Grömer 2015, courtesy of St. Stephan's Cathedral).

Mass a year before they are placed into the exhibition again. Other vestments from the 17th to 19th centuries stored in the sacristy of St. Stephan's are also worn. Usually this happens for specific High Festivities once a year (*e.g.* Eleonorenkasel on December 8th or Kleiner Breunerornat on December 26th in St. Stephen's).

Monasteries also possess and use historical garments, even of fur. The Premonstratensian monastery at Schlägl in Upper Austria was founded in c. 1200 and it holds a treasure of hundreds of liturgical vestments. Due to fire catastrophes in the 17th century the medieval inventory is very sparse; the oldest still existing chasuble was made before 1576 (Pichler 1978). At Schlägl, the capes of the traditional Premonstratensian monks are made of squirrel fur. Some of them were made c. 1750 and are still in use (see Fig. 8a).

Smaller churches like Vienna-Oberlaa also still possess old vestments. More than 20 historic chasubles in different colours from c. 1700 to 1900 are stored there together with the associated stoles, copes (*pluviali*) and maniples (Inventory Oberlaa 2013). The oldest garment still in use is a green chasuble with corresponding stole and maniple, dated to 1706 (Inventory Oberlaa 2013). These items were worn once a year until 2014 (Fig. 8b).

The decision to use or not to use old vestments rests with the priests but it also depends on the traditions of the church and the parish. In cathedrals and monasteries the vestments are usually used to emphasise a long and rich tradition, and especially monasteries have a strong semiotic system of referring to history and traditions. Therefore, if an old vestment is used, it is also handled with particular care. A chasuble is never worn directly on the skin, and linen and cotton undergarments such as the long-sleeved albs are used, while the stoles are protected with a narrow linen strap around the neck (Fig. 9a). The use of such garments in Holy Mass lasts about 1.5 to 2 hours, including taking it on and off. Nevertheless, there are problems of preservation involved in the use of old and sometimes brittle textiles. In particular, movements by the priest may harm the objects, and when the priest leans against the altar or if he sits down, the chasuble can be damaged. In some churches specific seats were installed to overcome these problems and to protect the valuable historic garments during their use. For instance, at St. Stephan's the *kathedra* of the bishop has a slit between the seat and seat back, so that the chasuble can hang freely without the priest sitting on it (Fig. 9b).

Conclusion

In archaeological excavations carried out in early modern graveyards and churches sometimes graves of Catholic priests can be identified. In cases of good preservation the liturgical garments in which the priest was buried can be identified. Ecclesiastical textiles (*vestes sacrae*) play an important role in textile history and our understanding of the history of Catholicism in Europe. It is important to describe new finds, and there are still old paraments from the 16th

Fig. 8. Liturgical garments in use: a) Schlägl monastery, rose vestments and squirrel cape from 1730-1750; b) Oberlaa, chasuble, stole and maniple from 1706 (Photos: K. Grömer 2014, courtesy of Oberlaa Church and Schlägl monastery).

Fig. 9. Protection of historical vestments during use in St. Stephan's Cathedral: a) priest wearing a stole and chasuble from 1740; b) seat of the bishop (Photos: K. Grömer 2015, courtesy of St. Stephan's Cathedral).

to 18th centuries stored in the sacristies of Austrian houses of worship, from small village churches to cathedrals and monasteries, that still need to be recorded. In some cases, historical textiles are still in use – not only garments from the 19th century, but also numerous Baroque paraments and even items from earlier periods.

An important aspect concerning the dating of objects found in graves has to be addressed here. As historical paraments are still in use in Catholic churches, at least in Austria, a discussion is needed about which garments have been selected for the burial of a priest: *i.e.* were they 'new' garments or ones that were already hundreds of years old, no longer suitable for daily service and therefore chosen to serve as funeral garments? This has implications for archaeological dating practice, as archaeologists tend to date graves according to the date of grave goods and clothing found within. It means that in some cases the dating of the grave (if there is a tombstone) and the dating of the liturgical garment found in it might differ. Finally, it is important to note that practice in the contemporary world is different: since the Second Vatican Council it is has been forbidden to bury historical liturgical vestments in graves.

Acknowledgements

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Svetlana Kochkurkina and Olga Orfinskaya

Archaeological Textiles of the 10th to the 12th Century from the Gaigovo Barrow Group in Russia

Introduction

Most of the extant funerary monuments of the 10th to 13th centuries in the southeastern Ladoga area (Russia, Leningrad oblast) and the Republic of Karelia are barrows. These are situated on the banks of the rivers S'as', Tikhvinka, Voronezhka, Pasha, Kapsha, Oiat', Svir', Olonka, Tuloksa, Vidlitsa and on the north bank of Lake Onega (Fig. 1). The past 150 years' work has created a substantial database of many aspects of material culture and history from this period (for more details, see Кочкуркина and Линевский 1985, 118-130; Кочкуркина 1989; 1996, 286-310) (the authors have not been able to find literature about these monuments in other languages). The barrows are securely dated owing to such datable articles as Scandinavian brooches and weapons such as swords and spearheads, as well as western European, Byzantine and oriental coins. Coins with riveted loops were used, along with beads, to form necklaces; perforated coins could have been sewn onto clothes (Кочкуркина 2013). As far as textile remains are concerned, organic materials survive poorly in sandy barrow mounds. Textiles tend to be found alongside bronze articles and birch bark.

The first investigator of the textiles from burials of the Ladoga Kurgan culture was O. I. Davidan (Davidan 1989, 316-336) more than 20 years ago. In the meantime, techniques for working with archaeological textiles have improved with the use of methods from the natural sciences, and the database of archaeological artefacts has increased substantially. Moreover, some of the textile samples from the barrows found by A. M. Linevsky had not yet been subjected to careful analysis

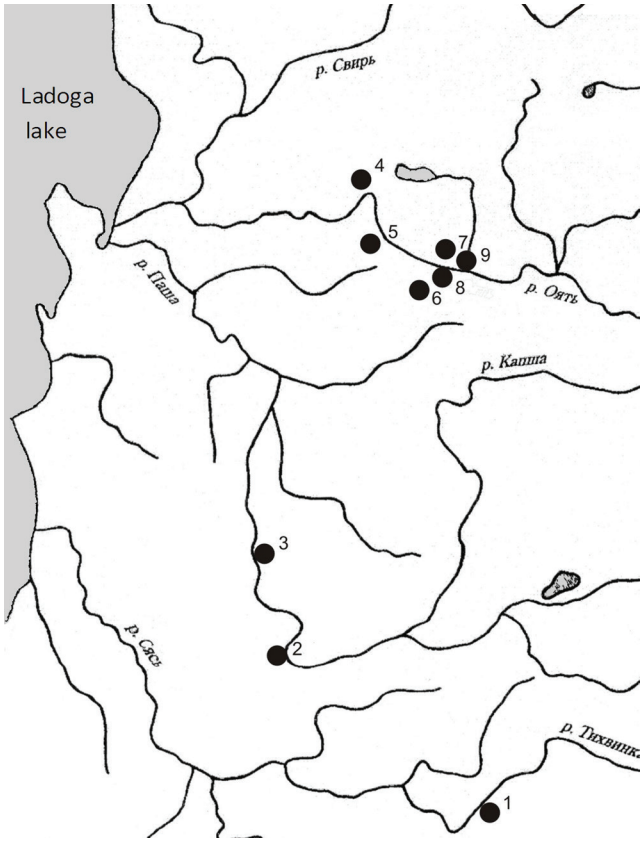

Fig. 1. Map of barrows with textile remains.

1 – Novoselsk 14
2 – Zaozer'e-6
3 – Leonovo-112
4 – Akulova Gora
5 – Kurgino
6 – Alekhovshchina-1
7 – Gaigovo
8 – Niubinichi
9 – Kiagino-Kruglitsy

at all. We therefore decided to return to the textiles in the hope of gaining some new information about the textile qualities and origins, and possibly also about the dress styles of the Ladoga population in the 10th to the 12th century.

Textile preservation

Where textiles were in contact with bronze objects and bark, they were preserved in the sandy ground. The storage facility of the Institute of Language, Literature and History of the Karelian Research Centre of the Russian Academy of Sciences received those textile fragments and archaeological objects in the years 1947-1949. They were kept between glass panes (a storage method of that time); photo fixation and preservation description were not carried out. The textiles were taken out of their glass containers for this study. Dry and fragile fabrics were washed in 5-10% polyethylene glycol solution in water (a restoration technique developed in the Department of Archaeological Textile and Leather Restoration of the Igor Grabar Restoration Centre (Moscow) led by Natalia Sinitsyn) and thus became softer; any deformations were removed during washing. Other tissues that were in a stable state were not subjected to such techniques. The fabric fragments were then put into individual packages made from special museum paper and documented. The state of the textiles were monitored, and appropriate temperature and humidity conditions were provided.

The Gaigovo Kurgan group

The Gaigovo Kurgan group of barrows consisted of 14 mounds situated on the right bank of the Oiat' River 0.7 km upstream from the village of Gaigovo on a high ridge some 30 m above the river level between two forest roads. By the 1980s, all traces of the barrow group had been obliterated. Eleven mounds excavated by Linevski in the 1940s were set in a row, whilst mounds 2 and 3 were located somewhat aside. Mounds 1-4 (12 x 10 m) were relatively high and steep-sloped, mounds 3 and 4 had deep hollows reaching to the bottom, and barrows 1 and 2 had shallow pits. Barrows 5-14 were low and disintegrated. All mounds except 8 and 12 (apart from 5, 7 and 14, which had been empty), had been looted. The cemetery was an important find as a result of the rich materials from the first four barrows, including western European coins.

Research methods

Textile remains were discovered beneath three barrows. Whilst it would have been desirable to have used thin layer chromatography to determine the colourants on the textiles and to explore the Sr isotopes in the wool,

Fig. 2. Gaigovo-1. Birch bark fragment with remains of twill (1) and a tabby (2) fabric (Photo: Authors).

the resources available only made it possible to use general microscopic techniques as follows:

- the structure of fabrics and ribbons was investigated by optical microscopy in non-polarised light with 10-40x magnification
- optical microscopy in transmitted and reflected polarised light with 200-400x magnification was used to define the nature of textile fibres.

Chemical methods of research for the presence of protein were also used to determine the plant fibres and the sinew threads of the fragments in a poor state of preservation.

Results

Barrow 1

(11 x 10.5, 2.5 m high, 0.9 m to ground level)

General description: This barrow, containing a cremation burial, was located on the western border of the Gaigovo cemetery. About half of the mound was dug over. The burial contained three sets of women's ornaments belonging probably to a single (adolescent) female.

The first set was wrapped in birch bark and measured 0.4 x 0.2 x 0.1 m. It consisted of three parts divided by sand layers. The first part of this set, unharmed by the fire, yielded 18 beads (carnelian of various shapes, mosaic glass and crystal) and three bronze pendants. There were no calcified bones. The second part was divided from the first by a layer of pure sand 5-6 cm thick and contained calcified bones mixed with women's dress objects in bronze partially damaged by fire – arm-rings, duck-shaped pendants, wire spirals and horseshoe-shaped fasteners – as well as three Czech coins of the following dates: 1) Boleslav I (AD 935-967); 2) during an interregnum (AD 1003); 3) unknown date. The sand layer may have originally

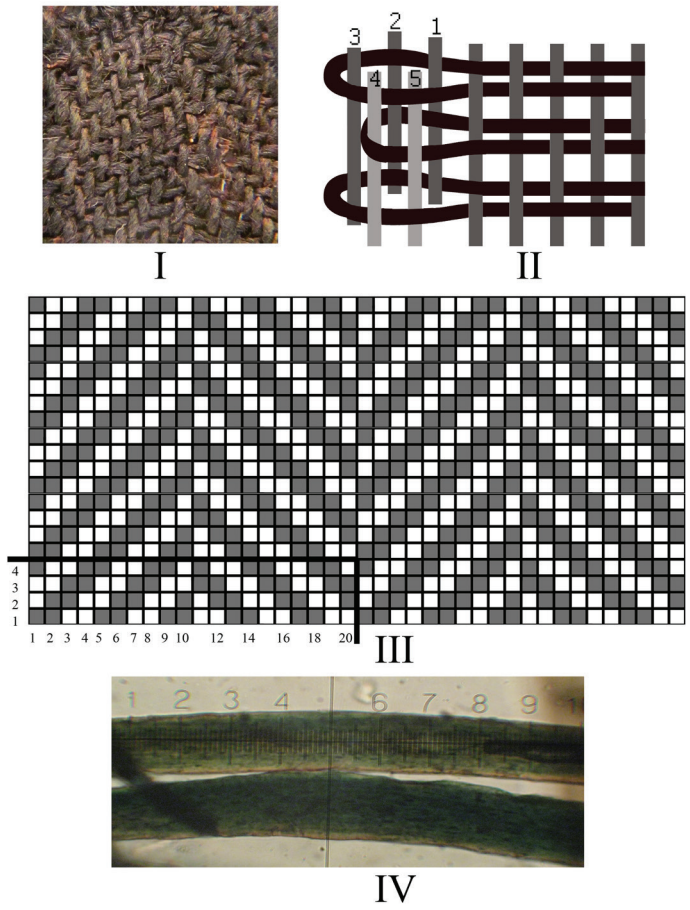

Fig. 3. Gaigovo-1. Twill fabric (2/2).
I) Microphoto of fabric
II) Pattern of round selvedge of fabric from five threads
III) Pattern of weave with twill pattern unit of 20 threads
IV) Microphoto of wool fibres (division 0.0017 mm)
(Photos and drawings: Authors).

contained textiles. The third part of the bundle was also divided from the second by a 5-6 cm-wide layer of pure sand, again perhaps originally containing textiles. It yielded such bronze articles as 19 round decorated bells, seven fragments of spirals about 3.5 cm long from which the bells hung, two fastenings with knotted tips, a decorated ear-pick with a ring for hanging and a knife binding with a ring. Iron articles included a chain for a cauldron 39 cm long, a key, two knives melded together with calcified bones, a whetstone and four beads. The birch bark inner surface bore the remnants of a black wool broken twill cloth (Fig. 2). It appears that human bones and articles used in the cremation were wrapped in a black cloth or an unidentified article made thereof after the cremation. Ornaments not subjected to fire, probably votive articles, were put into the same package. The division of the birch bark package into three parts by sand layers 5-6 cm thick can be accounted for by the presence of a completely vanished organic material. Similar sand layers can be seen in a birch bark basket from a 10th-century chamber grave at Pskov (Зубкова and Орфинская 2007, 56-75).

The second set of artefacts was located on the surface of the ground in the southwestern section. A handmade vessel contained bronze articles – two duck-shaped slotted pendants and two undecorated lamellar arm rings – and two teeth of a ruminant. These articles had not been subjected to fire.

The third set was discovered at the same level 0.9 m to the west. They contained textile remains tied with a long, decorated wool ribbon, which survived in a birch bark bundle. Inside the bundle there was also a necklace 130 cm long and consisting of 53 double bronze beads; these were attached with thongs to two fasteners, one made from wire and another braided as a plait from three wires and fragments of decorated bone appliqués as well as one twisted and four narrow lamellar arm rings (a votive deposit?). This burial is dated to the early 11th century AD. There was an oval pyre site (1.8 x 1 m) in the mound and three handmade vessels.

Textiles: The first and third bundles in Barrow 1 yielded a dark, almost black, broken twill fabric made from wool fibres (Fig. 3). In total, it was found in 29 small fragments. The largest fragment has a size of 10 x 2 cm, the smallest 1 x 1 cm. The warp and weft threads are similar in thickness and spinning (z-spun). The thickness in different samples varies from 0.2 to 0.8 mm, mainly owing to differing states of preservation. The average thickness of threads is 0.5-0.6 mm. The thread count in the various fragments is 14-22 warp threads and 12-17 weft threads per cm. The average thread count of these fabrics is 18/15 per cm. Microscopic examination shows that wool fibres of the cloth contain a blue dye, namely indigo (the indigo particles are clearly visible on the micrographs of the fibres). Thus, the fabric may have been either navy blue, or black if a brown dye was added. The tubular selvedge made from 5 warp threads has survived on three fragments.

A light-coloured tabby weave fabric with painted decoration was recovered from the third bundle in 15 fragments (Fig. 4). The largest fragment has

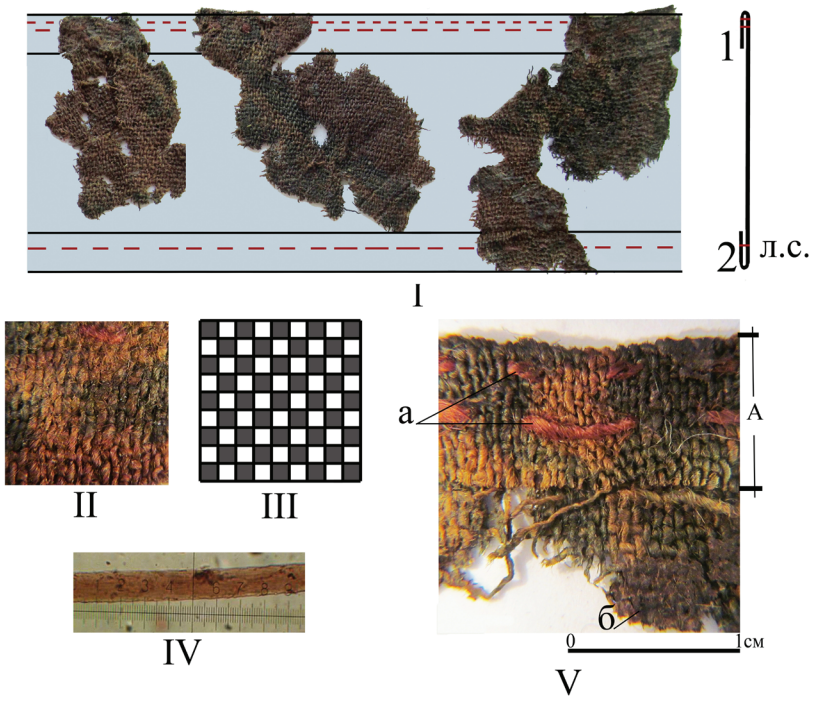

Fig. 4. Gaigovo-1. Light-coloured tabby fabric:
I)Pattern of the strip of light-coloured fabric (reconstruction)
II) Microphoto of the fabric (square side 1 cm)
III) Pattern of textile weaves
IV) Microphoto of woollen fibres (division 0.0017 mm)
V) Microphoto of part of the light-coloured fabric:
A) tucked-in section
a) stitching threads
б) remains of badly damaged dark-coloured fabric
(Photo and drawings: Authors).

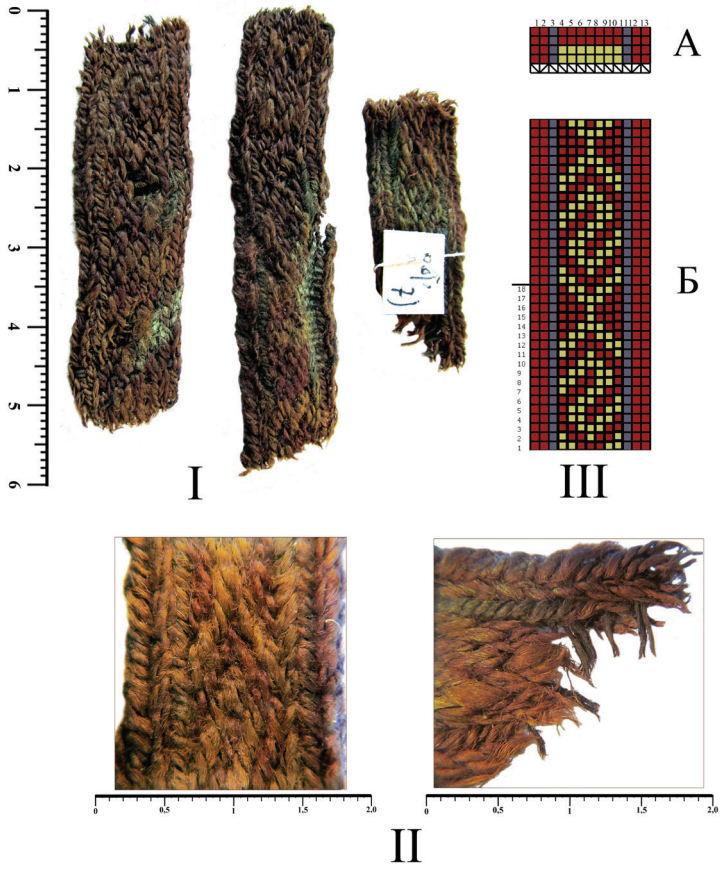

Fig. 5. Gaigovo-1. The ribbon with red-yellow design:
I) General view of fragments
II) Microphoto of ribbon
III) Pattern of textile weaves:
A) pattern of tablet threading
Б) design pattern
(Photos and drawings: Authors).

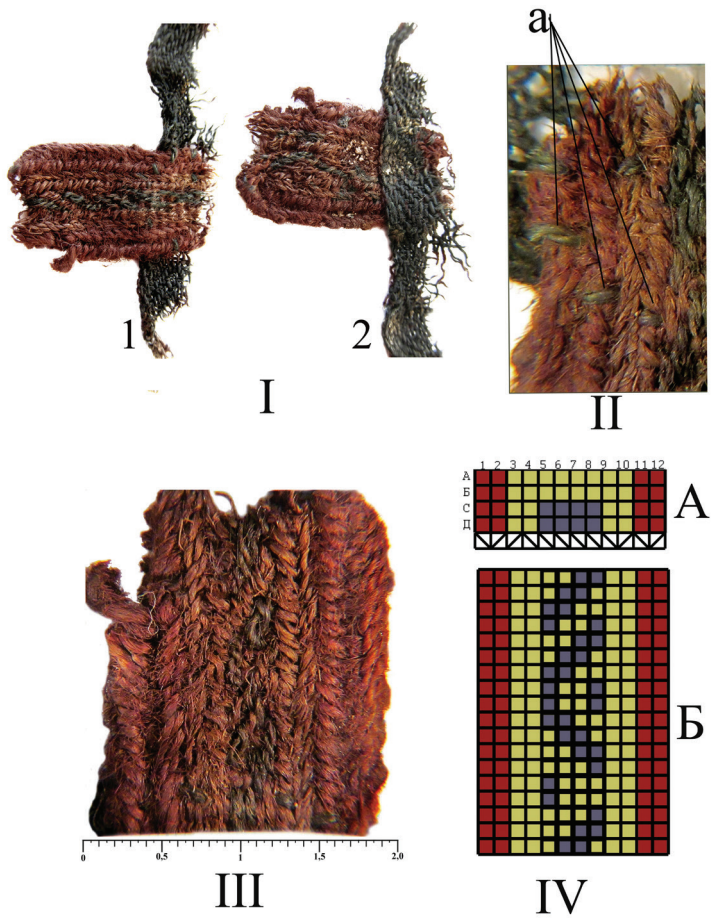

Fig. 6. Gaigovo-1. Fabric fragment with a sewn-on ribbon:
I) General view of fragment:
1) reverse
2) face
II) Microphoto of part of ribbon joining fabric:
a) stitching threads
III) Microphoto of ribbon
IV) Pattern of textile weaves:
А) pattern of tablet threading
Б) design pattern
(Photos and drawings: Authors).

a size of 5 x 4 cm, the smallest 0.5 x 0.8 cm. The fabric has a wool warp and weft threads similar in thickness and spinning (z-spun). Their average thickness is 0.5 mm. The space between the warp threads is much less than that between the weft threads. The average thread count of the fabric is 18/10 per cm. Blurred outlines of painted decoration in blue/green and yellow on a light brown background can be seen on the cloth. The fragments in question are too small to identify the painting technique, so we called this 'cloth printed fabric'. The fragments have tucked-in hems and seams made from red wool thread. One fragment was tucked in on two opposite sides, which implies that a strip of the fabric was cut and sewn onto another fabric. The width of the strip without tucked-in hems is 5 cm. On its inner side there is a thin dark layer identified by microscopic investigation as a dark wool fabric in an advanced stage of decomposition. In other words, the woven strip was an appliqué sewn onto an object which was probably made from the wool fabric detected in this bundle. The seams were made with the forward movement of the needle and a red wool thread of the second order (s2z) was used.

The third bundle contained four varieties of ribbons woven with tablets that can be divided into two groups based on their technological characteristics:
1. A ribbon 1.6-1.8 cm wide made of relatively thick threads (0.6-1.0 mm) with S2z spun red, yellow and dark blue/green wool where the brown weft thread is also made of wool (z) and is used in double weaving. The ribbon bears impressions of bronze articles on both sides (Fig. 5) and is in three fragments (6, 7 and 4 cm in length). Thirteen tablets were used to weave the ribbon, each with 4 holes, producing a density of 32 warp and 6 weft threads per cm. In addition, a broken twill fragment has a ribbon perpendicularly sewn onto a side selvedge with a green woollen thread (width 1.8 cm / length 3.2 cm). This ribbon has a blue design on a yellow background (Fig. 6). The warp threads are red, yellow and blue wool, 0.8 mm thick, with twist S2z. The weft threads are brown wool 0.6 mm thick with a double Z twist. This ribbon needed 12 tablets with 4 holes in each, producing a density of 27 warps and 8 weft threads per cm. Small fragments of this ribbon were found embedded into the birch bark that was probably used to wrap the fabric. The characteristics of

the threads of these ribbons are similar; the difference is in the design and the number of tablets used.
2. A ribbon about 1 cm wide was made of thinner wool warp threads (0.6-0.8 mm) (Fig. 7). There were 11 such fragments (3-18 cm in length). Its main distinctive trait is the presence of weft fibres derived not from wool but from a plant; these are almost completely lost. The weaving was performed using 8 tablets with 4 holes each. This second group can be divided into two subgroups: a) those with a design of wool threads and b) those without it (as of 2013). A thin, plant-derived thread used as warp thread was encountered in several samples. It implies that this group once had a more elaborate decoration. Narrow ribbons could have been either clothes trimmings or separate articles, or could also have been included in a headdress system involving straps and metal decorations.

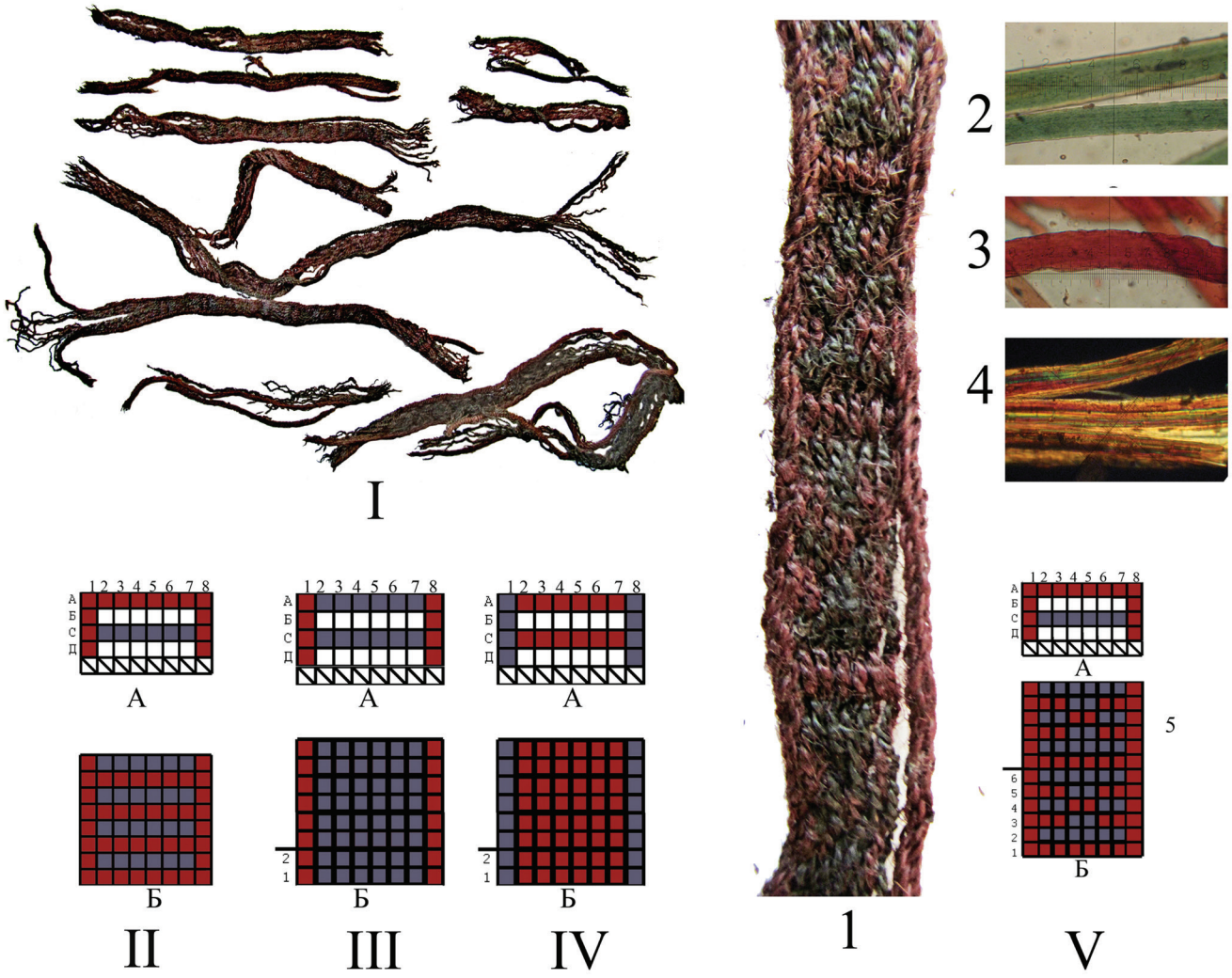

Fig. 7. Gaigovo-1. Second group of ribbons.
I) General view of fragments
II) Cross-striped ribbon; pattern of textile weaves
III) Blue ribbon with blue selvedge; pattern of textile weaves
IV) Red ribbon with blue selvedge; ribbon with geometric design:
1) general view of ribbon
2) microphoto of either blue or green woollen threads
3) microphoto of red woollen threads
4) microphoto of plant fibres (темное поле)
5) pattern of textile weaves
А) Pattern of tablet threading
Б) design pattern
(Photos and drawings: Authors).

Results: The existence of the following items can now be stated:

- black (or at least dark) wool fabric used to wrap the bones and the metal jewellery after cremation;
- precious metal products, probably funerary gifts, wrapped in the same fabric or wrapped in something made from that fabric (such as a bag, dress or apron);
- fabric ribbons which may have been used for tying the birch bark scrolls, as belts, as clothing decoration or as part of the headdress system involving straps and metal decorations;
- black fabric with a tubular selvedge (round frame) which was woven on the vertical loom.

Fig. 8. I) The archaeological material from Barrow 2 at Gaigovo.
II) The female costume design from Barrow 2 (after V.A. Bazegsky).

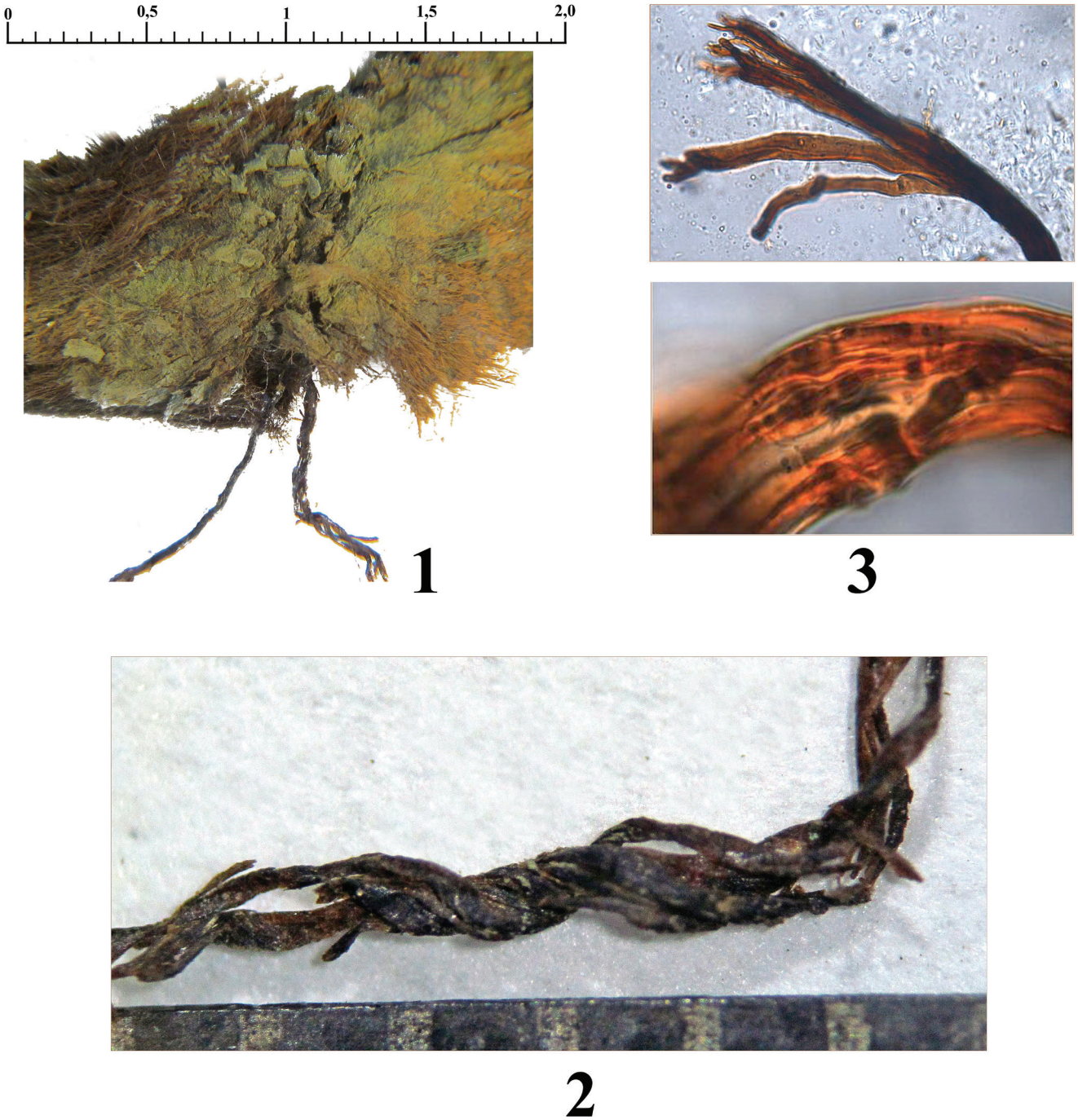

Fig. 9. Gaigovo-2. Fragment of fur article sewn with sinew threads. 1) Section of fur with a seam. 2 and 3) Microphoto of sinew thread at different magnifications (Photos: Authors).

Barrow 2
(9 x 9.5 m, 1.5-2 m high, 0.8-1 m to ground level)
General description: This barrow with two inhumations was located 20 m away from the main group. A burial pit (2.3 x 1.4 x 1.5 m) in the southwestern section contained a burial of a man lying with the head to the southwest. Inside the pit there was a single-row timber structure affixed with eight nails, two at every corner. The bottom was covered with bearskin. The remains of the skull including fragments of the upper and lower jaws were encountered in the southern end of the burial. No traces of the skeleton bones were found on the thick fur bedding. A spearhead pointing west lay on the bottom of the burial pit near its north wall.

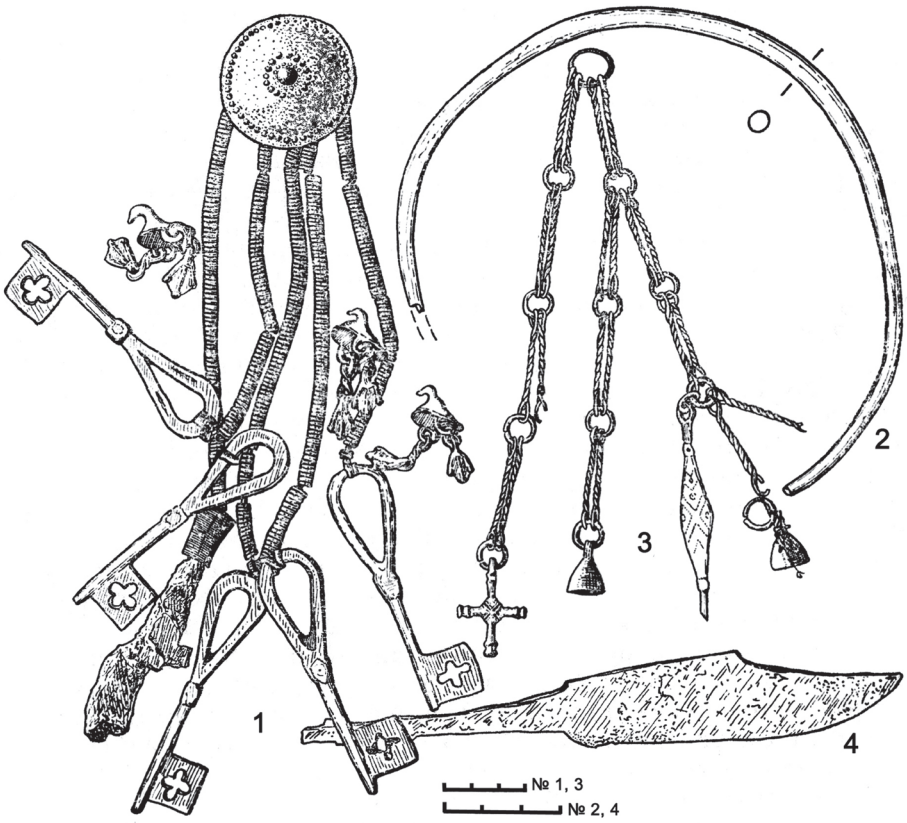

Fig. 10. The archaeological material from Barrow 3 at Gaigovo.

On the ground surface near the edge of the burial pit there was a woman's inhumation (the deceased's height was 160-165 cm) with the head pointing south. The body was wrapped up in birch bark which provided a high degree of conservation. Four bronze temple rings with a scroll at one tip, worn two on each side, were found at the head of the deceased. One ring had a shallow bead of the same metal strung on it and a bronze wire wound around it. There were 15 glass beads and a ribbon around the neck, the latter of which was not preserved (the archaeological report mentions the ribbon but does not contain any more information about it). A complex ornament including a ring-shaped fastening with a chain made of double and triple rings 24 cm long, from the end of which hung a crucifix and conical pendants, lay a little below the collar-bone on the right side of the chest. Another complex ornament consisting of a fastening, a chain of triple rings 20 cm long with an attached needle-case, a fang and an ear-pick with decoration was also found. Yet another set was found to the right of the pelvis. It included a decorated belt ring, seven spirals with beads (each 34-37 cm long), two rattling, shallow duck-shaped pendants and two key amulets. The next spiral had a similar duck-shaped pendant and a single-sided comb with decorated appliqués (Fig. 8). An unclosed arm ring, a decorated finger ring, a flat

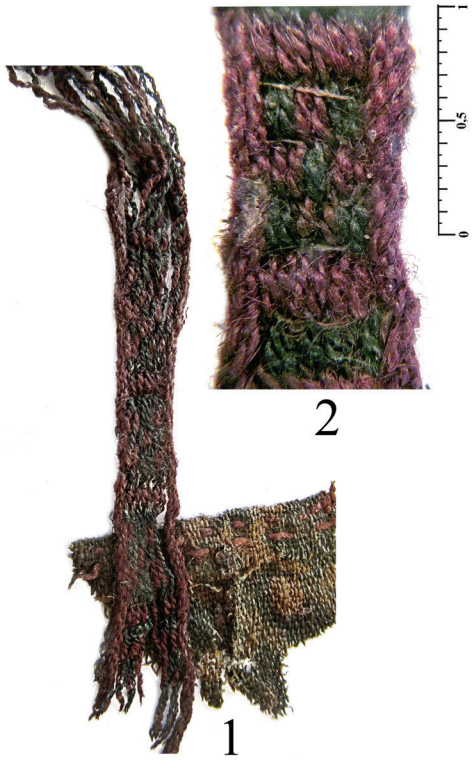

Fig. 11. Barrow 3 at Gaigovo. Fragment of tabby fabric with sewn-on ribbon. 1) General view of fragment. 2) Microphoto of ribbon (Photo: Authors).

finger ring and three Frisian coins minted in Emden under count Hermann von Kalvelage in AD 1020-1051 and in Dokkum and Garrelsweer (or Groningen) under Ekbert II, margrave of Friesland in AD 1068-1090 (two items) were placed near the left arm stretched out along the body. Two wool cloth scraps one over the other and a few pieces of squirrel fur survived under the bronze spirals. A one-sided comb with decorated bone appliqués and a fragment of a bronze binding of a leather case were found on the ground under the mound.

Fragments of five wheel-thrown vessels were discovered east of the burial pit. Fire remains were identified 0.5 m above the ground surface near the burial pit and partially above it. Both burials date to the 11th to early 12th century. A cylindrical black bead with spiral-waved inlay and small fragments of a fur article sewn with sinew threads (Fig. 9) were found in the northeastern section in a looter's pit near the centre of the barrow. The remains of a tabby fabric made from plant fibres have survived on the hair side. It may be inferred that these are fragments of a fur coat and a piece of clothing made from plant fibres, either a shirt or a gown.

Textiles: The ribbon, which was described in the report, has not been preserved, and there was no information recorded about its structure and composition. Small areas with heavily damaged tissue were found on the separate fur fragments. The technological characteristics of the textile could not be determined because of the poor state of preservation. Plant fibres were identified in these parts. The only indication for a reconstruction of the garments is the set of metal jewellery in the barrow.

Results: The existence of the following items can now be suggested:

- fur clothing in one of the graves, probably closed at the top using fabric made of plant fibres;
- fur fragments that may have been remnants of clothes or a headdress, perhaps overlapped with cloth that covered all of the buried body;
- underclothes (shirt or dress), if the side with fur was facing inward to the person.
- a ribbon on the woman's neck which may or may not have held the glass beads;
- the two layers of textile and fur fragments on the right-hand side of the pelvis (not preserved), which may have belonged to a bag.

Barrow 3

(10 x 10.5 m, 2 m high, 0.9 m to ground level)

General description: This barrow contained an inhumation and a destroyed burial and was located 12 m east of Barrow 2. The central part of the mound (5 x 5 m) was destroyed by a looter's pit 2 m deep. An unidentified western European silver coin was found at its bottom.

A female inhumation pointing south was revealed on the ground surface in the southwestern section. Two temple rings with a scroll at the tip survived at the head of the deceased, along with a wire torque and carnelian beads around the neck. Chains 11-12 cm long consisting of doubled twisted sticks and loops at the tips alternating with rings hung from a wire ring near the left shoulder; a cross similar to that from Barrow 2, a conical pendant with a geometric design, an ear-pick and another conical pendant hung from the tips of the chains at the same level. A jewellery set was found on the right side of the chest yet somewhat lower, nearer to the waist. The set included a circular fastening with small protrusions along the rim and at the centre, five key amulets hanging from it on five spiral threads and a knife wrapped with bronze wire with a partially surviving leather case. There were three hollow, rattling, duck-shaped pendants (Fig. 10). Eight Frisian coins were found approximately at the same level. They were struck in Ewer under Ordulf, Duke of Saxony, in AD 1059-1071 (three coins); in Groningen under Emperor Heinrich IV and Wilhelm de Ponte in AD 1056-1076; in Emden under count Hermann von Kalvelage in AD 1020-1051; in Dokkum under Ekbert II in AD 1068-1090; in Groningen under Ekbert I in AD 1057-1068; and in Garrelsweer under Count Hermann in AD 1059-1086. The ninth coin is unidentifiable. A knife was found separately in the northwestern section of the mound. A decorated wheel-thrown vessel with a stamp in a perfect state of preservation was discovered on the surface of the ground. The burial dates to the early 12th century.

Textiles: Textile samples were recovered from this burial but were not described in relation to the deceased. These were a light-coloured, patterned, wool tabby cloth, a composite ribbon with white, red and black colours and a wool broken twill fabric.

The light-coloured wool fabric was found in three fragments (3.5 x 4.5, 2 x 3.5 and 2 x 2 cm). The fabric has the same thickness and degree of (z-)twist in the warp and the weft. The medium thickness is 0.5 mm. The density is 20/10 threads per cm. Fuzzy outlines of a pattern in blue/green and yellow on a light brown background are visible on the textile. Hems and seams made of red wool thread are preserved on one fragment.

The ribbon, which is 1 cm in width and 14 cm in length (Fig. 11) was sewn to this fragment, perpendicularly to the hemmed edge. The warp threads of this are red and black wool with a thickness of 0.5-0.8 mm and S2z twist with some residues of warp threads of

plant fibres. The weft was made from plant fibres (in a poor state of preservation) about 0.2 mm thick; the twist could not be determined. Together it seems the original ribbon had a pattern of red, black and white, as the weft was almost certainly of linen. The ribbon was made using 8 wooden tablets with 4 holes each. The thread density we have calculated is 32 warp and 8 weft threads per cm.

Eight fragments of broken twill made from black wool threads also survived, the largest of which is 8 x 5 cm and the smallest 1.5 x 0.8 cm. The warp and weft threads of this are approximately the same thickness (about 0.6 mm) and degree of (z-)twist. The average thread count is 18/18 per cm. The microscopic study results have shown that there is blue indigo dye in the wool fibre of the textile. The tubular selvedge of 10 warp threads is preserved on one of the fragments.

Results: The examined fabrics and ribbons are akin to those from Barrow 1, yet the side selvedge of the twill cloth from this barrow has 10 selvedge cords instead of five. Ribbons sewn onto fabric were found both in Barrow 3 and in Barrow 1 (Fig. 11), although in Barrow 1 it was wide wool ribbon and in Barrow 3 it was narrow half-wool ribbon. The yellow-brown fabric made of plant fibres and mentioned in the excavation report is of interest, but unfortunately has been lost.

Conclusion

Barrows 1 and 3 contained similar textile sets consisting of two kinds of fabrics and ribbons. It seems likely that the patterned cloth in Barrow 1 acted as a decoration for the twill article. The presence of untreated side selvedges implies that the article was rectangular rather than of an elaborate cut. It is possible that a strip of tabby cloth was sewn to the short sides of this rectangle while ribbons were sewn either to both sides of a corner or to all four corners. This similarity suggests similar dress articles were worn by the buried women. However, the difference in funerary rites is worth noting: cremation in Barrow 1 and inhumation in Barrow 3. There is also a time lag of about 100 years between the construction of the two barrows, which may mean a certain amount of continuity in burial practices and weaving traditions between the Finnic and Baltic populations of the Oiat' River area, suggesting a community (in ritual and weaving) formed in the area.

The combining of western European and local ornaments is a characteristic of women's garments of the 10th century, particularly those of the population of the Oiat' River area. Many western and northern European articles disappear in the 11th century. Ring-shaped fasteners with spiral tips become typical of women's ornaments instead of Scandinavian brooches with two catchplates that fasten the clothes on the shoulders. They were replaced by the ring-shaped fasteners – which performed the same role – under the influence of fashion or ethnic movements. This means the shape of the garments may not have changed, becoming the local tradition for this place. Complex breast ornaments with diverse animal- and bird-shaped pendants also appear. The set of women's ornaments also changes in the 12th to 13th centuries: temple rings become widespread under Slavic influence.

Some details of men's clothing can be discerned from the archaeological record of other barrows from the Ladoga area, although grave goods in male burials are scarce: the shirt collar was usually fastened using a brooch with spiral tips, and a knife, a steel and a flint for striking fire hung from a leather belt sometimes decorated with bronze plaques.

Black wool twill fabric with decorations made from other materials similar to those discussed here was found in the burial ground of the Vetluzhsky-Vyatka region dating to the 9th to 11th centuries (Орфинская and Никитина 2014, 70-92). Broken twill fabrics were found all over Europe in that era (Bender Jørgensen 1992, 85): they form around 35% of textile remains at Birka (Geijer 1938, 37-39) and around 32% of those at Volin (Nahlik 1958, 257). The Scandinavian broken/diamond twill finds (Viking periods) were discussed by Bender Jørgensen in 1986 (Bender Jørgensen 1986, 357-358). This type of fabric is also known in the central and northwestern parts of Russia (Нахлик 1963, 228-313; Ефимова 1966, 127-134; Давидан 1982, 100-113; Bender Jørgensen 1992, 85; Елкина 2005, 141-146; Орфинская 2005, 147-156; Иванова and Орфинская 2014, 64-68). Cybulska and Maik considered broken twill fabric in the 11th to 12th centuries to have been both locally made and imported to Poland (Cybulska and Maik 2014, 317-331).

Where exactly the broken twill fabric for the Lake Ladoga region was made is still an open question. We see a high level of technological sophistication in the spinning and weaving, as well as the ability to dye wool fibres in a black colour: this shows a relatively high level of craft development. However, it is not clear if the people who left those burials had such skills. Tablet-woven wool ribbons were almost certainly made by local production. Ribbons made from plant fibres (probably linen), cannot confidently be attributed to local production as we have so little information on the qualities of these threads and their source.

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Abbreviations
РАН – Russian Academy of Sciences
ИА РАН – Institute of Archaeology Russian Academy of Sciences.
НЦ РАН – Science Centre of the Russian Academy of Sciences
АН РТ – Academy of Sciences of the Republic of Tatarstan

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An 11th-Century 2/2 Twill from a Burial in Shekshovo in Russia

Fig. 1. Shekshovo burial site (1) and dwelling site (2) (Photo: The excavators).

Fig. 2. Overview of site (Photo: The Institute of Archaeology, Academy of Sciences, Moscow).

Introduction

During the excavations in 2011 of the Shekshovo 9 burial site, located in the Ivanovo region, Upper Volga, 180 km northeast of Moscow, directed by N. Makarov, I. Zaytseva and A. Krasnikova of the Institute of Archaeology, remains of a remarkable burial with preserved textile came to light (Makarov *et al.* 2016, 98-100).

Shekshovo 9 is one of the well-known Viking Age burial places of the Suzdal principality, which formed the northeastern part of medieval Rus'. Field investigations in Shekshovo began in 1852, when Alexej Uvarov excavated 244 barrows with cremations and inhumations with grave goods of the 10th-12th centuries in the framework of his extensive excavation campaign in the Suzdal area. The burial site was rediscovered in 2011 after long-term surveys. The area has now been completely levelled by ploughing and there are no traces of grave mounds on the cultivated land (Fig. 1). Excavations conducted in 2011-2014 revealed the remains of 10 levelled burial mounds with both destroyed and intact cremations and inhumations, remains of ground cremations, dispersed in the ploughed topsoil, and 12 flat inhumations in the ground pits (Makarov *et al.* 2013a). Of special interest is the platform of a large mound, 17 m in diameter, surrounded by a circular ditch: the remains of barrow 1 where the textile was found (Fig. 2).

On the ancient surface soil at the centre of the platform, investigations disclosed the battle axe decorated with silver inlay (Fig. 3) with the remains of a wooden handle and a silver, gilded, horseshoe-shaped brooch with a piece of textile in close proximity to each other. The textile was found between the arc and the tongue of the brooch (Fig. 4). The artefacts were identified

Fig. 3. Battle axe (Photo: the Institute of Archaeo-logy, Academy of Sciences, Moscow).

as grave goods from a male burial on the platform of the barrow, despite the fact that the remains of the deceased have entirely disappeared due to ploughing. The battle axe was decorated with geometric ornamentation, a cross and two Ruric symbols (special symbols of the princes of the Ruric dynasty), which are known from the coins of the princes Vladimir and Yaroslav, as well as some other objects. Weapons with the Ruric symbols are unique finds in graves and in cultural deposits. Horseshoe-shaped brooches were used both in female and male costume. Two brooches of similar type are known from graves in the Suzdal region and in the Middle Dnieper, but their find context is not clear in either case. The burial is dated, on the basis of the artefacts and hand-made pottery from the ditch, to the first half of the 11th century AD (Makarov *et al.* 2013b).

Fig. 4. Shekshovo brooch with textile (Photo: Institute of Archaeology, Academy of Sciences).

Textile analysis
The bundle of textile fragments submitted for examination measures c. 1 cm and consists of several layers of fabric (Figs 5 and 6); they are of similar type and weave. The fragment is degraded and partly mineralised due to its contact with the metals.

Weave
The fabric is woven in a 2/2 twill with a thread count of c. 25 x 20 threads per cm (Figs 7, 8 and 9). No traces of seams or edges are present.

Thread
The threads are rather homogeneous and on average 0.4 mm in diameter. All threads are z-spun. The threads in system A are quite tightly spun with a spin angle of c. 45 degrees, while the threads in system B are less tightly spun and have an angle of 20-30 degrees, suggesting that system A is the warp. System A has c. 2.2-2.5 threads per mm, and system B has c. 2 threads per mm. This gives a thread count of 22-25 threads/cm in the warp and c. 20 threads/cm in the weft (See Figs 10 and 11).

Fibres
The surface of the fibres is degraded, but surface remains of scales indicate that it is wool. The fibres are quite dark. Light microscopy illustrates that the scales are either highly damaged or have disappeared (Fig. 12).

Fig. 5-8. The bundle of textile fragments measures c. 1 cm, (Photo: Irene Skals, National Museum of Denmark).

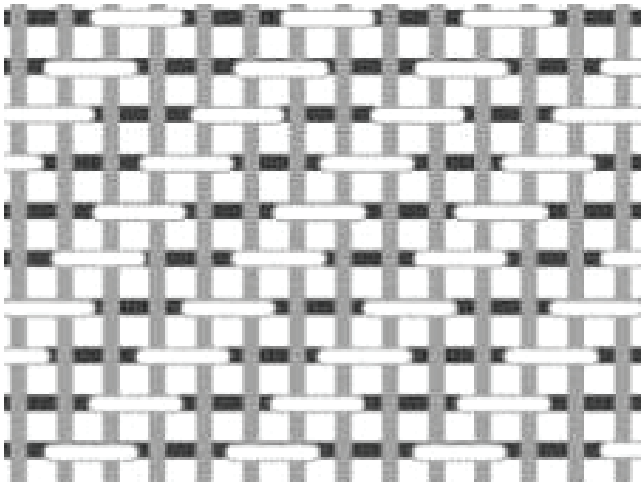

Fig. 9. Diagram of a 2/2 twill weave.

Fig. 10. The textile fragments (Photo: Irene Skals, National Museum of Denmark).

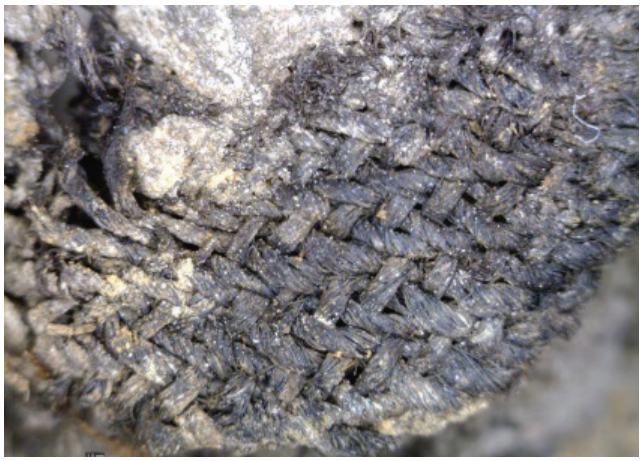

Fig. 11. The textile fragments (Photo: Irene Skals, National Museum of Denmark).

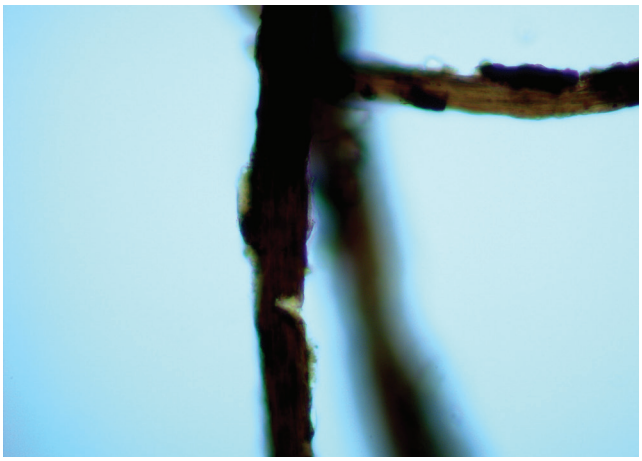

Fig. 12. The fibre in light microscopy (Photo: Irene Skals, National Museum of Denmark).

Fig. 13. Shekshovo sample magnification x40 (Photo: Ina Vanden Berghe, Koninklijk instituut voor het kunstpatrimonium, Federaal wetenschapsbeleid).

Dye and pigment analyses

Analyses were carried out by KIK-IRPA textile research unit (KIK analytical report 2013.12004, 13.09.2013). Organic dye compounds were analysed by HPLC-DAD on a single sample of thread (Fig. 13). Potential dyes were recovered from the fibres by two complementary extraction protocols, and thereafter analysed individually. (The identification of natural organic colourants was performed using High Performance Liquid Chromatography and photo diode array detection system (Alliance, Waters USA). Dye recovery was executed using (1) extraction with a hydrochloric acid, methanol, water solution followed by ethyl acetate extraction, and (2) by extraction in dimethylsulfoxide, followed by oxalic acid extraction (see Vanden Berghe *et al*. 2009, 1910-1921). No organic dye compounds were found.

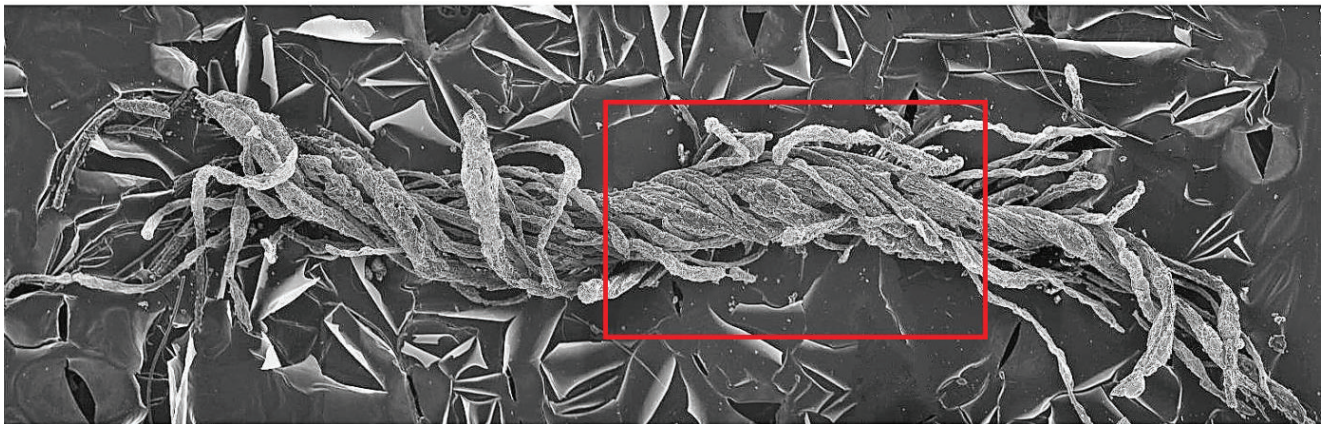

Fig. 14. SEM picture of black fragment with secondary electrons (magnification x80) (Photo: Ina Vanden Berghe, Koninklijk instituut voor het kunstpatrimonium, Federaal wetenschapsbeleid).

The presence of inorganic pigments was investigated by element analysis using scanning electron microscopy and energy dispersive X-ray detection (SEM-EDX, Jeol JSM 6300 and an Oxford Instruments detector). Prior to the analysis, the sample was coated with carbon to avoid charge effects. This revealed the occurrence of silver in the entire thread, as well as iron, copper, silicon and aluminium. Aside from the analysis of the thread as a whole (red selected area, see Fig. 14), point analyses were performed on fibres on the inside and surface of the threads (see Fig. 15 and Table 1).
Silver (Ag), iron (Fe) and copper (Cu) most likely derive from contact with the accompanying battle axe or other objects in the near surroundings of the textile. Humidity of the area may have caused the migration of these elements. The presence of iron could possibly also be indicative of black dyeing of the textile if combined with tannin. However, no such indication of tannin was found by HPLC analysis to support this hypothesis.
Aluminium (Al) and silicon (Si) are possibly indicative of aluminium silicates in the soil. Similar to the minor amounts of magnesium (Mg), potassium (K) and calcium (Ca), essentially found on the fibre surface, their presence can be attributed to contamination by the environment.

Strontium isotope analyses

Strontium isotope analyses were conducted with the aim of investigating the provenance of the textile fibre material. The textile sample used in the strontium isotopic investigations weighed only 6.89 mg.[1] Since the HPLC analyses revealed no evidence of organic dyes, the investigations did not incorporate the APDS step to remove contamination of organic dyestuffs but included a multistep pre-cleaning procedure specifically developed to remove dust particles (mostly silicates, based on hydrofluoric acid leaching) as well as potential carbonate particles (based on hydrochloric acid leaching, see Frei 2014).

Baseline

The geology of the area is highly complex, consisting of several cratons covered by sedimentary platforms and interrupted by mountain chains. Shekshovo lies on the East European craton, which is characterised by geologically old Precambrian igneous and metamorphic rocks. In order to establish a preliminary baseline of the site, samples of plants, soil and mussels from the Shekshovo area were analysed to provide the bioavailable strontium isotopic range of the area.[2] The results are presented in Table 2 and point to the complex geological background of the area as revealed by the quite large spread resulting from the strontium isotope analyses of the local plants, soil and mussels, from $^{87}Sr/^{86}Sr$ = 0.71041 (mussel) to 0.71575 (flower).[3] As the nature of these samples is quite different, they seem to indicate micro-geological environments like,

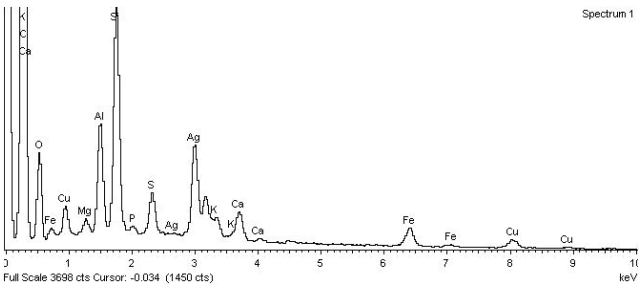

Fig. 15. SEM-EDX spectrum 1 (Photo: Ina Vanden Berghe, Koninklijk instituut voor het kunstpatrimonium, Federaal wetenschapsbeleid).

SEM-EDX Description	Type of analysis	Main elements	Minor elements
Global analysis of the thread	Selected area	Si, Al, Ag, O, S, Fe, Cu, Ca	K, Mg, P, C
Fibres inside the thread	Point analysis	Si, Al, O, Ag, Fe	S, Mg, Cu, K, P, C
Fibres on the surface	Point analysis	Ag, O, Si, Cu, Al, S, Ca, Fe	Mg, K, C
	Point analysis	Si, Ag, O, Al, S, Cu, Fe, Ca	Mg, P, C

Table 1. Detected inorganic elements in the sample.

for example, the mussels, which have the lowest strontium isotope composition. However, the various types of plants/flowers were collected in order to detect a broad range of root catchment levels, and to obtain a wide estimation of possible lithogenic soil variations. Hence, if we assume that these samples provide the extreme ends of the bioavailable strontium isotope range, then the baseline for the area lies between ~ $^{87}Sr/^{86}Sr$ = 0.7104 to 0.7157.

Textile sample

The strontium isotope composition of the wool and the corresponding leachates from the pre-cleaning steps are presented in Table 2. The strontium isotope composition of the wool (residue) yielded $^{87}Sr/^{86}Sr$ = 0.70999. When compared to the Shekshovo baseline range presented above, the textile sample thus points to wool of non-local origin, as it has a strontium isotope ratio that lies outside the bioavailable range, *i.e.* the wool sample is less radiogenic than the lowest baseline sample measured in the area (Fig. 16). However, future baseline investigations accompanied by a detailed local geological map are highly recommended in order to better determine the isoscape of the area.

Historical context

To date, textile finds have been rare in the Suzdal region and the textile find from Shekshovo presented here is therefore a first insight into the textile techniques of this time and area. The high thread count of the twill demonstrates a very fine quality of fabric, and could suggest it was used for (male) clothing. No organic

Lab. Nr.	chemical procedure	material	$^{87}Sr/^{86}Sr$	error (ppm)
KF 674	Textile (residue)	wool	**0,70999**	74
KF 674	HF leachate	wool	0,73485	7
KF 674	HCl leachate	wool	0,70817	3
Baseline				
KF 670 A		mussel	0,71041	10
KF 670 B		mussel	0,71046	9
KF 672		flower	0,71537	8
KF 673	Leachate	soil	0,71122	9
KF 797		*Asteracea s.*	0,71392	7
KF 798		*Populus tremula*	0,71352	10
KF 799		*Equisetum s.*	0,71575	11

Table 2. The strontium isotope composition of the textile, the leachates from the pre-cleaning steps and from plants, soil and mussels.

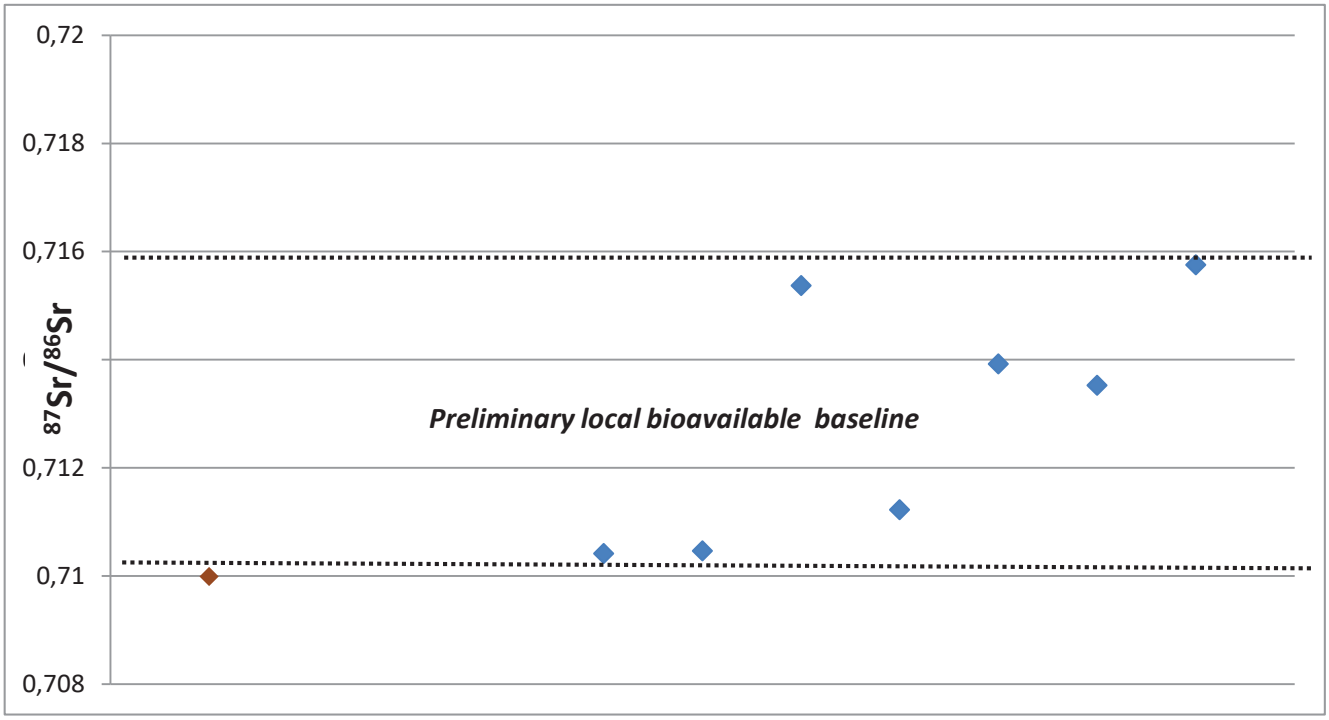

Fig. 16. Strontium isotope diagram depicting the bioavailable strontium isotopic range of the Shekshovo area – the so-called isoscape. Each baseline sample is marked in blue and the resulting preliminary baseline is marked between the two dotted lines. The strontium isotope composition of the wool thread is marked in brown and lies outside the preliminary local baseline, indicating that the wool is of non-local provenance. (Graphics: Karin Margarita Frei, National Museum of Denmark).

or inorganic evidence for dyeing was found on the black wool textile fragment from Shekshovo. The presence of silver, iron and copper is most probably due to contamination (migration) from the battle axe or other surrounding metal objects. The presence of iron together with tannin might have suggested black dyeing of the textile, but no tannin was found. So it is more likely that the blackening occurred in the burial due to the migration of the metals onto the fabric. In the geochemical tracing analyses, a preliminary baseline of the bioavailable strontium isotopic range was established based on samples of plants, soil and mussels from the Shekshovo area. It revealed the expected complex geological background of the area with a rather large strontium isotope bioavailable baseline spread ($^{87}Sr/^{86}Sr$ = 0.7104 to 0.7157). It is important to note that the strontium isotope composition of the textile is less radiogenic than the baseline range ($^{87}Sr/^{86}Sr$ = 0.70999) suggesting a non-local origin of the wool.

This type of twill, 2/2 twill of z-spun yarns, is very common in early medieval northern Europe and Russia. Among textiles from 9th- to 11th-century graves in Lithuania, the vast majority are 2/2 twills, although with lower thread counts than at Shekshovo (Pečeliūnaitė-Bazienė 2010, 189-194, especially 190-191). Fabrics of 2/2 twill and z/z spun yarn have come to light in graves dating to the turn of the 1st to the 2nd millennium AD, especially in eastern Finland and Karelia (Bender Jørgensen 1992, 97-98), but with lower thread counts than the Shekshovo fabric. Finland also has contemporary finds of 11th century 2/2 twills (Bender Jørgensen 1992, 97-98, 254-255). Fine quality 2/2 twills, although dated earlier, are also known from Viking Age Hedeby and Birka (Geijer 1938; Hägg 1985; 2015; Bender Jørgensen 1986).

Nahlik (1963, 254-258) analysed the types of fabrics found in Novgorod, and defined a certain type of local fabric, which is a twill weave with the characteristic fine, even yarns, and rather high density of warp in relation to weft, that distinguishes it from the fabric type found at Shekshovo. Khvoschchinskaia (1992, 128-133) has reviewed several thousand textiles from the mid-10th century AD from the area of Novgorod, and she concludes that the Novgorod textiles continue the Ladoga textile traditions of the 8th and 9th centuries of z-spun yarns and 2/2 twills: "In Novgorod and Ladoga, as well as in northern Europe, the majority of wool textiles are 2/2 twill" (Khvoschchinskaia 1992, 130). In contrast, in Western Europe, textiles from

early medieval Dutch settlements were composed of nearly 50% woven in a diamond twill, but 2/2 plain twills also represent a large group (Brandenburgh 2010, 41-79). Bender Jørgensen considers the plain 2/2 twill z/z spun yarn as "an eastern feature" (Type 4 in Bender Jørgensen 1992, 99) and notes that it is attested at the sites of Mikkeli Tuukkala in southeast Finland and Kaukola Kekomäki in Karelia, whereas sites in southwest Finland do not have samples of this type. This would suggest placing the Shekshovo fabric in a documented and recognised Northeastern textile tradition. The 2/2 twills with high thread count are, however, also well-attested in Scandinavian Viking-Age burials (Geijer 1938; Hägg 1985, 2015; Bender Jørgensen 1986; Andersson Strand 2011, 1-17;). Despite the numerous examples of comparanda, it must be concluded that no exact parallel has been identified in the region; it may also be relevant to search for parallels further east, and the 2/2 twill in itself does not necessarily place Shekshovo textile technology in a western tradition.

Conclusion

The new analyses presented here suggest that the Shekshovo garment in the burial was made of a fine quality, white or light-coloured wool, undyed, and probably not from local wool but traded from elsewhere. The fabric could have been woven elsewhere, or the wool was transported to Shekshovo and woven by skilled craftspeople locally. Either way it ended up as a valuable item of clothing in a high-status male grave.

Notes

1. Generally, it is recommended that samples should weigh a minimum of c. 20 mg.
2. These samples were collected and provided by N. Marakov and M. Dobrovolskaya in 2014.
3. Further baseline investigations of the area are necessary to provide a more final baseline knowledge, which may eventually answer certain questions that as yet remain unanswered.

Acknowledgements

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Agata Ulanowska

Experimental Approach to the Ergonomics of Textile Production in Bronze Age Greece

Introduction

When he introduced the term ergonomics in 1857, Wojciech Jastrzębowski had in mind holistic research on human and non-human(!) work which he perceived as a positive driving force of development leading to general benefits for humanity such as increasing property, skills, perfection and happiness (Jastrzębowski 1857). In this paper, the term 'ergonomics' is defined as a tendency for humans to adjust their working environment to the capacity of the human body and it is used to describe labour required by textile technology and an effective organisation of textile work (see Penrose 2013, 686-695 for the concept of ergonomics in the archaeology of the contemporary world; for modern definitions of ergonomics see Dempsey *et al.* 2006). But it also refers to Jastrzębowski's original ideas perceiving pleasantness, playfulness, satisfaction, skills and theoretical knowledge as integral components of human work.

It seems that ergonomics, being so closely related to the human body and to work, is scarcely reflected in archaeological evidence and, therefore, remains largely intangible for textile archaeology and difficult to examine in the academic discourse. However, the precepts of ergonomics may be investigated by tracing all those means which were applied to optimise work and workloads, organise a workplace and design tools in order to make them the most convenient for human use.

This paper presents a short overview of how ergonomics may be approached by integrating archaeological evidence with experimental and experience textile archaeology, taking the textile technology in Bronze Age Greece as the focal point of reference. It aims to suggest that the ergonomics of textile production constitutes a substantial component of textile technology, especially with regard to the organisation of a workplace, the division of labour, the balance between labour investment and efficiency, and the usability of tools. It also suggests that the results of contemporary experiments may shed some new light on how the textile labour may have been maintained and perceived in the past.

Ergonomics and awareness of it in past societies

It may be suggested that the term ergonomics correlates with other concepts referring to work, practice and skills, such as tacit, non-discursive or embodied knowledge excluding, however, the frequently-acknowledged dichotomy between theoretical knowledge and practice or technology (*cf.* Ryle 1949, 14-48; Polanyi 1966, 4-52, especially 7; Dobres 2000; Molander 2004; Bender Jørgensen 2007; 2012; Ciszuk 2007; Budden and Sofaer 2009, 203-205, 207-209; Kuijpers 2012). On the contrary, the ergonomic organisation of work and design of tools may be perceived as a manifested combination of both 'mechanical' and theoretical aspects of the argued duality of technology and knowledge.

The origins of ergonomic needs for efficient and convenient tools and for minimising workloads have already been traced back to distant prehistory (*cf.* Bailey 1983; Lupo and Schmitt 2002; Menin *et al.* 2012).

But a more conscious improvement in living and working conditions, implying a human-centred basis for the overall design, was argued to have been born in classical Greece (Marmaras *et al.* 1999). Since the explicit use of the concept of ergonomics in societies of Bronze Age Greece cannot be argued, the term 'ergonomic criteria' has been introduced to indicate those aspects of labour which reflect the human need for ergonomic adjustments to the working environment.

Considering the large scale, complexity and highly time-consuming and labour-intensive character of textile production in Bronze Age Greece, it may be suggested that ergonomic criteria for the organisation of workplaces, the division of labour and the designing of tools were already present at this time. Even if efficiency itself may not have been the prime concern of the earliest textile workers (*cf.* Barber 1994 for near-idyllic images of the work of early textile workers), the need for minimising labour investment likely existed as well.

Ergonomic criteria for the organisation of textile production in Bronze Age Greece

Ergonomics of workplaces

Although several textile workshops and dye-works have been identified with certainty in archaeological evidence, such discoveries are as yet quite random. Function, date and (incomplete) state of preservation do not allow, therefore, any generalised overview of the ergonomic criteria applied in the spatial and architectonic design of textile workplaces to be presented.

Various strategies for the organisation of work may, however, be traced in specific buildings and installations, demonstrating a broad range of ergonomic choices and reflecting both specific technical requirements for activities conducted and various modes of the organisation of work. From the Neolithic period onwards, archaeological evidence has allowed us to distinguish between domestic and public contexts of textile production (*e.g.* Knossos and Phaistos: Evans 1964; 1968; Burke 2010; Militello 2012), complex and specialised dye-work installations (*e.g.* Chryssi and Pefka: Apostolakou *et al.* 2012; Betancourt *et al.* 2012; Brogan *et al.* 2012), specialised and large weaving workshops (*e.g.* Akrotiri: Tzachili 1990; 2007) and multi-craft workshops where several industries were practiced within one space (*e.g.* Mochlos: Soles 1997).

Even small-scale remains of textile production, such as the early Bronze Age settlement at Myrtos Fournou Korifi on Crete, show ergonomic criteria for the organisation of the workplace (Warren 1972). Textile production at Myrtos was carried out at only a few spots recognised thanks to the concentration of textile tools combined with several built-in installations providing heating, dyeing and drying facilities in the close vicinity. Those arrangements allowed consecutive procedural sequences to be executed, such as heating water, preparing fibres and dyes, washing/dyeing, drying, spinning and weaving at the very same spot, showing that thinking about work and workloads from the perspective of ergonomics was already there.

Ergonomic design of textile tools

Recently, the functionality of textile tools and the complex relationship between their forms and the parameters of final products, *i.e.* yarns and textiles, have been clearly acknowledged (Andersson Strand and Nosch 2015), proving that the forms of tools were designed to meet technical requirements of the products.

Several archaeological experiments in spinning have suggested that the quality of yarn may also result from an individual preference of the spinner for spinning threads of a certain diameter (Grömer 2005; 2010, 93, Abb. 36; Kania 2013; 2015), and this may, in turn, suggest that some personal preferences for specific tools or forms of tools existed as well.

The forms of textile tools in Bronze Age Greece did not differ a lot from tools found in the neighbouring areas (*cf.* Barber 1991; Andersson Strand and Nosch 2015). However, certain specific forms were found almost exclusively in quite restricted areas, such as the cuboid and spherical loom weights from central and eastern Crete (Barber 1991; Burke 2010; Cutler 2012; Andersson Strand and Nosch 2015). Other forms, such as discoid loom weights, spread over a large area and, in addition to the already acknowledged factors which may have contributed to their wide distribution (Cutler 2012; Pavúk 2012), the ergonomic design of those loom weights resulting in their universal usability may also be highlighted.

Generally, the long-lasting forms of textile tools, some of which had appeared as early as the Neolithic period and have survived until recently, may suggest the appropriate, if not optimal, tool design and their high expediency for users (*cf.* Marmaras *et al.* 1999, 365).

Division of labour and workloads

It is generally assumed that textile production was highly gendered and performed predominantly by female workers (*cf.* Barber 1991; 1994; Olsen 2014). Although other studies admit that the complex *chaîne opératoire* of textile manufacturing also required the involvement and work of men, children and the elders (*cf.* Barber 2007; Breniquet 2010; Costin 2013), the

monotonous and safe character of several operational sequences (namely spinning and weaving) which allowed work to be combined with childcare was argued as a general rationale behind engendering the labour (Brown 1970; Barber 1994, especially 29-30).
For most phases of the Bronze Age in Greece, it is difficult to speculate about the division of labour beyond this general assumption, with a notable exception of the Mycenaean administration system which left behind fairly large amount of specific data about the huge scale and meticulous organisation of the textile industry controlled by the palaces. Thanks to those records, it is possible to assess the number of textile workers employed in one working group/workshop contracted or run by the palace, to consider the social position and occupations of textile workers, to estimate expected production deliverables (including specialist products) and even to speculate about the existence of a craft education system (*cf.* Killen 2007; Burke 2010, 66-103; del Freo *et al.* 2010; Olsen 2014).
Experimental and historic comparanda imply that large workloads were required to fulfil the contracted or ordered tasks (Andersson and Nosch 2003; Nosch 2012; Olofsson *et al.* 2015) and it may be assumed that the efficiency of textile production was of much concern to the Mycenaean palatial administration. However, more specific ergonomic criteria applied to meet such high needs and expectations cannot be recognised at present.

Experimental approach to the ergonomics of textile production

The ergonomics of textile production has become a subject of study of experimental archaeology, even if the ergonomics itself was not specifically addressed in the posed research questions. In a result of experimental research on the workloads required at each of the consecutive operational sequences, the highly time-consuming character of textile work has been clearly acknowledged (Andersson and Nosch 2003; Andersson Strand 2010b; Olofsson *et al.* 2015, 97-98), thus highlighting the importance of the ergonomic organisation of work. The experimental approach to the functionality of textile tools has demonstrated that the design of those implements, especially their weight, height, diameter and thickness, were subordinated to practical needs for obtaining threads and textiles of various quality (Mårtensson *et al.* 2009; Olofsson *et al.* 2015). As C. Cheval has demonstrated experimentally, even certain peculiarities of shape which may not be easily explained by using the criteria of usability, such as grooves at the upper edge of some discoid loom weights, may have had their rationale in the manufacturing process (Cheval 2008).
According to E. Andersson Strand, a broad terminological umbrella of 'experimental textile archaeology' entails three main research methods: experimental archaeology as a method, ethnographic studies and experience archaeology (Andersson Strand 2010a). The last term encompasses a general hands-on introduction to technology. Alternatively, experience archaeology is also defined as 'exploratory experimental archaeology' (Miller 2007, 34-35) and 'experiential activities' (Outram 2008, 3-4). Acquiring of hands-on experience in textile technology allows one to perceive the nature of labour in person and raises the awareness of how the non-discursive components of technology, such as hardships, pleasantness and satisfaction from work, may have affected the final effectiveness and productivity. Therefore, experience archaeology may be seen as one of the methods of investigating, or at least penetrating, the ergonomics of textile production.

Experience archaeology and academic discourse

Experience archaeology serves primarily as an effective, if not indispensable, teaching tool in studies on any technology (Clarkson and Shipton 2015). Due to the less formal organisation of hands-on activities, usually lacking for any explicit hypothesis to be tested and being less strictly relevant to any specific archaeological evidence, the research value of experience archaeology seems to be seriously limited. However, the results of experiential activities have still been acknowledged as a possible source of analogies with the past (*cf.* Miller 2007, 35), especially if the tests are repetitive and documented over a longer period of time, and performed according to previously established principles (Ulanowska 2016 forthcoming). The weaving activities discussed herein were conducted by me with students of the Institute of Archaeology at the University of Warsaw since 2011, as part of regular teaching courses dedicated to textile production and technology in Bronze Age Greece. Each course is scheduled within a 60 hour time-span, comprising c. 30 hours of lectures and c. 30 hours of hands-on activities. Until now, 70 participants altogether have completed the courses, including seven students who decided to attend twice. The comparable number of participants each year, the repetitiveness of the experienced activities, as well as the considerable time investment in practice, have inspired me to monitor students' work and to use those observations as possible comparanda to textile work in the past.
In 2013, in order to make the process of monitoring more scholarly and systematic, a card system of

Department of Aegean Archaeology, Institute of Archaeology UW
BAND WOVEN ON A LOOM WITH A RIGID HEDDLE - DOCUMENTATION CARD

Name and surname	Band no.	Date

SCHEME OF THREADING

BAND PARAMETERS:		LOOM PARAMETERS:			TIME OF WORK:
Fibres:		Loom width in cm:			Time of designing the pattern in min:
Thread diameter in mm:		Shed height in cm:			
Threads / 1 cm^2:		Loom setting:			Time of warping the loom in min:
WA:	WE:	backstrap	vertical	horizontal	
Weight of band:		Warp setting:			Weaving time in min:
		vertical	horizontal	diagonal	
Fabric dimensions in cm (without finishing):		Warp tension, if possible to determine:			Finishing time in min:
L:	W:	Total in g:	1 thread/g:		
Finishing:		Length of working area in cm:			Total working time in min:

DESCRIPTION OF WORK:

Required level of attention:				General comfort of work:	Satisfaction from work:
warping	high	medium	low	high	high
weaving	high	medium	low	medium	medium
finishing	high	medium	low	low	low

OTHER OBSERVATIONS AND A DESCRIPTION OF WORK:

Picture overleaf

Fig. 1. Documentation card for a band woven on the rigid heddle.

documentation was elaborated (Ulanowska 2014, 153-157; 2016 forthcoming). This system was designed to record those activities which are practiced more than once during each course, *i.e.* weaving on rigid heddles (tabby bands and tabby bands in warp-floating technique), weaving on tablets and weaving on warp-weighted looms. It is comprised of four card layouts respectively, tailored to record the parameters of a fabric and the process of weaving it by an individual weaver (Fig. 1). All cards contain similar components, referring to the weaver and his/her experience (name, date, number of fabrics woven in a recorded technique), the fabric (its structure and parameters), the process of weaving (setting up the loom, working position) and, finally, the work (time of work, subjective comfort of work, satisfaction from work). But, since each card was designed to document a specific weaving technique, it also contains specialist questions about it. The card system is open-ended and more cards and more questions may be included in the documentation in the future.

Over time, the underlying methodological principles were established by formulating the following tenets of performance, inspired by the principles established at the Danish National Research Foundation's Centre for Textile Research for experimental research on the function of textile tools (Andersson Strand 2010a; Olofsson *et al.* 2015, 76-77):

- all activities are scheduled according to the *chaîne opératoire* sequences and their temporal organisation as Do It Yourself tasks;
- looms and weaving techniques are selected based on the current knowledge of the Aegean Bronze Age textile implements and weaves;
- all loom weights, spools and spindle-whorls used in experience activities are copies of Bronze Age implements from archaeological sites in Greece;
- students/actors are always informed of gaps in archaeological evidence, either for operational sequences of weaving, the construction of looms or certain categories of textile tools;
- students/actors are always informed that textile production in Bronze Age Greece was highly specialised and that there were various modes of organisation but the manner in which they proceed has no relevance to those organisational systems;
- students/actors are always informed that the manner in which they proceed is suggested by traditional craft and ethnographic analogies and that there may be more than one manner of execution for each of the tested activities;
- whenever there is a greater number of manners of execution or procedural choices, at least two of

Fig. 2a-c. Textile workshop in the Institute of Archaeology, University of Warsaw with ergonomic arrangements of the work place (Photo: Author).

them are demonstrated and tested;
- the documentation system covers descriptions and photographs of all operational sequences combined with a card system for documenting pieces of experientially woven textiles and their weaving as the work of an individual;
- students/actors are not skilled craftspeople and their observations on weaving can only be further analysed bearing in mind this important qualification (*cf.* Ulanowska 2014; 2016 forthcoming).

Bearing in mind the limitations resulting from the said principles, the documented experience of labour will be further discussed with regard to the concept of ergonomics.

Experience of the workplace and the ergonomics of textile tools

Since 2012, all the experience activities have been performed in a 'textile workshop' arranged in a staff office-room in the Institute of Archaeology with an area of c. 30 m^2. Depending on the nature of the performed jobs, the room may comfortably hold up to ten working people, although more students happened to work simultaneously in clearly less comfortable conditions (Fig. 2). The basic arrangement of the room could not have been changed, except for the place where two warp-weighted looms and a big working table were placed. All smaller textile tools and yarns are kept in cardboard boxes in the office cupboards and on the floor.

The ergonomic arrangement of this workplace was, therefore, largely limited but still several unplanned improvements to the workplace were successively made. All of them resulted from the need for optimising the working conditions, even if the work itself was performed occasionally and within the time-span limited to the three hours of a single lesson. Within those adaptive strategies all openings/holes, pegs or hooks in the looms and on the walls were employed to put aside the used tools, such as shuttles, weft bobbins, weaving combs, pins, scissors, in order to free the workers' hands. Accordingly, all tools which turned out to be suspendable were provided with threads or strings which made it possible to hang them up or to hang them on the workers themselves.

The main use of the textile tools employed in experiential activities is adequate to their recognised function in the *chaîne opératoire* of textile technology. Nearly all replicated and tested Bronze Age Aegean loom weights, such as discoid, cuboid and crescent-shaped forms, as well as tools identified as possible loom weights, such as spools and cylindrical weights with three perforations, were evaluated as suitable if not comfortable tools for weaving. A preference for choosing heavier tools which provide higher tension has been observed among inexperienced weavers who usually perceived the heavier tools as being easier to work with.

It seems, however, that ergonomic thinking about how the workplace and tools may be fully exploited resulted in less obvious techniques of use of the available equipment. The warp-weighted looms also appeared to be practical devices for weaving starting borders and warping, and their cloth-beams were set up for being used in various techniques of band weaving (Fig. 3) with crescents, cylinders with three perforations, large cones and spools employed as expedient weights for vertical tensioning of warps (*cf.* Ulanowska forthcoming). The highly ergonomic design was especially recognised in the form of spool-shaped objects which may also serve as thread containers and reels providing continuously unwinding thread for knitting the heddles (*cf.* Siennicka and Ulanowska 2016).

Experience of textile labour and labour division

Weaving and spinning is practised in the classroom in the manner which I have been taught by Anna Grossman, archaeologist and textile practitioner from the Biskupin Archaeological Museum in Poland. But the basic manner of performance has been modified or adjusted, according to scholarly descriptions of weaving techniques (*e.g.* Hoffmann 1974; Collingwood 1982; Ræder Knudsen 2014), new solutions resulting from our practice and experience (*cf.* Siennicka, Ulanowska 2016) and consultations with colleagues.

Weaving bands on rigid heddles and tablets is demonstrated and experienced in two working positions: sitting and standing. In sitting position, the tension is provided by the body of the weaver who ties himself/herself to the band loom or by stretching warps between two fixed points. In standing position the warp is set up vertically and gravity-tensioning is provided by a suspended weight or spools. The students are encouraged to practise band weaving in all working positions and then to choose the one they feel the most comfortable with.

According to the principles established for the experience tests under discussion, all hands-on activities should be performed as DIY tasks. Throughout the course, the students practise weaving bands on rigid heddles and tablets individually, but other activities, such as off-loom weaving with heddling devices, weaving starting borders on rigid heddles or tablets, setting up the warp-weighted loom and weaving on the warp-weighted loom, are usually performed in groups of two to three actors.

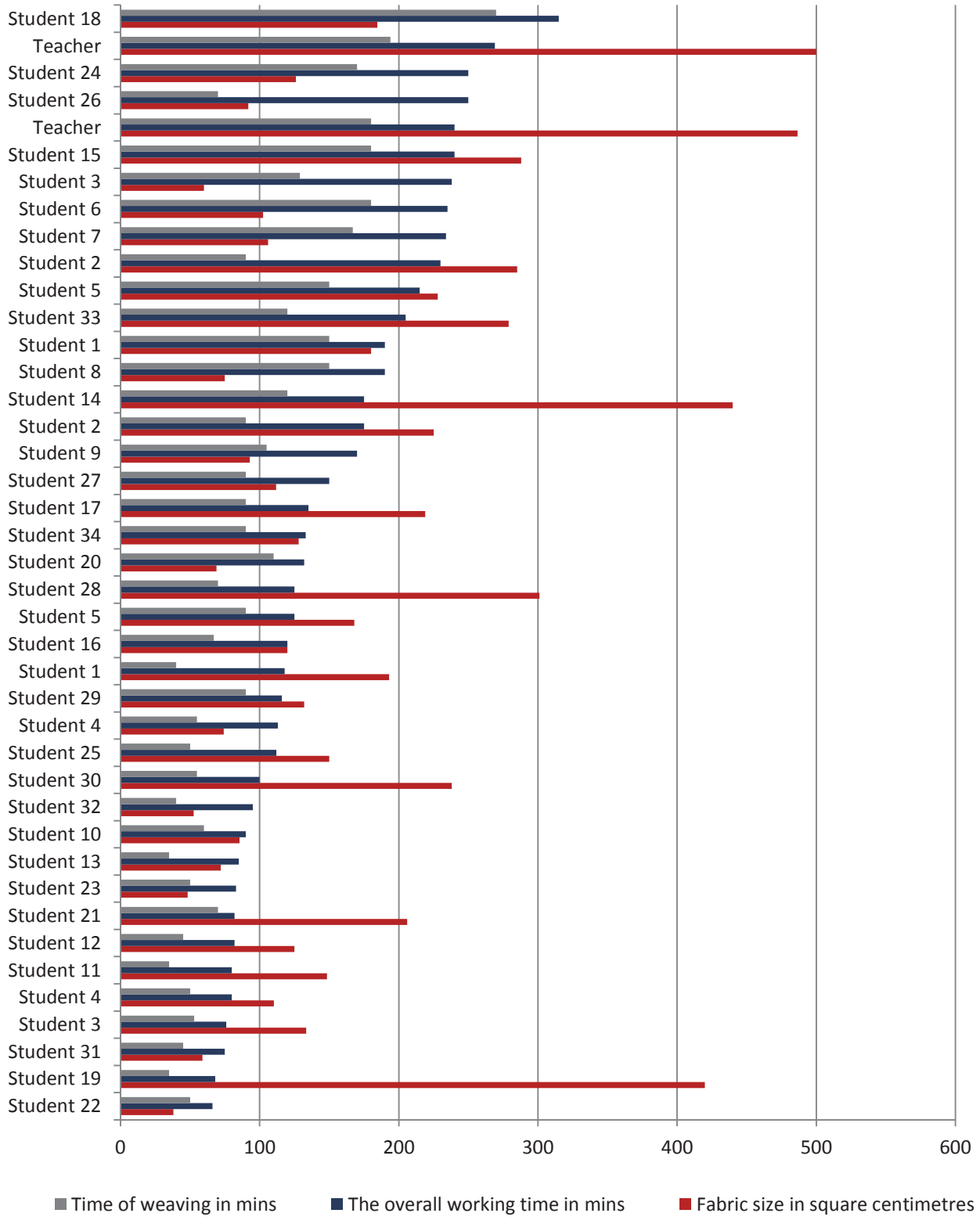

Fig. 3. The comparison of the individual overall working time with the duration of the weaving phase and the size of the obtained fabric (41 respondents altogether).

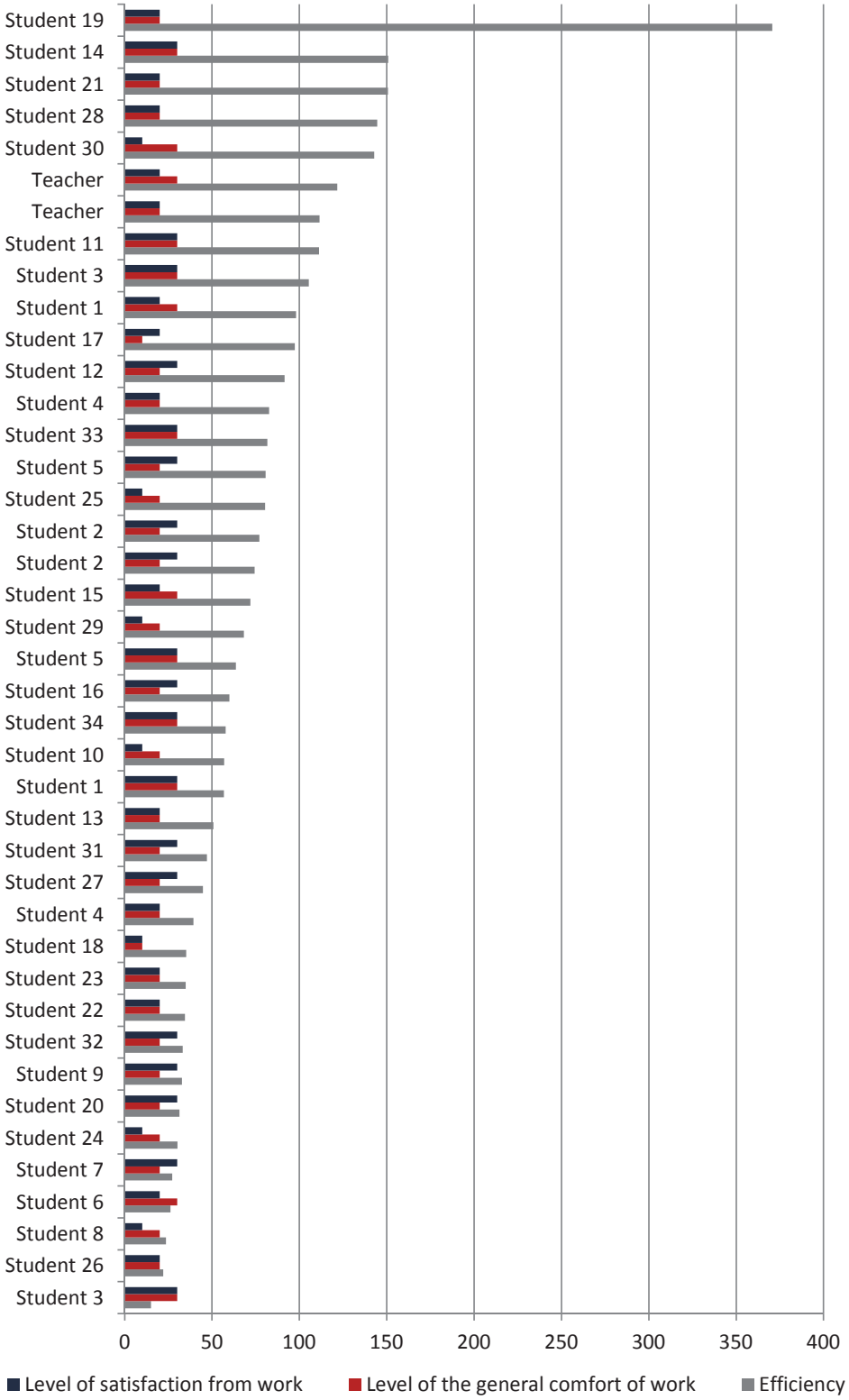

Fig. 4. Individual efficiency of the overall weaving process expressed in terms of the size of a fabric to be obtained within one hour of work, and compared with subjective feelings accompanying the work, such as the comfort of work and satisfaction from work. The level of emotions, recorded as being low, medium and high, were transformed into the numerical values: 10, 20 and 30 respectively.

Even though all of these tasks may also be executed individually, it seems that cooperation and social interaction make the job easier to learn and perform. In the case of a working group, the efficiency was not taken into consideration or measured but, based on mere observations, it is may be suggested that two weavers working together seem to be optimal for most of the tasks and, possibly, such a group may also add to the overall effectiveness. Therefore, the observed tendency towards collective labour may also reflect the ergonomic strategies in the organisation of work.

Work times, efficiency and emotions accompanying the work

The card system introduced in 2013 has allowed us to record and compare the amount of time spent on the successive sequences of weaving, such as designing, warping, weaving and finishing, and the subjective feelings accompanying the work, such as the comfort of work, the level of attention required and the final satisfaction from the work (Ulanowska 2014 153-157; 2016 forthcoming).

The records analysed herein refer exclusively to the most frequently practised technique and, presumably, the easiest one, *i.e.* weaving bands on rigid heddles (Fig. 1). So far, 42 cards documenting weaving of simple bands (36 cards) and bands with warp-floats (six cards) have been transferred to an electronic data base in Excel, which made the data easy to search and available for statistical analyses. All the subjective feelings described by the actors by choosing one of three levels of the accompanying emotions, namely low, medium or high, have been translated into numerical values, such as 3, 6 or 9, or 10, 20 or 30 respectively, in order to present them as graphs and compare them with other variables. From among that data, one card was rejected as being incorrect, whereas the other cards, documented the third band (17 cards), the fourth band and subsequent bands woven by an individual weaver (21 cards), which implies that most of the actors, although not skilled, have already acquired some basic knowledge of the tested technique.

As expected, the said lack of skill has a negative impact on the effectiveness of weaving. This may be illustrated by a comparing the overall working time with a distinguished sequence of weaving alone, and the size of fabric in centimetres (Fig. 3). Although the operational sequence of weaving seems to be the most time-consuming phase which directly affects the overall effectiveness, even if the actors are not skilled, the resultant size of the fabric, in several cases, is not clearly related to the time of work or to the already acquired experience in band weaving. Whereas two less efficient actors documented their fifth (Student 3) and third (Student 26) band woven on a rigid heddle, the most efficient ones: Students 19 and 14 documented their third and second band, respectively

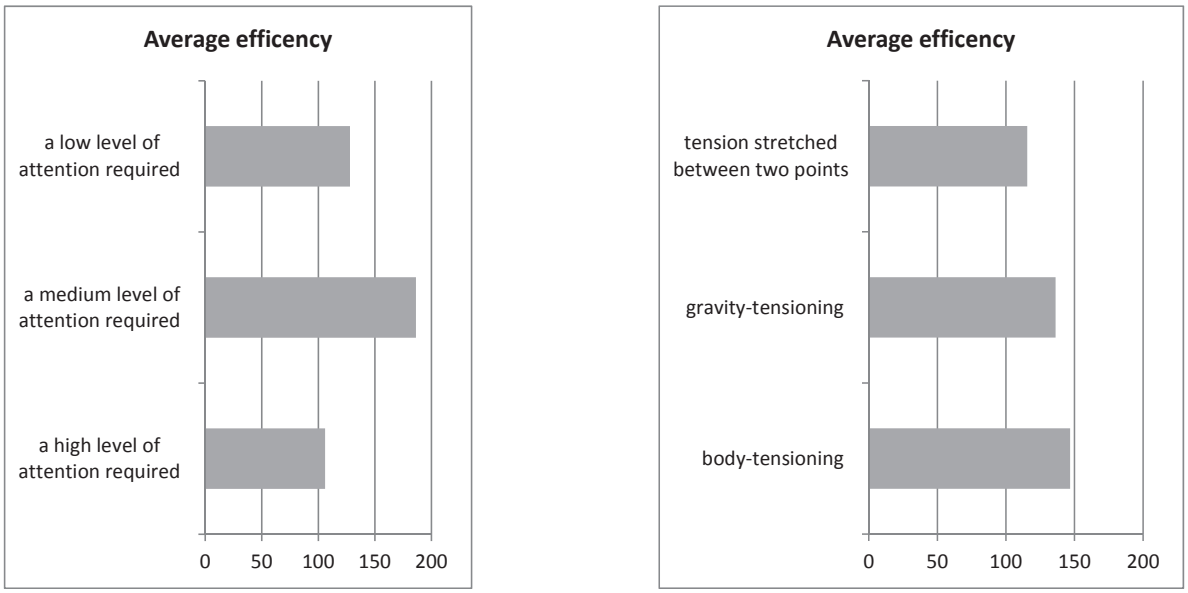

Fig. 5. Comparison of the average efficiency calculated per hour of the weaving phase alone with the high, low, or medium level of attention required (12, 5, 24 respondents respectively), and comparison of the average efficiency of the weaving alone with the manner of tensioning the loom: tension stretched between two points, vertical, body-tensioning (18, 4, 19 respondents respectively).

(Fig. 4). This lack of a clear correlation between the time of work and the size of the fabric obtained may be explained by various levels of individual manual dexterity. However, among the group of actors who attended the course twice or submitted more than one documentation card (Students 1, 2, 3, 4, 5, Teacher), only Student 2 seemed not to improve his/her efficiency while weaving more times (Fig. 4).

The average efficiency was calculated for the size of a fabric to be obtained within one hour of work, and it results in 76.51 cm of textile to be woven per hour, but this seemingly good result needs to be considered with the qualification that all the textiles discussed are narrow widths measuring from one to six cm in width and, therefore, they are relatively fast to weave (Fig. 4). In the analyses considering the efficiency of a single phase of weaving, such as examining the possible impact of the manner in which the loom was tensioned, efficiency was measured per hour of weaving instead of one hour of the overall working time.

The individual efficiency was not related to the reported feelings describing the comfort of work and satisfaction from work and translated into numerical values: 30 to indicate the high level of emotions, 20 medium, and 10 low (Fig. 4). The recorded results may also suggest that for the majority of actors the weaving experience was perceived as both satisfying and comfortable, disregarding the duration of work and the quality of the fabrics obtained. A low level of comfort of work was reported only by two actors (a high level of comfort of work was reported by 13 actors; the medium one by 26 of them). The majority of actors seemed to be quite satisfied with the work, describing the level of their satisfaction as being high and medium (19 and 16 respondents respectively), with six being displeased. The satisfaction from work and the comfort of work experienced by the said group of actors who documented weaving of more than one band, suggests that the emotions accompanying the work did not change much with the subsequent weaving trials. It may be observed that the medium level of attention required by the weaving alone may have a positive effect on the average efficiency of the weaving phase, since the highest rate of said efficiency was observed in correlation with the medium level of attention (Fig. 5). Accordingly, the other correlations may suggest that too little and too much attention required by the work may reduce its effectiveness. As regards the manner in which the loom is tensioned, it seems that the body-tensioning may slightly favour the higher rate of the average efficiency of the weaving alone (Fig. 5).

However, it should be clearly stressed that all the efficiencies discussed, as well as the overall effectiveness of work, seem to be primarily related to the level of an individual's manual dexterity for weaving and that the given results may have been different if all actors were more advanced in the craft skills.

Conclusions

Ergonomics may be seen as an inevitable part of any work and the tendency towards optimising working conditions, minimising workload and using available equipment in full seems to be a natural need of any worker who is allowed to arrange or adjust his/her workplace. The use of various ergonomic criteria in the organisation of textile work, *e.g.* ergonomic arrangements of workplaces, ergonomic design of tools and division of labour, could be traced in the preserved material evidence of textile production. But the complex emotions accompanying the work, referring to the collectivity of labour, the level of attention it required, its comfort and pleasantness, and, finally, satisfaction from work, remain largely intangible for textile researchers. Since these tacit components of technology must have had a direct impact on the overall productivity, being an important part of everyday life, the should also be more clearly addressed in academic discourse.

Experimental approaches to investigating the ergonomics of textile production seem to offer a new method of penetrating the nature of textile work. Especially the acquiring of hands-on experience in textile techniques may be seen as an efficient tool allowing for personal reflections about this work. But in order to use experience archaeology as a research method, the outcomes resulting from the hands-on activities have to be defined, documented and translated into the academic discourse.

The examples discussed of the experience approach to the ergonomics of textile production in Bronze Age Greece suggest the manner in which the individual experience of modern actors may be compared and verbalised. Specifically, the system of the documentation demonstrates how the standardised questionnaires may be used to record hands-on experience and hands-on learning. Obviously, the relations or lack of relations between the time of work, its comfort, satisfaction from work and the efficiency cannot be seen as any comparanda to the experience of work performed by the textile workers in the past. But still, these relations do demonstrate how various emotions accompanying the work may have influenced its effectiveness.

The statistic analyses presented here refer only to one technique of weaving. In the future, however, continued documenting of other textile techniques

practised with students may allow for comparison between the work and workloads required by various weaving techniques. It would be also interesting to collect and analyse the comparative evidence of textile work performed by modern craftspeople and more experienced hobbyists.
Finally, it may be suggested that the overall concept of ergonomics had to exist in societies of the past and may be used to describe the technical knowledge and skills, the organisation of textile production, its economics and the socio-cultural meaning of textile work as well as the social position of workers, even if some of the aforementioned aspects of work were not consciously perceived and valued as being important by the textile workers in the past.

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Jane Malcolm-Davies

An Early Modern Mystery

A Pilot Study of Knitting, Napping and Capping

Introduction

The development of knitting was a key technological innovation of the Medieval and Early Modern eras for which there is little published scientific evidence. There are more than 100 knitted caps of the kind worn by ordinary people in the 16th century in museum collections worldwide - an astonishing number given the paucity of extant garments from the period. These are recorded as having been shipwrecked, deliberately concealed, preserved in peat bogs or discarded as beyond use (Fig. 1). Many were unearthed in construction work in cities, during building renovations or discovered on the seabed in far-flung locations – as far north as Norway and as far south as Croatia in Europe, on the east coast of Canada (Kjellberg 1988; Flury-Lemberg 1988) and by 20th century acquisition in North America. A previous study of the caps suggested that they have remarkable similarities in their materials and manufacture which illustrate trade in knitted garments as consumer goods in the emerging Early Modern European marketplace (Malcolm-Davies and Davidson 2015).

Unusually for a craft activity, European knitting has a short history. It appeared late and moved through Europe at speed compared to other textile crafts (such as weaving, netting and knotting, which are millennia older) – a phenomenon almost unnoticed by historians. It appears in geographically diverse places from the 13th to 15th centuries in some cases associated with "magic" garments said to have been worn by the infant Christ, which expanded as he grew (Rutt 1987; Warburg 1984; Wyss 1973). Two-way elasticity was then a property unknown in contemporary textiles. Its lack was fulfilled by twill-woven wool textiles, which had to be cut on the bias to achieve the necessary close fit, most notably in legwear. The transition from cloth hose to knitted stockings produced a significant shift in the functionality of clothing, but it did not happen with the advent of knitting and it took more than a century for this revolution to be complete (Anthony 1980).

One reason this important development in clothing construction has gone unreported is that knitting is undervalued, owing in part to its association with the domestic and the feminine spheres (Turney 2009). Very little research has been done on Medieval or

Fig. 1 Knitted cap with neckflap (single-brimmed) and extant red lining (inventory number A6346) purchased from the estate of John Seymour Lucas in 1913 after excavation in Finsbury, London possibly in 1902. (© Museum of London).

Early Modern knitting despite numerous extant items in museum collections and some literary and legislative references in, for example, wills, probate records and trade protection law (Dahl 2014; Gilbert 2009; Ringgaard 2010; Rutt 1987; Sturtewagen, 2016, 80; Thirsk 2003; Turnau 1991). Most published work on knitting pays little regard to the archaeological record. Headwear in particular has been of scant interest to scholars with a few notable exceptions (Zander-Seidel 1990, 129-130; Ribbert 2003). Only a few Early Modern knitted caps have been studied and reported in any detail (Botticello 2003; Buckland 2005, 31-35; Flury-Lemberg 1988; Maeder 1980; Walton 1981; Zimmerman 1998 & 2007). Other work on knitted caps has been cursory (Levey 1982; Buckland 2008/9) or speculative (Black 2012; Zimmerman 2000). Most of it is descriptive rather than analytical, including a study identifying five distinct categories of caps of which the most common is the flat cap – a term which belies its constructional complexity (Malcolm-Davies and Davidson 2015).

The 100 knitted caps are a rich source of reliable information worthy of systematic scientific study. The current KEME 2015-2017 project aims to examine, analyse, record and compare them to fill a gap in the archaeological record of the craft of knitting. It follows other successful scientific studies of long-overlooked textile evidence (for example, Styles 2010). The first phase of KEME (reported here) applied a scientific archaeological approach (as is used for ancient textiles) within an interdisciplinary framework pioneered at the Danish National Research Foundation's Centre for Textile Research at the University of Copenhagen (Harlow and Nosch 2014). Previous work on textile tools suggested appropriate ways of approaching a scientific analysis, including the need to isolate all variables as for a laboratory experiment (Andersson and Rasmussen 2008, appendix D). KEME employs a triangulated research methodology to collect data about the materials and manufacture of knitted caps – using Early Modern documents and pictorial evidence, and experimental archaeology – to identify relevant variables and explore them. This paper reports the first phase of KEME.

Five categories of evidence for Early Modern knitting were identified: the archaeological material in museum collections, documentary descriptions, pictorial depictions of contemporary trade activities, current comparative craft practices and insights offered by experimental archaeology. Contemporary documents in which knitted garments are mentioned and pictorial sources relevant to the manufacture of knitwear reveal details about the land, labour, capital and technology available in the Early Modern era. Many of these sources are identified by Turnau's (1991 and 1983) and Buckland's (1979, 2005 and 2008/2009) descriptive works but further information comes from archives and art collections, where references to knitting are hard won among the details of daily life and death. These provide evidence for the tools and techniques used in the capping industry in the Early Modern era and suggest the key stages in the process are: knitting, fulling, napping and shearing in addition to other activities such as sorting, scouring and spinning the fleece, and pressing and blocking the caps to finish them.

Tools and techniques

An essential tool in the process of capping evades precise definition. That there were knitting needles (or pins) is corroborated by contemporary records. A Worcester capper's inventory of 1561 listed two pairs (sets) of knitting pins (Dyer 1967, 20). In 1564, a Southampton merchant had knitting needles in his shop valued at 4d (four pence) (Roberts and Parker 1992, 216-217). In 1593 and 1597, a merchant and a mercer in Northumberland were selling "knytinge nedeles" and "knitting prickes" by weight: a pound and a half cost 2s 6d (two shillings six pence) and 2s 1d (two shillings and a penny) respectively (Greenwell 1860, 235 and 281). Edward Hadley, an ironmonger from Oxfordshire was selling "nett needles and pynnes 6d (six pence)" in 1600 (Gibson 1985, 163) and a Scottish bonnet maker in Glasgow owned a dozen "bonnat brodds" in 1605 (National Archives of Scotland CC 9/7/3,15r quoted in Bennett 1981, 133). The Sankeys, mercers of Lancashire in 1613, sold knitting needles which were valued at 6d (six pence) (anon 1966, 15) and the Howard family recorded the purchase of knitting needles for 3d (three pence) in September 1621 (Ornsby 1878, 162).

The most famous and frequently-cited sources for early knitting are paintings of saints, including the Virgin Mary (*Our Lady of Siena*, c. 1325-1350, studio of Ambrogio Lorenzetti; *Our Lady of Buxtehude*, c. 1370, Master Bertam of Munich). Despite details which confuse the representation of the actions required, they do provide evidence of needles, their number (at least four) and their form (long, thin, cylindrical sticks or wires with pointed ends). Archaeological evidence for what must have been ubiquitous tools does not survive in any quantity or, if it does, it is not yet recognised as such. Excavated domestic settings often reveal thousands of pins, as was the case at Acton Court in Gloucestershire, United Kingdom, a modest manor house, where 3,539 were found (Rodwell and Bell 2004). Nevertheless, even excavations of sites which are said to have been capping workshops report no

finds that might reasonably be interpreted as knitting needles (for example, Blackfriars in Gloucester, UK). But, as knitting was probably done by outworkers, their needles are unlikely to have been found in large numbers at professional establishments, and these finds may represent the few from domestic settings that have been recognised as tools of the trade. A review of evidence for early knitting needles has proved similarly inconclusive (Gagneux-Granade 2016, 89-93). The sparse data thus far is two double-pointed copper alloy rods (inventory numbers 14697 and 14698) excavated from a 14th-century layer in a tenement building at 2 Aldwark, York (United Kingdom) identified as knitting needles. A third potential knitting needle found at the Foundry site in the same city is probably post-medieval (inventory number 13304). The two from Aldwark are not likely to be from the same set of needles despite being the same length (180mm) because their diameters do not match (2.6mm/UK size 12/US size 2 and 1.9mm/UK size 14/US size 0) (Walton Rogers 2002, 2743-2744). Another medieval knitting needle was reported as having been found at Blackfriars in London (Egan 2001, 5).

After the caps were knitted, they were fulled, a process which woven textiles also underwent. This must be distinguished from felting, which is the process of creating fabric from wool fibres which are not spun:

> "The cloth … was soaped and beaten in a damp state with heavy wooden hammers, so as to make it warmer, opaque, and more durable. The original process of fulling consisted in trampling the cloth underfoot … on this account the fuller was sometimes called a walker" (Lipson 1921 139).

Knitted caps were often referred to as being "thicked" as in the *Bill for Thicking of Caps by Means Feet and Hands,* which was read in parliament in London on 13 February 1559 (Simonds d'Ewes 1682, 44-49). Equipment for fulling could be as simple as a wooden trough for kneading or treading the knitted caps such as is preserved at the Ethnographic Museum in Kraków (Turnau 1991, plate 25) or there might be paddles with which to beat them (Lipson 1921, frontispiece). Fulling mills harnessed water to power hammers which not only beat the caps but moved them around so that they rubbed against one another which accelerated the thicking process (Turriano 1595). Mills were thought to produce lower quality goods than human effort and an attempt to outlaw them was made in England and Wales in 1482 (Beck 1882, 135).

Napping was another intense process: "Partly dried woollen knitwear was subjected to roughing with thistle brushes or with combs which were then sheared with large scissors" (Turnau 1991, 116). A regular supply of teasels, the prickly seed heads of *dipsacus fullonum var sativus*, a cultivated variety of the wild thistle, are necessary for the nap to be raised on knitted and fulled fabric. These were imported into London in large quantities – for example a ship from Antwerp named the *George* delivered 22,000 teasels in 1568 (London Record Society 1972). The dried teasels have hooked spikes which are strong, sharp and sufficiently hardwearing that they can be used repeatedly to brush the knitted fabric, thereby raising the hairs from the fulled fabric. Teasels were mounted on several spindles to create a gig, which increased the efficiency of the process, as the hooks of multiple heads could be run over the fabric surface simultaneously.

After napping, the raised nap was shorn. The Worcester capper's inventory of 1561 listed two pairs of shears (Dyer 1967, 20) and the inventory of John Nasmyth and son, bonnetmakers in Glasgow, included "ane scheir" (National Archives of Scotland, CC 9/7/3,15r quoted in Bennett 1981, 133). Shears are shown on a Polish coffin shield of 1655 which match those included in Diderot's comprehensive depiction of the tools of the *bonnetier de la foule* (Diderot 1751, plate II fig 9).

It is noteworthy that representations of the tools of the trade later in the Early Modern era do not show the needles since little of the actual knitting was done by the cappers themselves. A Polish coffin shield dated to 1655 (Masner 1924 quoted by Turnau, 1991, 212) and a Hungarian guild insignia of 1725 (Iparmüvészeti Museum, Budapest, inventory number 522907-1) show the teasels and the shears. Even the most comprehensive depiction dating from the 18th century omits needles but includes wooden forms on which the garments were mounted during the napping and shearing processes (Diderot 1751, plate 2), although by 1792, an engraved glass tumbler from Prague (Czech Republic) omits the shears in favour of a ball of wool with four needles stuck through it (Hálová-Jahodová 1955 quoted in Turnau, 1991, 212).

There are craftspeople and workshops still producing garments of cultural and/or touristic value today with a direct link to the way knitted caps were finished in the 16th century. The Tunisian *chechia*, the Turkish and Egyptian *fez* and the Basque *beret* (all headgear with significant political associations) provide evidence of the likely manufacturing process. The Boinas La Encartada Museum in Balmaseda, near Bilbao (Spain) demonstrates how machine-knitted Basque berets were fulled, napped and shorn using water-powered machinery based very closely on the hand-finishing processes from before the industrial revolution. Wooden fulling troughs with paddles (now reinforced

with metal) fulled as many as 70 caps at a time, which were tumbled against the shaped ends. Teasels mounted on metal spindles fixed to spinning drums raised the knitted surface. Wooden and leather forms were inserted into the caps to keep them rigid during napping and shearing respectively.

The study of sheep breeds and their history has a long tradition (for example, Trow-Smith 1957; Ryder 1964). Work on surviving textiles and animal skeletons from the Middle Ages shows the predominant type of sheep was comparable to modern Orkney and Shetland breeds (Ryder 1981). The highly-praised "Lemster Ore" or Leominster gold of the Middle Ages and Early Modern era was a very fine wool, and was likely to have been produced by an ancestor of the Hereford sheep, which is now identified with the Ryeland breed, as it conforms to the most common depiction of sheep in the 15th and 16th centuries (Ryder 1983, 464 and 467-468). It produced fine fleeces "unsurpassed by any other breed" with a fibre diameter estimated to be 34 microns (Youatt 1837, 261 quoted by Buckland 1979, 10). The Welsh Mountain sheep is said to have originated in the 13th century but it had already undergone an improvement in its fleece which distinguished it from that of the Cardy, a primitive breed, by the 16th century (Trow-Smith 1957, 162). The present-day Black Welsh Mountain sheep (officially recognised in 1922) was produced by selective breeding to secure a dominant black gene (The Livestock Conservancy 2016). Nowadays, the wool is sufficiently fine, soft and densely stapled to be regarded as a speciality type and the fleece is used to good effect in combination with other wools. The Wensleydale breed of sheep originated in north Yorkshire early in the 19th century from a cross between a local long wool breed (the Teeswater) and a Dishley Leicester ram named Bluecap, born in 1839 and said to have superb wool, among other qualities. The breed was not named until 1876 (Ryder 1964, 11; Wensleydale Longwool Sheep Breeders' Association, 2016). Zwartbles is a sheep breed which originated in the late 19th and early 20th centuries and is thought to be descended from the Schoonebeker, which historically grazed the heaths of north-east Netherlands (Zwartbles Sheep Association 2016). Merino originated in the 1340s as a coarse Spanish wool but eventually became the finest of fleeces in the later Middle Ages (Munro 2002). Studies of sheep traded in the 12th century show an important price differential between those producing coarse (6d per animal) and fine wool (10d). Only one in more than 100 manors produced fine wool, demonstrating its rarity (Trow-Smith 1957). A reference to the mingling of Spanish and English wool in Flanders in 1436 suggests that Merino blends were also used in the Early Modern era (Myers 1969, 1033). There is no evidence thus far of the desirable characteristics of wool to be processed into knitted caps in the 16th century but court records provide a tantalising glimpse. On 29 August 1548, Robert Mason robbed Lissott Bannour's house taking wool which was "clearly cap yarn" valued at 12d (12 pence) (Monmouth Borough Archives, quoted in Buckland, 1979, 3). Something made the wool recognisable as such but the account gives no further details.

This survey of contemporary sources confirms the necessary equipment consisted of knitting needles (or pins), fulling troughs, paddles and power, forms for shaping the cap, teasels for raising the nap and shears for clipping it to a pile. There are also suggestions of the need for other agents (for example, fuller's earth) to aid the processes of scouring, degreasing and washing the fleece. Another variable is the preparation of the yarn before it is knitted. Spinning may be undertaken using a range of spindles and wheels and in one of two ways. The woollen spin method is used for short staple fibres, which have been carded, while the worsted spin method is suitable for long staple fibres after combing. Carding produces a bundle of fluffy fibres and a relatively soft, woolly yarn, whereas combing arranges the fibres in parallel and produces a relatively firm, smooth yarn (Hiatt 2012, 557-559 and 663). However, the other necessary ingredient for successful capping is the wool. The choice of fleece, and the sheep from which it comes, is a key variable in the process. An indicative summary of the variables appears in Table 1.

Archaeological evidence

There are five distinct types of caps of which the most common is the flat cap with a variety of brim styles (single, split and half), in addition to brimless examples and head-hugging coifs. A previous study identified rudimentary measurements and some key patterns in the data: the caps were knitted in the round in plain knit stitches on at least four needles. The number of stitches (more properly called "wales" – the vertical loops) and rows ("courses" – the horizontal loops) per 25 mm vary considerably but cap crowns are usually finer than brims and linings (Malcolm-Davies and Davidson 2015). Crown diameters and head circumferences suggest the caps were mostly for adult men, maybe some women (Zander-Seidel 2010, 41) and a few for boys, although all show substantial deviation from their original circular form – probably as they shaped themselves to the wearers' heads even allowing for distortion through burial or other archaeological contexts.

Many of the caps have separate knitted linings and

	Type	Tools: materials/size/ form/no.	Power: hand/ machine	Processes	Agents	Other	Temperature	Time
Sheep	Breed	Shears	√	Washing	Water	Health & diet		Shearing season
Fleece		Combs/Carders Sticks		Sorting Combing/carding Washing Scouring	Water Soap Urine Soapwort (*Saponia officinalis*)	Quality: including *fibre diameter* *fibre length* *pigmentation* *staple length crimp* *lustre* *elasticity* *texture* *strength*	√	
Yarn		Distaffs Spindles Wheels Winder	√ √	Sorting Spinning Plying/doubling	Oil	Twist (direction S/Z) Twist (angle) Tension		
Knitting		Needles				Gauge or tension (wales/stitches) Gauge or tension (courses/rows)		
Dyeing		Vessels			Water Dyestuffs Mordants	Fleece/Yarn/Fabric	√	√
Fulling		Trough Paddles Hammers Mill	√	Fullers earth (Calcium montmorillonite) Soap Urine	Water/steam	Pressure	√	√
Napping		Teasels Gig	√			Species Technique		√
Clipping		Shears Form	√					√
Blocking		Press/iron Form	√	Pressing Drying	Water/steam		√ √	√

Table 1. Variables in the production of knitted caps and linings.

there are also linings which survive without their caps. The knitted linings form a useful subset of the data, providing a small and manageable sample for exploratory work before embarking on scientific analysis of all the knitted items. There were 29 linings available for this first phase of research. All except one are in the United Kingdom: at the Museum of London (15), Victoria and Albert Museum (10), and one each at the Buckinghamshire County Museum in Wendover, the Mary Rose Trust in Portsmouth, Leicester City Museum, and the Memorial University of Newfoundland in St Johns, Canada.

An important consideration is the state of the cap linings now and how representative it is of their 16th-century appearance. Their current characteristics may not provide clear evidence of their original form because, in most cases, they are degraded and retain little of their former colour. Their poor condition is a result of their hard use as headwear in the 16th century and long years buried in the earth, under the sea or in similarly harsh environments. Most also underwent undocumented conservation treatments in line with conventional understanding of what might preserve textiles in the past. Many have been thoroughly rinsed with water, washed with detergents and/or impregnated with oils, varnishes or glycerine to improve their appearance or stabilise their form. All of these treatments have distorted the materials now available for study. A comprehensive review of relevant studies, and soil burial tests in particular, suggests that degradation muddies our view of archaeological textiles and how we interpret them. Evidence from controlled experiments show test swatches experience severe overall colour change, stiffen, have a lower areal density, and shrink when dried (Peacock 2014).

Recording methods

Each of the extant 16th-century cap linings was examined using what has been termed a "slow approach to seeing" (Mida and Kim 2015, 13). This method advocates the use of a checklist for specific measurements and observations, and plenty of time to contemplate what is being observed. The process is divided into three phases: observation, reflection and interpretation (Mida and Kim 2015, 27). These phases refer to capturing the information from the artefact, considering its embodied experience and contextual material, and linking the observations and reflections to theory. There is no accepted protocol for recording knitting in an archaeological or museological context. The CIETA methodology offers a regimented approach to documenting woven textiles using a *dossier de recensement* (CIETA 2006, 4). It is notably more detailed than other methodologies (for example, Walton and Eastwood 1988) with 15 specific observations aiming to capture the set-up of the loom required to weave specific effects. As a result, it is not immediately applicable to knitting, although KEME's aim is to emulate the rigour of the CIETA recording system.

New criteria proposed to supplement the technical definitions in basic standard woven textile recording systems have been dubbed "a fourth dimension" in textile analysis (Hammarlund 2005, 88). It has been described as a subjective system requiring analysis by an expert craftsperson. However, the model is defined with five essential characteristics and two further measurements, which attempt to capture the complexity of a fabric's appearance (Hammarlund 2005): yarn (length, fineness, fibre diameter, crimp, absorbency, abrasion resistance, twist and direction, orientation, diameter), binding (the system of interlacing threads in the warp and weft), thread count, weaving (the effects of the interplay of the loom, other tools and the weaver), finishing (wetting, stretching, dyeing, fulling or a mix of these techniques), thickness (indicated by yarn diameter) and density (calculated as the cover factor, using the textile industry's standard formula – see Russell 1965). The first five factors are presented as a pentagon with the last two being the

Fig. 2. Knitted cap lining at the Victoria and Albert Museum (T.191A-1958) with cast-off (or cast-on) circumference edge cut away, substantial extant nap (darker in colour than the yarn from which it is raised), and a slit to allow an overlap for it to fit inside the crown of the cap. (Photo: Jane Malcolm-Davies, published by courtesy of the Victoria and Albert Museum).

result of interplay between the basic five (Hammarlund 2005, 105-107). One objective of this pilot study was to assess how these seven observations could be adapted for recording knitted fabrics. Emphasis is placed on the importance of recording them when viewing the original object and not relying on photographs, although these are recognised as helpful resources for follow-up work (Hammarlund 2005).

Dino-Lite microscopes offering magnification up to x480 facilitated more detailed observations than are available to the naked eye. These observations were taken at a distance from the object and therefore did not require much handling or the removal of any material. Examination of the knitted items carried out with this equipment helps to ensure stitch (wale) and row (course) counts are accurate and facilitates close inspection of increases and decreases in the number of stitches, and other construction details. High-resolution images were taken using the microscope which permit further measurements to be taken, such as yarn diameters and spin angle, and second opinions on the material to be gathered after the initial field work (Rast-Eicher and Jørgensen 2012).

Analysis of cap linings

The 29 flat, roughly circular cap linings are notably similar in many ways. None are perfectly circular, making all measurements approximate. They are on average 900 mm in circumference in a range between 525 mm and 1050 mm. The linings are 255 mm in diameter in a range from 210 to 360 mm based on 27 examples, although six are 310 mm. Only 17 are preserved inside their caps but these help to explain notable features in 23 of the linings. Most have a slit (18 examples) or a fold (five examples) from the centre to the circumference allowing an overlap so that the lining matches the cap's crown in size when inside it (Fig. 2). Three have both a slit and a fold and four have neither. Another five linings are incomplete and it is not possible to tell if they had these features, although there is evidence that a slit or a fold is what caused them to become fragmentary.

Most of the linings were probably knitted as flat circles in the round on at least four needles in plain stitches cast on to create the centres and presumably cast off at the outer circumference edges, none of which remain. Some show evidence of having been cast on at the outer edge and knitted towards the centre (although accurate diagnosis of the knitting direction is a still work in progress). The increases (probably made by knitting twice into one stitch or by the yarn over method) occur at arithmetically random intervals or "haphazardly", as has been recorded of knitted fragments from the 14th century (Crowfoot *et al.* 1992, 73). Knitting in the round (as opposed to flat knitting on two needles) produces plain knit stitches (or face loops) on one side of the fabric and purl stitches (or reverse loops) on the other. The reverse loop surface appears to have been regarded as the face of the lining (the right side which was worn next to the wearer's head) for all those still inside their caps. This is unlikely to be coincidental given their current locations at many different museums. The exception is the example at St Johns in Canada (EkBc-1:39762H) which now has the face loops on the outside, as does its cap. There is no record of its excavation or conservation in the documentary evidence of its discovery. It is possible that the cap and lining were turned inside out to facilitate the removal of human remains after excavation or during the conservation process.

The linings' weights ranged from 18 g to 123 g with an average of 56 g but some were considerable overestimates because the linings are attached to conservation supports of heavy woven fabrics. Others are partial linings for which the weight has been multiplied to be more representative of a complete item.

All the linings were sufficiently fulled for the cast-off (or cast-on) edges at the circumferences to have been cut away without the fabric unravelling. Their removal and the fulling process make it possible for the linings to lie flat, although there may have been some other purpose for it being cut away. The majority of the linings (25 examples) have nap remaining in substantial patches (Fig. 2). Most of this is on the purl (reverse loop) sides rather than on the plain (face loop) sides (which lay next to the undersides of the cap crowns), although there is evidence of there having been nap on both sides. Where it is best preserved, this nap consists of straight, silky fibres standing perpendicular to the knitted surface. Where it is not so well preserved, the nap is matt and fuzzy. It is noteworthy that some linings have areas of plush nap and other areas which are completely bare. Taken in isolation, the bare patches would suggest the caps were not fulled. Knitted fragments of a late 14th-century close-fitting cap found in London have been reported as not fulled (Crowfoot *et al.* 1992, 73) but since they were deliberately discarded, it is possible that they too had nap when new which wore away in wear.

When the caps and linings were worn in the 16th century, it was not obvious that they were knitted because the stitches were entirely obscured by this nap, which might better be described as "pile". This pile makes knitted items almost impossible to identify in contemporary representations. The mock velvet surface was acceptable for wear by those for whom real silk velvet was discouraged by convention and

Linings' locations	Inventory numbers	Circumference (mm)	Crown diameter (mm)	Fold (1 yes; 0 no)	Slit (1 yes; 0 no)	Extant pile (1 yes; 0 no)	Yarn paler than pile (1 yes; 0 no)	Stitches (wales) per 25mm (number)	Rows (courses) per 25mm (number)	Weight (grams)	Yarn diameter (mm)	Fibre diameter (microns)
Leicester City Museum	C21.1939.2.2.2	750	256	0	1	1	1	8	12	Not available	1.33	
MUN, St Johns, Canada	EkBc-1:39762H	563	338	0	1	0	Not relevant	6	7	50	5.68	
Museum of London	22392	844	269	0	0	0	Not relevant	6	Not available	58	1.38	
Museum of London	22388	950	300	0	1	1	1	7	Not available	78	1.23	
Museum of London	A6342	963	300	0	1	1	1	8	Not available	52	Not available	
Museum of London	5010	613	200	Not relevant	Not relevant	Not available	Not available	7	Not available	82	Not available	
Museum of London	4570*	963	250	1	1	1	1	10	14	67	1.10	
Museum of London	A26567	775	300	0	1	1	1	7	10	78		
Museum of London	A6060	675	250	0	1	1	1	9	13	54	1.28	
Museum of London	5004	713	225	1	0	1	1	6.5	10	Not available	1.43	
Museum of London	A6346	531	250	1	1	1	1	9	14	Not available	1.01	
Museum of London	74.42/1	825	238	0	0	1	1	6	10	75	1.90	
Museum of London	22390	788	250	0	1	1	1	8	14	51	1.38	
Museum of London	5005	700	263	0	1	1	1	9	16	53	Not available	
Museum of London	5013	513	225	0	0	0	Not relevant	5	9	Not available	Not available	
Museum of London	22391	981	313	0	0	1	1	6	11	65	1.52	
Museum of London	22389	900	288	0	1	1	1	7	16	62	1.23	
The Mary Rose	MR81A6961	Not available	Not available	Not available	Not available	1	1	9	14	18	1.08	
V&A Museum	1574-1901	688	213	1	0	1	1	7	7	51	1.73	33
V&A Museum	1563A-1901	894	306	1	1	1	1	12	12	62	1.18	21
V&A Museum	T.618A-1913	Not available	238	Not available	Not available	1	1	7	7	18	1.44	28
V&A Museum	T.618-1913	Not available	263	Not available	Not available	1	1	6.5	7	24	1.76	39
V&A Museum	T.191A-1958	825	256	0	1	1	1	10	11	48	1.29	29
V&A Museum	1575-1901	763	238	0	1	1	1	6	8	123	1.08	37
V&A Museum	T.619A-1913	550	238	0	1	1	1	5	7	35	1.38	43
V&A Museum	T.618B-1913	Not available	263	Not available	Not available	1	1	8	12	26	1.08	25
V&A Museum	1562A-1901	775	244	0	1	1	1	9	14	63	1.45	25
V&A Museum	T.188-1958A	688	213	0	1	1	1	6	10	40	1.25	26
Buckinghamshire County Museum	ABCM: 1948.5HN	850	263	0	1	1	1	7	10	57	1.17	
	Average/Total	**763**	**259**	5	18	25	25	**7**	**11**	**56**	**1.53**	**31**

Table 2. Characteristics of extant knitted cap linings (29 examples).

sumptuary law in, for example, England and Wales from 1533 by Henry VIII, again by Philip and Mary in 1553 and further enforced by Elizabeth I in 1556 and 1559 (Archer and Douglas Price 2011; Williams 1995). A cap in the collection of the Bernisches Historisches Museum in Switzerland was originally catalogued in 1884 as being made of red velvet until conservation work revealed this "reasonable mistake" because of the sophistication with which the woollen yarn had been fulled, napped and clipped (Maeder 1980, 227).

The nap is usually a dark red colour. In two noteworthy cases, it is a purple red (MoL A6346 and V&A T.188-1958A). In others, the red colour is yellow/red or brown/red. In all cases with extant nap, the yarn is paler in colour than the pile, although it too is discernibly red. Whether it was red originally is hard to know. A study of buried fabrics demonstrated the role of dyestuffs in preservation and decomposition of wool fibres. There were indications that madder has a preservative effect on wool fibres and that it easily migrates to surrounding textiles during burial (Ringgaard and Scharff 2010, 223). This suggests that knitted items dyed with madder may be better preserved than those treated with other dyestuffs and that items which were originally undyed may now be red.

The gauge (often referred to as the tension) of the knitting varies greatly: from 5 to 12 stitches (wales) per 25 mm with an average of 7; and from 8 to 16 rows (courses) per 25 mm (RPI), with an average of 11. Nearly half the linings have equal numbers of stitches and rows per 25 mm. For more than half, the number of rows (courses) per 25 mm is double the stitches (wales).

Some observations were very hard to make: for example, whether the yarn was twisted at all, and, if so, whether it had an S or a Z spin. This was often because the surface was heavily fulled and, even where the nap had worn away, the fibres of the yarn were too well fused to distinguish the spin. The yarn was also twisted into the stitches as it was knitted – with or against the original spin, if there was any. It is also a challenge to establish whether the yarn is plyed (*i.e.* with two or more strands twisted together to form the yarn). Occasionally, it is possible to discern two strands in a single knitted stitch (Fig. 3) but these often lie side by side and are not twisted together (plyed) as is the case with modern yarn. This effect may have been achieved by knitting from two separate balls of yarn or from each end of a single ball of yarn.

A sub-set of the linings was analysed with a Dino-Lite microscope to determine the fibre diameters. A total of ten linings was observed at x435 magnification with ten measures of the fibre diameters recorded for each,

Fig. 3. The red nap on a knitted cap lining at the Museum of London (A6346) at x25 magnification showing the yarn is paler than the pile and two strands forming each stitch (wale). (Photo: Jane Malcolm-Davies, published by courtesy of the Museum of London).

from which an average of 31 microns was calculated. The range was 21 to 43 microns, with six examples between 21 and 29 microns, and three between 33 and 39 microns. A summary of the data obtained from the 29 linings is shown in Table 2. There are three previous studies which report the fibre diameters of the wool used to make four Early Modern knitted caps rather than linings at 25.2 microns (Walton 1981), 22.4 microns (Ryder 1984), 20.4 microns and 21.6 microns (Botticello 2003). In isolation, these statistics are of limited value, especially since the process of sorting wool has now been recognised as relevant to fleece identification from fibre diameters (Rast-Eicher and Bender Jørgensen 2012), although they are all nearer to the fine end of the wool fibre spectrum (17 microns) than the coarse end (40 microns).

The pentagon model (adapted for application to knitting) was useful for data recording when examining the archaeological evidence, although not all the data collected are recorded in this paper. It proved less subjective than predicted as most of the measurements were obtained objectively (for example, yarn diameter as an indicator of thickness). But some criteria were hard to ascertain: for example, spin, ply and whether or not the fabric had been fulled now that all the surface texture had disappeared through wear and tear. But it will be possible to measure and record the direction and angle of spin using magnified images taken with a Dino-Lite microscope.

Experimental archaeology

Attempts at reconstructing historic garments have provided useful evidence as to how fabrics perform

when made into garments (for example, Kruseman and Feis 2014). Most reports on them simply document the choices made (for example, Grömer 2009; Hendzsel *et al.* 2008). There are very few academic projects which discuss or record in detail the choice of modern materials used to mimic the originals (for example, Demant, 2009; Arnold 2000), although this is a very popular approach to reconstructing garments among reenactors who explain their compromises with evidence and justification (for example, *Alessandra's Closet* 2016). Very few published projects have documented an approach to knitted garments but the reconstruction of the Gunnister man's cap from Shetland is a notable exception (Christiansen and Hammarlund 2013). The project reported here offered an opportunity to develop an approach to the selection of materials for experimental reconstruction of a knitted garment from the Early Modern era in detail. It has been recognised that "an industrial process was at work … with some 15 to 20 successive stages" but that "much has yet to be learned about the introduction and early history of knitting" (Staniland 1997, 246). The potential finishing techniques have not been much studied despite being indicative of a highly developed and specialised industry. Some clues to its sophistication are available in the documents of the period, including an English statute of 1571, which lists 14 processes the caps underwent but fails to define them (Archer and Douglas Price 2011).

The reconstruction of knitted caps is a challenge which has been tackled in various ways in the past - often without the benefit of close examination of the archaeological evidence (for example, Merrill *et al.* 1990). However, even more of a mystery – and so-named in the Medieval period for the secrecy with which it was protected – is the method of producing a silky pile which provided a touch of luxury and much-needed warmth in the Little Ice Age of the 16th century (Fagan 2000, 53, 84 and 94). The mock velvet texture was not achieved by the knitting but by the finishing processes that followed. Likewise, it is the surface treatments that produce significant visual and textural differences in woven fabrics with the same weave. Previous studies have noted the challenge of understanding these treatments and the failure of standard identification methods (for example, Walton and Eastwood 1988) to differentiate between them (Hammarlund 1997 and 2005). Knitted fabrics present the same difficulty.

Key evidence from the contemporary evidence and the archaeological survey was used to design experimental archaeology intended to test how different yarns behave when knitted, fulled, napped and sheared. The purpose of the experiment was to investigate whether it would yield useful results before designing more complex and costly work. The experimental archaeology was confined to exploring one of the variables – the choice of fleece – to see how it affected the production of the nap on the knitted surface.

Guidelines for using experimental archaeology as a scientific method were originally drafted for testing textile tools (Andersson Strand 2014). These were adapted to the choice of materials (which were selected according to current knowledge of archaeological fibres) and labour. The guidelines also recommend that all processes be documented and some filmed, and that all products must be evaluated by external examiners. There are very few documented methods of evaluation for items produced using experimental archaeology, and only one for reconstructed garments has so far been identified (Marendy 1993). It investigated how best to reconstruct an original garment. Toiles (test garments) of an 1880s gown in the study collection at the University of Alberta, Canada were produced using three pattern drafting systems. Evaluation of the reproductions was carried out by a panel of 12 people drawn from local cultural institutions, who did not know how the reconstructions were made. They undertook their evaluations independently in three parts using a five-point descriptive rating scale, a list of features to be compared with the originals, and ranked the toiles as first, second and third choice in similarity to the original garment (Marendy 1993). This provided guidance for the evaluation processes employed in the current study.

Although there are choices in all the raw materials, processes and equipment used at each stage of manufacture (Table 1), these were standardised as far as possible for this experiment in order to investigate the yarn as the primary variable. Sheep breeds today have moved a long way from their Early Modern ancestors and it is difficult to know the precise differences in the yarns produced now compared to those of the past (Ryder 1964, 7). Five commercially available yarns were selected for the study but they are very different from those observed in the archaeological record. None had been treated to prevent fulling as is the case, for example, with superwash brands. Four were two-ply and one was three-ply (*i.e.* the yarn was composed of more than one strand twisted together). All were aran weight (also known as medium and approximating to the United States' worsted weight), and are marketed as from "heritage" sheep: Shetland, Ryeland, Zwartbles/Merino, Wensleydale and Black Welsh Mountain. They had a range of fibre diameters according to a published guideline (British Wool Marketing Board 2016). Three were worsted spun and

Fleece (century)	Yarn diameter (mm)		Fibre diameter (microns)		Staple	Yarn count:	Spin		Ply
	Pre-fulling	Post-fulling	Pre-fulling*	Post-fulling	Length* cm	length/weight (Nm)	(twist)	(type)	
Shetland (c8th)	5	3.3 (-)	31	31 (=)	9	1.2	S	Worsted	2
Ryeland (c12th)	3	2.6 (-)	31	34 (+)	7	1.4	S	Woollen	2
Zwartbles/Merino blend (c20th)	4	3.5 (-)	33	35 (+)	11	1.6	S	Worsted	2
Wensleydale (c19th)	2	2.1 (+)	33	31 (-)	23	1.6	S	Worsted	2
Black Welsh Mountain (c13th)	2.5	2.5 (=)	34	30 (-)	8	1.4	Z	Woollen	3
Archaeological yarn	Not known	1.53 (average)	Not known	21 to 43	Not known	Not known	Not yet known	Not yet known	1, 2 or 3 strands

Table 3. Characteristics of modern yarns in comparison with extant knitted cap linings (*published guideline).

two were woollen spun. The five yarns were selected in different colours for ease of identification. These details, including specific weights expressed as yarn counts, and other comparative data are in Table 3.

Circular swatches (dubbed "swircles") were designed to represent the cap linings, which were on average 254 mm in diameter with approximately 7 stitches (wales) per 25 mm and 11 rows (courses) per 25 mm. The swircles were knitted half size (128 mm in diameter) to reduce the time and effort required to produce them for experimental purposes. The swircles were all knitted by an expert in spinning and knitting who was recruited by recommendation from professional craftspeople. A test set of swircles was knitted, fulled, napped and sheared (Fig. 4). The set consisted of one swircle knitted from each yarn. They were all knitted on the same size needles (2.5 mm/UK size 12-13/US size 1-2) and had approximately six SPI or 25 mm and seven RPI or 25 mm.

The swircles were soaked in hot water for at least five minutes. Fulling was done by hand by rubbing the knitted fabric vigorously, using soap on a flat, ribbed metal surface. Both a soft tallow soap and a green olive soap were used on the swircles. Each was rinsed in hand-hot water, then plunged into cold water. When they were dry, the swircles were napped and the resulting pile sheared. This demonstrated that all five yarns could successfully undergo the primary activities of capping. The same craftsperson knitted six sets of five swircles (one of each yarn). Five of these sets were used by volunteers at five workshops to investigate potential capping techniques. A total of 100 workshop participants with a range of expertise (from sheep rearing through competent knitting to a passing interest in the fibre arts) took turns fulling, napping and shearing in groups of two to three. The sixth set of swircles was kept for reference and in order to facilitate a repeat workshop if there were any difficulties with the processing which rendered the results unusable or invalid. During the workshops, all the swircles were soaked in hot, soapy water for at least five minutes. Most were repeatedly soaked during the 45 minutes they underwent fulling. This was done by hand rubbing the knitted fabric vigorously and beating it with wooden mallets, used singly or in pairs to approximate the action of hammers used by hand or in a fulling mill. In some cases, the wet surface of the swircles was napped using teasels and a few were sheared in part or in full. The cast-off edge around half of the circumference was cut away to see whether the edge was stable. The workshop participants were all asked to review the test set of swircles knitted, fulled, napped and sheared by the expert craftsperson and assess how silky, velvety and dense they were relative to each other. The participants used a five-point scale from 1 for most to 5 for least for each characteristic.

Fig. 4. Knitted, fulled, napped and sheared swircles (clockwise from bottom left) – Ryeland (natural), Shetland (red), Zwartbles/Merino (grey), Wensleydale (coral) and Black Welsh Mountain (brown). (Photo: Jane Malcolm-Davies).

Yarn	Swircle diameter (mm)		Percent change	Stitches (wales per 25mm		Rows (courses) per 25mm	
	Pre-fulling	Post-fulling		Pre-fulling	Post-fulling	Pre-fulling	Post-fulling
Shetland	130	130	0	6	6	8	9
Ryeland	130	145	+12	5	6	8	9
Zwartbles/Merino blend	130	125	-4	7	7	9	10
Wensleydale	130	115	-12	7	7	8	10
Black Welsh Mountain	130	125	-4	6	6	8	10
Averages				**6**	**6**	**8**	**10**

Table 4. Comparative swircle measurements pre- and post-fulling.

Results

All the swircles measured 130 mm in diameter when knitted. Fulling caused three swircles to shrink and there were some changes in the gauge (tension) (see Table 4). The Shetland remained 130 mm in diameter and the Ryeland expanded by 12% to 145 mm. The Wensleydale shrank the most (by 12% to 115 mm) whereas both the Zwartbles/Merino and Welsh Black Mountain shrank by 4% to 125 mm. This suggests that Wensleydale creates the most dense fabric through fulling. However, cutting away 25 mm of the cast-off edge at the circumference of each swircle was unsuccessful for all the yarns. The cut edges began to unravel immediately with only the slightest agitation.

Most of the yarn diameters shrank during fulling: the Shetland by 34%; the Ryeland by 14%; Zwartbles/Merino by 12% and the Black Welsh Mountain (which was the only 3-ply yarn) by 2%. The Wensleydale increased in diameter by 3%. Despite the enormous shrinkage in the yarn, the Shetland swircle remained the same size and the Ryeland expanded. The Zwartbles/Merino and the Black Welsh Mountain decreased in both the yarn and the swircle diamaters. The Wensleydale yarn increased in size but the swircle contracted. Comparisons between the fibre diameters before fulling (based on the published guideline) and after fulling suggested that either the raw yarns differed from the published guideline or they underwent a change – shrinking (two yarns) or thickening (two yarns). The Shetland fibres remained the same in diameter. The Ryeland fibres thickened by 10% and Zwartbles/Merino by 6%. Wensleydale thinned by 6% and Black Welsh Mountain by 12%. These were interesting and unexpected results because most published work on wool assumes that the fibre diameter remains constant.

After fulling, it was extremely difficult to see the separate loops in the swircles and this made comparable counts impossible to measure accurately. Shining a light through the fabric from underneath and using pins to mark the stitches and rows was the best way to count them by eye.

Some of the experimental swircles were sheared while still wet after fulling to create a vertical nap. The Wensleydale and the Black Welsh Mountain produced more vertical nap than the other thee yarns, which produced a fluffier surface. This demonstrated that all five yarns could be fulled, napped and sheared, and that there were clear differences in the surfaces produced. It was noteworthy that the swircles which were fulled for two 45-minute periods (*i.e.* by one set of workshop participants and then a second set) very quickly achieved much more impressive surface effects than those fulled for one workshop period only. This suggests that the critical moment at which a noticeable change occurs is after one hour. However, some yarns fulled more swiftly than others.

The workshop participants were asked to examine the swircles made using the five test yarns which were knitted, fulled, napped and sheared in advance. Their experience of fulling, napping and shearing swircles and prior exposure to photographs of the extant linings and Early Modern depictions of caps helped them approach the evaluation exercise with confidence, although only a small number provided written feedback, representing 15% of the potential total.

The evaluation criteria under consideration were how dense, silky and velvet-like the swircles were. The participants were asked to rate each criterion of the five on a scale (1 for most and 5 for least). An award-winning expert craftsperson (who was not involved in the manufacture or processing of the swircles) was asked to rank the swircles to see how this evaluation compared to the workshop participants' opinions. The participants and the expert ranked Shetland as the most dense. Silky was interpreted as a measure of how glossy the surface appeared and how smooth

it was to the touch. The participants ranked Ryeland and the expert identified Wenselydale as the most silky. Evaluating a velvet-like surface proved the most challenging. The expert ranked Shetland the most like velvet and the participants ranked Shetland and Wensleydale equally against this criterion. Most participants said they did not think any of the swircles were very much like velvet.

Discussion of results

A review of sources for the relevant capital, equipment, labour and raw materials suggests there is more to discover which will better inform the understanding of how knitted caps were manufactured in the Early Modern era. A critical issue is the need for more precise terminology to describe characteristics of knitted fabric and the actions required to make it. A triangulated approach to the specific problem of processing knitted caps produced useful indications of the variables requiring further study and refinement. The project fulfilled its primary purpose by testing the proposed investigative framework and practical methodology. A limitation was the relatively small sample of original yarn fibres (from 29 items). Study of the wider body of evidence in the next phase of KEME will provide a more credible assessment of the range of woollen yarn being used for capping in the 16th century. Further and more detailed examination of the magnified images of the knitted stitches is required for accurate data on the twist (s or z) and ply of the yarn used in the original linings. The stitches (wales) and rows (courses) were very difficult to count providing only approximate guidance on the gauge (tension) of the knitting after fulling. More work on the wale (stitch) to course (row) ratio is also required. New methods of measuring these are under investigation (for example, tomographic scanning). The limited shrinkage of the fabric during the fulling process suggests the caps and linings were not knitted to a significantly larger size and reduced by processing to a close fit to the head (as is the case with modern machine-knitted berets).

Observation by eye and up to x435 magnification was not sufficient for the structure of the fibres to be examined but it was adequate for yarn and fibre diameter measurements. These will provide useful data for comparison with other yarn fibre studies. The modern yarns measured between 31 and 34 microns in fibre diameter with an average of 32 microns before fulling according to the British Wool Marketing Board's published range. Measuring the actual yarn used before knitting and fulling to calibrate any fibre diameter change would provide a more reliable indication. The closest match in fibre diameters was between the wool in lining T.191A-1958 (29 microns) and Black Welsh Mountain (30 microns) but on average the archaeological yarn fibres were finer (21 to 43, average 31 microns) than the "heritage" yarn fibres (31 to 43, average 32 microns) after fulling. However, closer identification of the fleeces used in the extant knitted caps and linings would be helpful. The discovery that a majority of the linings had yarn paler than the pile (64%) suggests that the linings were dyed after they were knitted and napped, as the colour had not penetrated thoroughly beyond the nap to the yarn. There is some evidence for this from documentary sources recording the activities of dyers in Bruges (Kruseman *et al.* 2016). Alternatively, those areas where the nap has worn away and the yarn is exposed may have lost any remaining dye more easily than the nap. This phenomenon has been recorded as the result of moth damage in a cap at the Bernisches Historisches Museum in Switzerland, where the undyed core of the yarn was exposed (Maeder 1980, 227). An accurate method for recording colour would also help to describe the current state of the knitted fabric and to document changes in further experimental archaeology. Both the CIELAB and Munsell colour systems have been used for this purpose in dye analysis (Ringgaard and Scharff 2010). Two of the heritage yarns were already dyed (the Shetland and Wensleydale) before they were fulled, although this was unlikely to be the case for the originals. The dyestuffs may have affected the speed and effects of the fulling process and represent another variable to be removed from future experimental work.

More investigation into relevant comparative crafts may reveal the details of the yarns used for similar garments today. Modern Tunisian *chechia* (knitted by hand and fulled by foot) and Basque berets (processed by machine) are routinely made in sufficient numbers with uniform results that the raw materials may prove instructive. However, it is noteworthy that the berets are shrunk very much more than the *chechia*.

The pilot swircles produced initial indications of knitting and finishing effects with five different yarns. There was a wide variety of surface textures produced, although none reproduced the nap observable on the originals. Since this is of particular interest, a useful additional measurement on the original items would be the depth of the extant nap, even though in most cases the nap has been flattened by the environment in which the linings were found, subsequent conservation treatment and/or storage. Fulling the swircles by rubbing them together and for longer may produce more convincing results.

The expansion or contraction of the swircles, yarn and fibres provides further information for consideration. Only the Black Welsh Mountain decreased across

all three measures. The Shetland swircle and fibres remained the same size before and after fulling despite a one third contraction in yarn diameter, whereas the Ryeland swircle and fibres expanded, while the yarn diameter contracted. The Wensleydale swircle and fibre diameters contracted whereas the yarn expanded. The Zwartbles/Merino expanded in fibre diameter but shrank by the other two measures. Taken together, these findings reveal no useful pattern except for the consistency of swircle and fibre expansion/contraction in four out of the five cases. The exception was the Zwartbles/Merino and this result may have been due to the blend of two fleeces, which made fibre measurements more difficult.

There was no clear correlation between shrinkage and worsted/woollen spun yarn or whether it was 2- or 3-ply. Further work on how these characteristics affect the finished surface may be instructive. Other variables in the fibres which may be relevant are staple length (Table 3) and crimp.

The finished swircles permitted evaluation criteria to be identified which will help draw up guidelines for future review of items produced with more extensive experimentation. The criteria need to be more narrowly defined with explanations of the concepts to be captured by the terminology such as density, silkiness and velvetiness. Another refinement would be to provide reference material for evaluation of the nap, such as swatches of woven woollen fabrics which mimic velvet (for example, frizado). Several objective tests for evaluating the reconstructed fabrics were also generated. Success in cutting away the cast-off edge at the swircles' circumferences is indicated by the fabric lying flat and the staying intact rather than rolling up or unravelling.

An important challenge identified by this first phase of research is the recruitment of appropriate evaluators of the finished items. There are very few people familiar with the original knitted items in the museum collections and even fewer who have undertaken detailed examination. One way of tackling this is to devise a method of photographing and/or videoing the surface of the originals in fine detail. Polynomial texture mapping has been shown to capture the surface detail of velvet very satisfactorily (Zhao *et al.* 2011).

Further research

The next stage of the research will include more craftworkers with a wider diversity of experience, knowledge and skills. The volunteers who worked on the project also supplied helpful data on which to plan future archaeological experiments. Not many of them were familiar with the processes involved, although precise data on this was not collected during the event. In future stages of the research, volunteers will provide evidence of their knowledge and skills, and their contributions will be collected more systematically.

Further, the next phase of the project will interrogate the archaeological evidence more closely (including the use of micro CT-scanning) to discover further specific clues as to the sheep breeds which provided appropriate fleece for the knitted caps, discover whether there is a unique or range of wool employed, and, if the latte r, investigate how different modern yarns (including handspun examples) behave when treated with a variety of fulling agents and species of teasels. Reconstructions (including 3D visualisations) of complete caps in different styles will facilitate further information about the knitting methods employed.

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Germanic Linguistics and Textile Words

Introduction

Languages are not static. They develop and change over time, and different languages in different areas develop in different ways. Languages are related to each other. A language has a group of speakers, and as long as this group of speakers stays in close contact most of the time, they will keep speaking the same language, though the language is constantly changing. However, if this group of speakers splits up, the once-common language will sooner or later start to develop differently, at first with different dialects and later different languages. This is how a language family tree grows (Fig. 1). Of the different elements of language, sounds are the most consistent in their development. When a certain sound starts to change, it does not only change in one word, but in all words, and the change will be the same in all words. If, in some words, a given change does not happen, or another change occurs instead, the condition for the exception can usually be described, as well. A sound change without exceptions is called an unconditional sound law. In the opposite case, we talk about conditional sound laws. An example of a sound law, can be found by looking at Latin, Sanskrit, Greek and the Germanic language

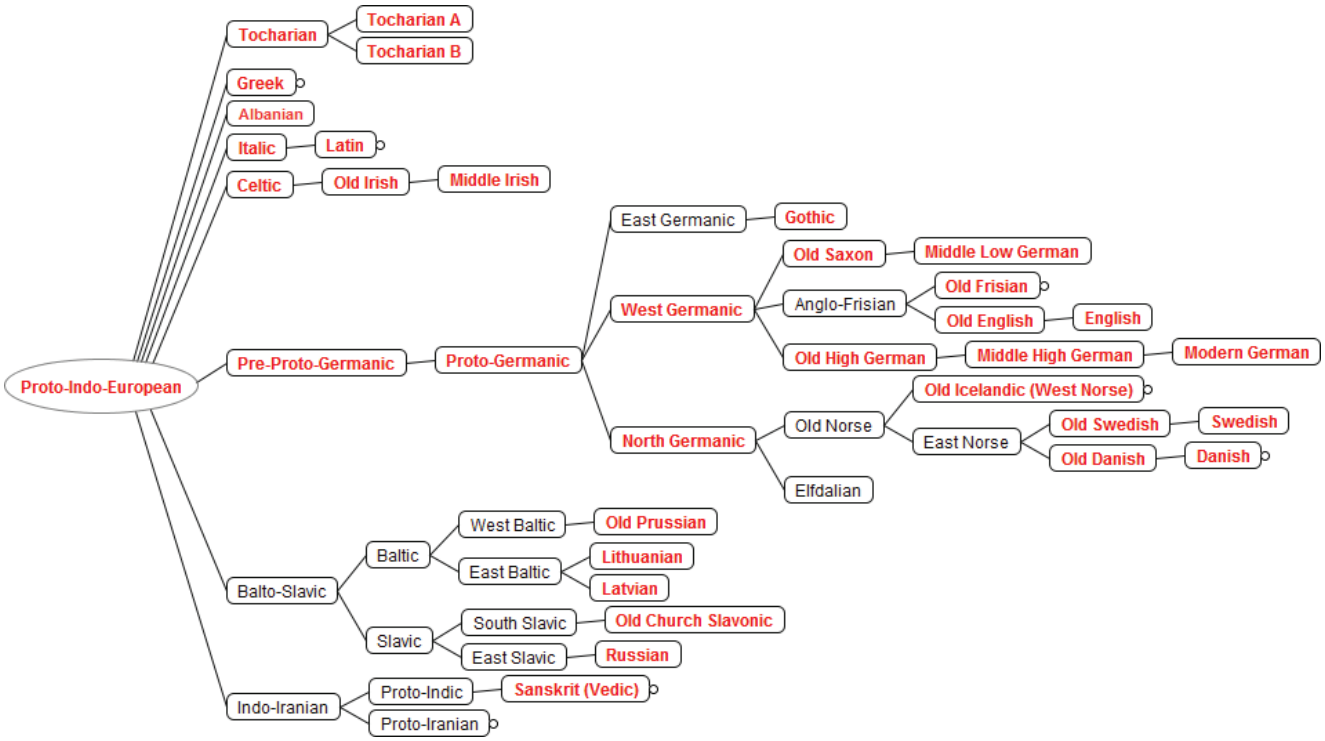

Fig. 1. Indo-European languages mentioned in this article are marked with red on the language tree (Graphics: Mikkel Nørtoft).

Proto-Germanic	Old High German	Old Saxon	Old Frisian	Middle Low German	Old English	Albanian
flahsan	***flahs*** 'flax'	***flahs*** 'flax'	***flax*** 'flax'	***flas*** 'flax' ***vlas-arne*** 'flax harvest' ***vlas-bote*** 'flax bundle' ***vlas-jart*** 'flax field'	***fleax*** 'flax'; ***fleax-æcer*** 'flax field'; ***fleax-hamm*** 'enclosed area where flax is grown'; ***fleax-līne*** 'a string of flax'	***plëhurë*** 'rough linen'; ***plaf*** 'woollen blanket, woollen sheet'

Table 1. Simplex and compound words from Proto-Germanic *flahsan (related words outside Germanic separated with double line).
Sources: Pokorny 1959, 835; Lübben 1965, 482; Blum 1971-1986, 941; Orel 2003, 104; Bosworth-Toller Anglo Saxon Dictionary http://bosworth.ff.cuni.cz/.

Danish. All these are Indo-European languages and are thus related. The modern Danish word *fader*, Latin *pater*, Greek, *patḗr*, Sanskrit *pitár* all have the meaning 'father', but in Greek, Latin and Sanskrit the word is written with a *p-* whereas in Danish it is written with an *f-*. Another example is the modern Danish word *flette* ('to plait, braid'), Latin *plectō* ('I plait, twine'), Greek *pléktō* ('I plait, twine, wind, braid, knit'), Sanskrit *praśnaḥ* ('wicker-work, wicker-basket'). Again, we observe that Latin, Greek and Sanskrit use *p-*, whereas Danish uses *f-*: thus a pattern emerges. The non-Germanic languages listed here have preserved the Proto-Indo-European **p* (the asterisk (*) in front of a word or letter indicating it to be a reconstruction) whereas the Germanic languages have changed it into an *f*. This development in Germanic is part of what is known as 'the First Germanic Sound Shift', and there are hundreds of other words besides *flette* and *fader* which confirm this pattern.

The sound laws constitute the most important tool when it comes to reconstructing a proto-language. They tell us what the original sound was like and what developments took place in each daughter language. By understanding the sound laws, we can reverse the sound changes. For example, we know that Latin has preserved the original Indo-European *p-* whereas it developed into *f-* in Germanic. We also know that Indo-European *sk* and *i* is preserved in both Germanic and Latin. So if we take the Old Icelandic word *fiskr* 'fish', and compare it to Latin *piscis* 'fish', we can reconstruct the Proto-Indo-European root **pisk-*. The root **pisk-* is, however, only attested in Germanic, Celtic and Italic, so some will call it a west Indo-European word. If we choose to call a word Proto-Indo-European, it is often because the word is attested in both the western and eastern area of the Indo-European language continuum. A good example of this is the word *flette*, as mentioned above, which exist both in Sanskrit, spoken in India, and in Danish, spoken in Scandinavia. It is not only because it is attested in both the east and the west, but also because the sound laws tell us that both languages have inherited it directly from Proto-Indo-European.

Phonetic changes are not the only changes a word can undergo. Processes such as analogy also have to be accounted for. An example of an analogy could be the English word *foot*, which in plural is *feet*, and the word *cat*, which in plural is *cats*, and then decided to make the word *foot* regular in a similar way by making up the plural form †*foots* (the dagger meaning that it is a constructed form never attested). This is indeed what happened to the word *brother*, which in plural most often occurs as *brothers*, but a more archaic plural form is *brethren*. This kind of change occurs all the time, but can often be sorted out, for example by looking at related languages which have no analogy for the same word. Of course neither analogy nor phonetic changes occur due to active decisions by a group of people. They often start out with a group of often young people starting to treat a word differently, and if the trend does not die out again, it will spread and become the new norm.

When it comes to semantics, we do not have anything similar to regular sound laws to rely on. The meaning of words also changes over time. Just as often as the meaning changes considerably, it is also often preserved or changed only a little. However, we do have some criteria for when we can reconstruct the semantics of a word. Just like reconstruction in general in comparative linguistics, *i.e.* if a word exists in both the eastern and western part, if we can see it is inherited, and if the meaning is identical or similar, we can reconstruct the meaning in the proto-language. It is also good, if the proto-language we are trying to investigate goes back to another proto-language which is well reconstructed. This is the case for Proto-

Germanic, which goes back to Proto-Indo-European. Hence, if a word can be reconstructed for Proto-Indo-European and if it is attested also in the Germanic daughter languages, then we do have solid evidence for its meaning. In the following I will take a look at three words related to flax and a few other words related to plant fibre textile production.

Three words related to flax

In Table 1 some simplex *flax* words and compounds from the same origin are given. The Proto-Germanic **flahsan* becomes in Old High German *flahs*, Old Saxon *flahs* and in Old Frisian *flax*, all meaning 'flax'. In Middle Low German we have *flas* ('flax') and the compounds *vlas-arne* ('flax harvest'), *vlas-bote* ('flax bundle') and *vlas-jart* ('flax field'). In Old English we have the simplex word *fleax* ('flax'), as well as the compounds *fleax-æcer* ('flax field'), *fleax-hamm* ('enclosed area where flax is grown') and *fleax-līne* ('a string of flax'). In Albanian we see the words *plëhurë* ('rough linen') and *plaf* ('woollen blanket, woollen sheet') which are cognates, *i.e.* derived from the same root, but in a separate language branch.

Further, in order to deduce the meaning of the Proto-Germanic word for flax, we can look at the context in which the words occur in the Old Germanic languages. From Old English we find the sentences *of* ðære *eorþan cymeþ* ðæt *fleax* ('flax comes of the earth'), *Swīðe hwīt fleax* ('very white flax') and *Hē hēt bewindan heora handa and fēt mid gesmyredum flexe* ('He had bound her hands and feet with lubricated flax'). In Old High German, we have the sentences *so iz tar in lande sito ist, tar der flahs uuahset* ('as it is custom in the country, there the flax grows') and *diu selba Ysis lerta den flahs arbeiten, unde spinnen* ('Isis she taught herself to work and spin the flax').

In Table 2, words originating from the Proto-Germanic **harzwaz* are given. The word occurs in Old High German as *haro* ('flax') and the compounds *haro-bôz* / *hara-poz* ('flax bundle'), *har-luf* ('flax string'), in Modern

Proto-Germanic	Old High German	Modern German	Old English	Old Icelandic	Old Danish	Old Swedish	Latin	Proto-Indo-European
**harzwaz*	***haro*** 'flax' ***haro-bôz / hara-poz*** 'flax bundle' ***har-luf*** 'flax string'	***haar*** 'flax'	***heorde*** 'tow, the course part of flax' ***heordan*** 'hards of flax'	***hǫrr*** 'flax' ***hǫr-dúkr*** 'white linen cloth' ***hǫr-skrýdd*** 'linen clothing' ***hǫr-týgill*** 'string of hamp or flax' ***hǫr-bil***, ***-brekka***, ***-fit***, ***-gefn*** ***-gerðr***, ***-nauma***, ***-skorða***, ***-veig***, **-**þella 'woman dressed in linen' ***hǫrva-sleipnir*** 'the flax horse (the gallows)'	***hør*** 'flax'	***hør*** 'flax'	***carrō*** 'to comb'	**korswo-*

Table 2. Simplex and compound words from Proto-Germanic *hazwaz/*harwaz (related words outside Germanic separated by double line).
Sources: Cleasby and Vigfusson 1874, 311; 312; Mayhew and Skeat 1887, 113; Söderwall 1925-1973, 342; Jacobsen and Maltras 1927-1928, 184; Pokorny 1959, 939; 585; De Vries 1962, 281-282; Wilhelm 1963, 633; Blum 1986, 723-724; Splett I,1 1993, 356; De Vaan 2008, 95; Beekes 2010, 682; Kroonen 2013, 213; Bosworth-Toller Anglo Saxon Dictionary, http://bosworth.ff.cuni.cz/.

German as *haar* ('flax'), in Old English *heorde* ('tow, the course part of flax') and *heordan* ('hards of flax'), in Old Icelandic *hǫrr* ('flax') with some of the compounds *hǫr-dúkr* ('white linen cloth'), *hǫr-skrýdd* ('linen clothing') and *hǫr-týgill* ('string of hamp or flax') (more words are given in Table 2). In Old Danish and Old Swedish we have the word *hør* ('flax') while outside the Germanic branch we have *e.g.* Latin *carrōa*'(to comb'). Altogether these cognates can be reconstructed to the Proto-Indo-European word **korswo-* which means 'to scratch, comb, hackle'.

Also, some sentences (Table 2) in Old High German enlighten the semantics of Proto-Germanic **harzwaz* further, *e.g. haro giu palkili habentan* ('already having a little flax ball'). In Middle High German it becomes *har*, and we find the word in the sentence *die plaffen santen ouch dar wol gezinnelohten har daz si in ze helfe spunnen* ('The Plaffe, they also sent them good and splendid flax, which they had spun to help them').

The word for linen is well attested in Germanic (Table 3). We have the Gothic *lein*, Old English *līn*, Old High German *līna*, Old Icelandic *lín*. We also see different compounds like Old Icelandic *lín-brækr* ('linen breeches'), *lín-dúkr* ('linen cloth'), *lín-garn* ('linen yarn'), *lín-kyrtill* ('linen tunic'), *lín-klæði* ('linen clothing'), *lín-fræ* ('flax seed') and *lín-akr* ('flax field') while Old High German has the compounds *līn-bruoh* ('linen trousers, breeches, loin cloth') and *līn-bōzo* ('flax bundle/bundle of linen'). Outside Germanic we have Greek *línon* ('anything made of flax') and the Latin *līnum* ('flax plant, linseed, linen'). In the Baltic branch we have the Old Prussian *lynno* ('flax as material'), in Lithuanian *lìnas* ('flax, plant') and *linãĩ* ('flax fibres'), and in the Slavic branch the Old Church Slavonic *lьnъ* ('flax') and the Russian *lën* ('flax').

Comparing the meaning of the three flax words

When we look at the three words **flahsan*, **harzwaz* and **līnan* in the daughter languages, we do not see a clear distinction in the meaning of the three words. At first glance, it seems as if they can all denote the plant, textile and product. As in Old Icelandic where we have *línklæði* vs *hǫrskrýdd* which both mean 'linen clothing'. In Old High German we have *līnbōzo* and *harobôz* which probably both mean 'bundle of flax'. When it comes to North Germanic and West Germanic languages, the earliest written sources beside runic inscriptions are dated from around AD 800 - 1000 and since Proto-Germanic is estimated to have been spoken around the 1st century AD at the latest (Fortson 2010, 338), the semantics could have changed and been mixed up.

Looking at **harzwaz*, we see that it goes back to the Indo-European root **korswo-* ('scratch, comb, hackle') while the Old English *heorde* means 'the coarse flax fibres', and the plural form *heordan* means 'hards of flax'. Hards of flax are processed by scotching, hackling and combing the fibres, and since **harzwaz* builds on a root which means 'scratch, comb, hackle', it is therefore likely that the original meaning of Proto-Germanic **harzwaz* is 'flax fibres'. Flax fibres are the raw material that is spun into yarn, and this fits well with the Middle High German sentence mentioned above: *die plaffen santen ouch dar wol gezinnelohten har daz si in ze helfe spunnen* ('The Plaffe they also send them good and splendid flax, which they had spun to help them').

The word **flahsan* is attested in Old English as *fleax-*æcer ('flax field') and *fleax-hamm*. Middle Low German has the word *vlas-arne* ('flax harvest') and *vlas-jart* ('flax field'). In Old English there is the sentence *of* ðære *eorþan cymeþ* ðæt *fleax* ('flax comes of the earth'), and in Old High German *so iz tar in lande sito ist, tar der*

Proto-Germanic	Gothic	Old High German	Old English	Old Icelandic	Greek
līnan	***lei***n 'linen'	***līna*** 'linen, flax as material and plant' ***līn-bruoh*** 'linen trousers, breeches, loin cloth' ***līn-bōzo*** 'flax bundle / bundle of linen'	***līn*** 'linen, flax as material and plant'	***lín*** 'linen, linen cloth' ***lín-brækr*** 'linen breeches' ***lín-dúkr*** 'linen cloth' ***lín-garn*** 'yarn of linen' ***lín-kyrtill*** 'linen tunic' ***lín-klæði*** 'linen clothing' ***lín-fræ*** 'flax seed' ***lín-akr*** 'flax field'	***línon*** 'anything made of flax'

Table 3. Simplex and compound words from Proto-Germanic *līnan (related words outside Germanic separated by language branches with double lines).
Sources: Lexer I 1872; 1923; Cleasby and Vigufsson 1874, 393; Orel 2003, 248; De Vann 2008, 344; Köbler 2013, http://www.koeblergerhard.de/ahdwbhin.html

flahs uuahset ('as it is custom in the country, there the flax grows'). The meaning of Proto-Germanic **flahsan* is most likely 'flax in the form of a plant'. However, Old Icelandic shows the presence of *lín-fræ* ('flax seed') and *lín-akr* ('flax field'), but since the word **flahsan* is not preserved in North Germanic, the meaning 'flax in plant form' could have been transferred to the word *lín*. Therefore, Old Icelandic *lín-fræ* and *lín-akr* do not necessarily contradict that **flahsan* means 'flax of a plant form'. It is harder to say what the original meaning of *flahsan* was, because unlike **harzwaz*, which had a meaning of 'hackle, comb, scratch' related to flax in both Pre- and Post-Proto-Germanic, admittedly we only have evidence for the 'flax in plant form' in Germanic. Outside the Germanic branch of the Indo-European language tree, we have the Albanian *plëhurë,* ('rough linen') and *plaf* which does not mean flax textile but ('woollen blanket, woollen sheet'). Within Germanic we have Old English *fleax-līne* ('flax line'). On the other hand, I have only found clear evidence in Old English that **flahsan* can be a material made from the plant, and there is no reason to believe that Albanian *plaf* ('woollen blanket, woollen sheet') indicates the original Indo-European meaning of the word. Therefore, I suggest that the meaning of **flahsan* in Proto-Germanic was indeed 'flax in plant form'.

The word *līnan*: in the languages related to Germanic, we see various meanings. Greek *línon* means 'anything made of flax', and Latin *līnum* means the flax plant, seed and material. Old Prussian *lynno* is flax as material, and Lithuanian has both *lìnas* ('flax, plant') and *linaĩ* ('flax fibres'). We get the same understanding in Old English where it can be both the plant and other forms. And then there is Old High German *līn-bōzo*, where it is uncertain whether it means bundle of flax or bundle of linen, although there is within Germanic a good handful of examples where it must be some kind of flax product as seen in the Old High German *līn-bruoh* ('linen trousers, breeches, loin cloth'), in the Old Icelandic *lín-brækr* ('linen breeches'), *lín-dúkr* ('linen cloth'), *lín-garn* ('yarn of linen'), *lín-kyrtill* ('linen tunic') and *lín-klæði* ('linen clothing'). The data presented here suggest that at least one meaning of *līnan* is 'linen' in the form of textile made of flax. Whether there are other meanings connected to the word I cannot tell.

Further, it is important to mention that the Proto-Germanic languages all have words for a flax field and words related to the cultivation of the plant. In Old Icelandic it is *lín-akr* ('flax field') and *lín-fræ* ('flax seed'), and in Old English *fleax*-æcer ('flax field') and *fleax-hamm* ('enclosed area where flax is grown'). In Middle Low German occur *vlas-arne* ('flax harvest'), *vlas-bote* and *vlas-jart* ('flax field'). Based on the data presented here, there is strong evidence in each daughter language of Proto-Germanic, that at least around AD 1000 specialised words for the task of growing flax were used in Europe. Since the languages do not have the exact same word etymologically, we cannot go further back in time through the linguistics comparative method, although we know from archaeological data that the cultivation and use of flax goes back to the Neolithic in Europe and even earlier outside Europe (Barber 1991).

Words related to plant fibre textile production

Finding words relating to tools specifically used for flax production is a difficult task, although it is not so hard to find words for tools in general. The problem is that most of these words are borrowed from Middle Low German into the other Germanic languages, which are apparent from the sound laws, and thus

	Latin	Old Prussian	Lithuanian	Old Church Slavonic	Russian
	līnum 'flax plant, linseed, linen'	***lynno*** 'flax as material'	***lìnas*** 'flax, plant' ***linaĩ*** 'flax fibres'	***льнъ*** 'flax'	***lën*** 'flax'

Proto-Germanic	Old High German	Middle Low German	Proto-Germanic	Old Icelandic	Old Swedish
**rippilaz*	*riffila* 'flax-comb'	*repel, repe* "flax-comb'	**rifilaz* /	*tan-**refill*** 'tusk-chisel': *rífa* 'to bite asunder'	*rīva* 'to bite asunder'

Table 4. Simplex and compound words from Proto-Germanic *rifilaz/*rippilaz.
Sources: Cleasby and Vigufsson 1874, 425; Pokorny 1959, 858; 859; Lübben 1965, 299.

Gothic	Old English	Old High German	Old Frisian	Middle Low German	Old Icelandic	Old Swedish	Tocharian A	Tocharian B	Lithuanian
spinnan 'to spin'	***spinnan*** 'to spin'	***spinna***n 'to spin, make a thread'	***spinna*** 'to spin'	***spinnen*** 'to spin'	***spinna*** 'to spin'	***spinna*** 'to spin'	***pänw-*** 'to spin'	***pänn*** 'to stretch, reach out for'	***spéndžiu*** 'to plait'

Table 5. Words related to English 'to spin' (related words in language branches outside Germanic separated by double lines).
Sources: Söderwall 1891-1900, 466; Orel 2003, 364.

Proto-Germanic	Old High German	Old Swedish	Old Icelandic	Old Irish	Latin	Greek	Sanskrit
****rukkaz*** 'distaff'	***roc, rocko*** 'distaff'	***rokker*** 'spinning wheel, distaff'	***rokkr*** 'spinning wheel, distaff'	***rucht*** 'tunic'	***runcō*** 'to weed out, to root up'	***orússō*** 'to dig up'	***luñcati*** 'to pull, pluck'

Table 6. Words related to Proto-Germanic *rukkaz (related words from language branches outside Germanic separated by double lines).
Sources: Hellquist 1826, 650; De Vries 1962, 451; Orel 2003, 308.

Proto Germanic	Old English	Old Saxon	Old High German	Old Frisian	Old Icelandic	Modern Swedish Dialect	Greek
****snāldiō*** / ****spennilō(n)*** 'spindle'	***spinel*** 'spindle'	***spinnila*** 'spindle'	***spinnala*** 'spindle'	***spindel*** 'spindle'	***snælda*** 'spindle'	***snåld*** 'spindle whorl'	**nẽntron** 'spindle'

Table 7. Words related to Proto-Germanic *snāldiō and *spennilō(n) (related words in language branches outside Germanic separated by double lines. Green words from *snāldiō and blue words from *spennilō(n)).
Sources: Holtenhausen 1974, 310; De Vries 1961, 527.

Proto-Germanic	Old English	Old High German	Old Icelandic	Old Swedish	Tocharian A	Greek	Albanian	Sanskrit
webanan 'to weave'	***wefan*** 'to weave'	***weban*** 'to weave'	***vefa*** 'to weave'	***væva*** 'to weave'	***wäp*** 'to weave'	***huphé*** 'web'	***vej*** 'to weave'	***ubhnáti*** 'to lace up, to cover'

Table 8. Words from Proto-Germanic *webanan (related words from language branches outside Germanic separated by double lines).
Sources: Hellquist 1826, 1179, 1180, 1181; Orel 2003, 451.

Proto-Germanic	Old Saxon	Old High German	Old Icelandic	Old Swedish	Modern Swedish dialect	Danish
wabjaz**/**wubjaz 'loom?'	***webbi*** 'loom'	***weppi*** 'loom' ***wuppi*** 'loom'	***vefr*** 'loom'	***væver*** 'loom'	öv 'loom'	***væv*** 'loom'

Table 9 Words from Proto-Germanic *wabjaz/wubjaz (blue words from *wabjaz and green words from *wubjaz).
Sources: Hellquist 1826, 1179-1181; Orel 2003, 451.

there is too little evidence to reconstruct them back to Proto-Germanic. A word which does not originate from Middle Low German is Old High German *riffila* ('flax-comb'), and the Old Icelandic *tann-refill* ('tusk-chisel') which could also be translated as "bone-comb". In Middle Low German we also have the word *repel* / *repe* ('flax-comb'), and the Old Icelandic *–refill* could have been borrowed from Old High German *riffila* or Middle Low German *repel, repe*, but that is not certain. Middle Low German *repel, repe* and Old High German *riffila* point to a Proto-Germanic **rippilaz*, while Old Icelandic *–refill* points to a Proto-Germanic **rifilaz* (Table 4). Both of the Proto-Germanic forms build on the Indo-European root **reip-*, which is also the base for Old Icelandic *rífa* ('to bite asunder'), Old Swedish *rīva* ('to bite asunder'). Even though the word could have been borrowed into the North Germanic languages from Middle Low German, there is nothing to confirm this, and the sound laws show that the word could be inherited in all the languages mentioned here. The semantics of the word is clear and straightforward in West Germanic. In Old Icelandic the meaning diverges in the compound *tann-refill*, a *-refill* for tusk. Nonetheless, the semantics of Old Icelandic *rífa* ('to bite asunder') and the Old Swedish *rīva* ('to bite asunder') fits well with a flax-comb, because combs have teeth. Thus I suggest reconstructing **rifilaz*/**rippilaz* for Proto-Germanic with the meaning 'a tool for combing'.

Word meaning 'to spin' are also well-attested in Indo-European languages (Table 5), where we see it in both Tocharian, which was spoken in western China in the Xinjiang province, and in Europe. The meaning 'to spin' is only found in Tocharian A *pänw-*, and in Germanic. Within Germanic the meaning of the word is, however, very consistent. The Proto-Germanic word can be reconstructed as **spenwanan*, which goes back to the Indo-European root **spen-w-*. Since the Germanic daughter languages all agree about the meaning, it is very safe to conclude that the meaning of **spenwanan* is also 'to spin'. In the Middle High German sentence *die plaffen santen ouch dar wol gezinnelohten har daz si in ze helfe spunnen* ('the Plaffe they also send them good and splendid flax, which they had spun to help them'), and the Old High German *diu selba Ysis lerta den flahs arbeiten, unde spinnen* ('Isis she taught herself to work and spin the flax'), we see the words *to spin* and *flax* together. In the Old High German sentence *haro giu palkili habentan* ('already having a little flax ball') the 'flax ball' probably is 'a ball of flax yarn'. Consequently, we can see a combination of the words for flax and 'to spin', and as there is linguistic evidence that flax was spun like wool, the Proto-Germanic **spenwanan* was most likely also used for processing flax.

Proto-Germanic	Old English	Old Saxon	Old High German	Old Frisian	Old Icelandic	Old Danish	Sanskrit	Lithuanian
***seujanan** 'to sew'	***siwian** 'to sew' ***seowian** 'to sew'	***siuwia** 'to sew'	***siuwen** 'to sew'	***sīa** 'to sew'	***sýja** 'to sew'	***sȳ** 'to sew'	***sīvyati** 'to sew'	***siuti** 'to sew'

Table 10. Words from Proto-Germanic *seujanan (related words from language branches outside Germanic separated by double lines).
Sources: Sejersted and Torp 1911, 1224; Pokorny 1959, 916; Bjorvand and Lindeman 2000, 895, 896.

Proto-Germanic	Gothic	Old English	Old Saxon	Old High German	Old Icelandic	Old Swedish	Old Danish
***nēþlō** 'needle'	***nēþla** 'needle'	***nēðl** 'needle' ***nædl** 'needle'	***nādla** 'needle' ***nāthla** 'needle'	***nādala** 'needle' ***nālda** 'needle'	***nál** 'needle'	***nāl** 'needle'	***nāl** 'needle'

Table 11. Words from Proto-Germanic *nēþlō (related words from language branches outside Germanic separated by double lines).
Sources: Pokorny 1959, 973; Bjorvand and Lindeman 2000, 679-680; Orel 2003, 287.

At first glance there does not seem to be much connection between the semantics in Germanic and the other Indo-European languages, except in the word related to the part of the spinning process where the fibres are pulled out. The Sanskrit word *luñcati* ('to pull, pluck') is not that far away when it comes to semantics. The Greek word *orussō* with the meaning 'to dig' is a little similar to 'pluck' in Sanskrit *luñcati*, and Latin *runcō* ('I weed out, to root up') is similar in the same way. The Old Irish *rucht* is 'made by spinning'. In Germanic we see the meanings of both 'spinning wheel' and 'distaff', while the Proto-Germanic word can be reconstructed as **rukkaz*, which goes back to the Indo-European root **h*$_3$*rewk-* (Table 6). Since the semantics are very similar in Germanic, and relatable in other Indo-European languages, I would say it is safe to reconstruct the meaning 'distaff' for **rukkaz*.

I have now looked at the verb for spinning, the word for distaff, and now turn towards the word for a spindle. The Swedish word *snåld* ('spindle whorl'), the Old Icelandic *snælda* ('spindle') and the Greek *nẽntron* ('spindle') go back to the same word etymologically, but also in other Germanic languages, *e.g.* the Old High German *spinnala* ('spindle'), Old Saxon *spinnila* ('spindle'), Old English and Old Frisian *spindel* ('spindle') agree very well with each other. Thus, it seems that Proto-Germanic had two words for 'spindle' and they can be reconstructed as **snāldiō* and **spennilō(n)* (Table 7).

All words related to the process of weaving go back to the Indo-European root **webh-*, and the Proto-Germanic word can be reconstructed as **webanan* (Table 8). The semantics of this word are all more or less the same in the Indo-European languages, except Sanskrit *ubhnā́ti* ('to lace up, to cover') and the Greek *huphḗ* ('web'), which are not that different from weave. The meaning 'to lace up' in *ubhnā́ti* has something to do with a string. Because we find the same semantics in the languages outside Germanic and the same semantics throughout the Germanic daughter languages, it should be safe to reconstruct the meaning of Proto-Germanic **webanan* as 'to weave'.

The semantics of Proto-Germanic **wubjaz* and **wabjaz* is most likely a 'loom' (Table 9). However, in Old High German *wuppi* and Swedish dialect öv point to a Proto-Germanic **wubjaz* while the semantics of the Danish word *væv*, Old Swedish *væver* , Old High German *weppi* and the Old Saxon *webbi* all meaning 'loom' are exactly the same, and points to the Proto-Germanic **wabjaz*.

In the Germanic languages we see the Old Danish word *sȳ* , Old English *siwian* and *seowian*, the Old Saxon *siuwia*, the Old High German *siuwen*, Old Icelandic *sýja* and Old Frisian *sīa* which all mean'to sew'. From these forms we can reconstruct a Proto-Germanic **seujanan* (Table 10). The meaning of the word is very consistent in Germanic, and in other Indo-European languages with the Sanskrit word

	Old Church Slavonic	Russian	Greek
	šiti 'to sew'	***šitь*** 'to sew'	***humḗn*** 'thin skin, membrane'

	Latvian	Middle Irish	Latin	Greek
	snāju 'to twine loosely together, to spin'	***snīid*** 'to twist, to bind'	***nēre*** 'to spin'	***nḗj*** 'to spin'

sĭ̄vyati ('to sew'), and in the Slavic branch Old Church Slavonic *šiti* ('to sew'), Russian *šitь* ('to sew') and in the Baltic branch Lithuanian *siuti* ('to sew') where the semantics are the same. One exception is Greek *humḗn* 'thin skin, membrane'. From the data presented here, there can be no doubt that Proto-Germanic **seujanan* is 'to sew', and the other branches also point to a Proto-Indo-European **syewH-*.

Finally, the Germanic words for needle can be reconstructed as Proto-Germanic **nēþlō*, and since the semantics in the Germanic languages are identical, there can be no problem in reconstructing the meaning 'needle' for Proto-Germanic **nēþlō* (Table 11). The suffix *-þlō in Proto-Germanic is a well-known instrumental suffix in the Indo-European languages typically reconstructed to Proto-Indo-European *-tlo-. Thus the formation *nē-þlō in Proto-Germanic could be analysed as 'a sewing tool' when looking at the root of the word in the other Indo-European languages: Latvian *snāju* ('to twine loosely together, to spin'), Middle Irish *snīid* ('to twist, to bind'), Latin *nēre* or *nḗj* ('to spin'). All of these words go back to the Indo-European root *$sneh_1$- / *$sneh_1i$-, which can sometimes also appear without initial *s- as *neh_1- / *neh_1i-, a phenomenon normally referred to as s-mobile, with the meaning of 'to sew together, to web, to spin'.

Conclusion

In this text I have gone through some words related to the cultivation and processing of flax. Linguistic evidence of flax occurs as fields, combing flax, tools and words for spinning, weaving and sewing. The results and conclusions reached are of mixed character, which is primarily due to the quantity of data I managed to gather about each word I have examined, in order to reconstruct Proto-Germanic forms and semantics of the words in question. In general, the reconstruction of the word forms is easy on account of the sound laws which function as a guide. It is much harder to reconstruct semantics, because it depends much more on the number of examples in different related languages, and how much the semantics in each language have changed and diverged from each other. When it comes to reconstruction, especially when we try to reconstruct semantics of words, we work with degrees of possibility, and the more attestations in different related languages we have, and the more similar the semantics are in the different attestations, the higher degree of possibility we have. For a correct interpretation of a word the best results can be obtained by using the comparative linguistic method in combination with the archaeological data we have when investigating dead languages, in which nothing is recorded. In this study, I have only presented a few examples, but there can be no doubt the comparative method can indeed increase our knowledge about the past by showing what words were used for different textile processes. Similar studies could be made with other materials, such as leather, fur, wool and nettle, and a more thorough investigation of tools and the technology of textile production is also desirable. In other words, the linguistic investigation of textile terminology continues, and this study serves only as one example of how comparative linguistics can contribute to our understanding of the past.

Comparative linguistics has many advantages, compared to archaeological remains. Many objects which were a part of our ancestors' lives decompose over time and leave no trace. But just because the object fades away, it does not mean that the word for the object fades away too. However, better results are obtained through cooperation between different disciplines and it is important to compare the results obtained through comparative linguistics with the results obtained from other disciplines, for example archaeology, history and biology, in order to get a better, wider and more detailed picture of the different textile technologies.

Languages are related to each other. They go back to a common language, commonly called a proto-language, which again is related to other languages. In

related languages we see reoccurring correspondences in their phonetic system, morphology, vocabulary and semantics. Even though we have nothing written down in the proto-language, a lot can be reconstructed by looking at its daughter languages. The most important method used to reconstruct an unattested language stage is called the comparative method. It is important to think of what words are. They are the tool we use to describe our world, what we imagine, talk and think about. If we can reconstruct words and their meanings for a proto-language, we can get a good deal of information about the culture and technology of the speakers of that proto-language. In this study, the comparative method has been applied to the Germanic languages, to see what we can tell about flax, both in the form of plant and textile.

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I would like to thank Birgit Anette Rasmussen, Bjarne Simmelkjær Sandgaard Hansen, Nicki Andersen and my fellow students Camilla Høj Sørensen for their comments and inputs, and Mikkel Nørtoft for editing this article. I would also like to thank Camilla Luise Dahl for introducing me to her former co-workers. Finally, I would like to give a special thanks to Ulla Mannering for offering the opportunity to write this article.

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Lena Bjerregaard

Non-Woven Textile Techniques in Pre-Columbian Peru

Introduction

Weaving was invented almost simultaneously all over the world in around 5000 BC without there being any connections between the developments. Long before that, many extremely complicated and similar, non-woven textile techniques were already in use. These non-woven techniques can produce any kind of textiles – from cloth to accessories. Most of these techniques, however, require more production time than woven items, and the loom could be said to have been an invention that simplified and expedited the manufacture of textile items. Nevertheless, non-woven techniques were sometimes better suited for certain items or conditions, and they continued to be widely used after the invention of the loom.

In this discussion I wish to focus on these non-woven techniques, and as examples I primarily use the pre-Columbian American artefacts with which I am most familiar (Bjerregaard 2002 and 2007). In some cases I also refer to objects from Europe produced using similar techniques in order to illustrate similarities or differences in the use of non-woven textiles in the Old and the New World.

The New and the Old World

Around the time of the Spanish conquest in AD 1532 Peru was home to a very rich textile production culture with a long history (Stone-Miller 1992). Textiles dating from as early as 500 BC have been recovered as part of the archaeological material excavated along the very dry coast of central and southern Peru: they were found in excellent condition and are today very well preserved and accessible in museums around the world. During my work as the conservator responsible for the largest European collection of Peruvian archaeological textiles in the Ethnological Museum in Berlin in Germany, I was able to study a vast number of pre-Columbian textiles, and especially the non-woven textile artefacts are fascinating in their complexity. The majority of the techniques were independently used in the Old and the New World: knitting was the only technique not found in pre-Columbian Peru, and fist-braiding was not used in Europe, although it is still practised in Tibet (Bjerregaard 2015).

Fibres and dyes of pre-Columbian Peru

In Peru textiles were made using cotton, camelid fibre and plant fibre; silk was first introduced by the Spaniards. The Peruvian cotton was of a local type (Barbadense) and grew abundantly on the coast. This was a long-fibred but quite coarse type of cotton. The camelid fibre was mainly obtained from alpacas, who were kept in herds in the highlands, and sometimes from the wild vicuña, a smaller type of camelid. The

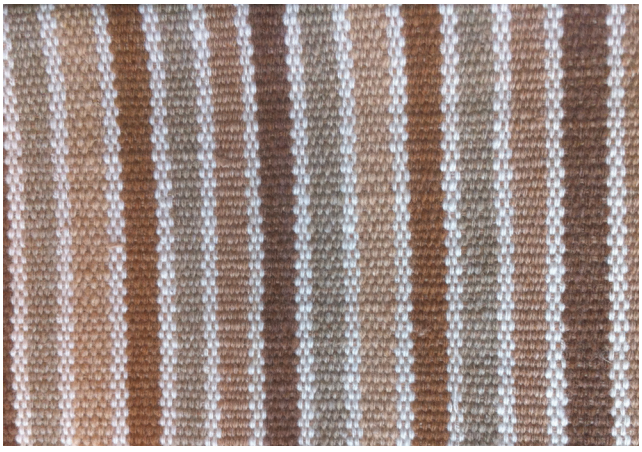

Fig. 1. Modern shawl from Peru made from undyed cotton in four shades of natural colours (Photo: Lena Bjerregaard).

alpaca, and especially the vicuña, have finer hair than most sheep, and the fibres do not have many scales. The wool is therefore more lustrous and softer than most sheep wool, and can be spun into very fine yarns. Due to the lack of scales on the fibre surface it cannot be felted, and therefore felt was not used in pre-Spanish Peru. The plant fibre used in most pre-Columbian textiles was a South American agave called *Furcreae andina*. It is still used in many South-American villages, mainly to produce bags and hats (Rowe 2003/2004).

The old Peruvians were master dyers. Of the three fibre types mentioned, the camelid fibre was the easiest to dye. The bright colours of the camelid fibre textiles are in many cases still preserved today because of the optimal preservation conditions in the graves in which they were found. With no humidity, no air and no temperature changes, in the salty environment of the Peruvian coast, 2500-year-old textiles can today look as bright as the day they were made. Cotton is harder to dye, and only paler colours can be obtained, but the Peruvian cotton grew in different shades, and so offered a variety of natural colours from white through tan to brown and greenish grey (Fig. 1). Plant fibre is the hardest to dye, and so it was mainly used in its natural tan colour. However, some plant fibre objects such as the hairnets from the central coast were painted purple using the shellfish *purpur mullox* (Bjerregaard 2010).

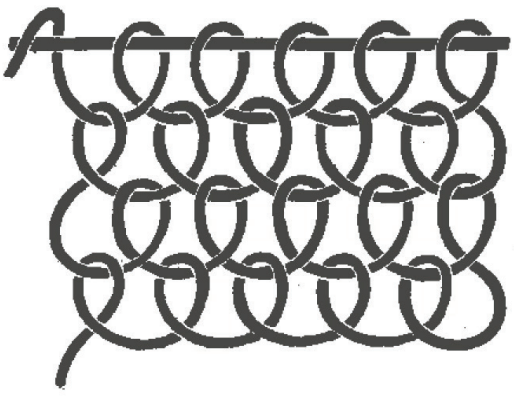

Fig. 2. Simple looping. (After D'Harcourt 1975, Fig. 68).

Various non-woven techniques in the New and the Old World

Simple looping

In ancient Peru both small and large items were sometimes made in simple looping instead of weaving (Fig. 2). Simple looping is still widely used in Latin America, Asia and the Pacific for making bags, but to my knowledge is not used for making larger textiles, as it was in the case of the large male tunics from the Paracas culture (500 BC – AD 500) in southern Peru (Fig. 3).

Fig. 3. Tunic in simple looping from the Paracas culture in southern Peru dated to 250-1 BC. The tunic was folded in the centre over the shoulders. It is made from simple looping using S2z camelid fibre yarns. There are 6 rows x 6 loops per cm. At the bottom edge and along the sleeve openings are tied-on fringes of un-spun camelid fibre. (VA 64262, Ethnological Museum, Berlin. Photo: Claudia Obrocki).

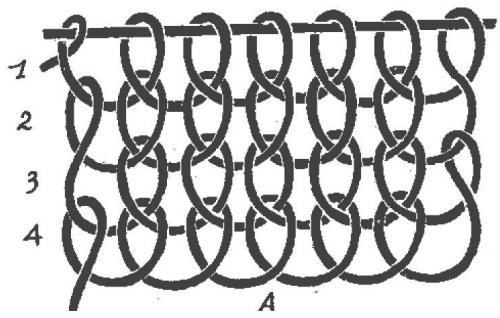

Fig 4. Needle-looping. (After D'Harcourt 1975, Fig. 73).

Fig. 7. Woollen mitten made from needle-looping found in Copenhagen in Denmark. It is dated to c. 1600 (D7303b, National Museum of Denmark. Photo: Charlotte Rimstad).

Fig. 5. The Calendar Mantle from the Gothenburg Collection, now at the Museo Nacional de Antropologia, Arqueologia y Historia Peru (1935.32.0179/RT-38072. Photo: The National Museums of World Culture, Sweden).

Fig. 6. Band made from needle-looping (VA 44829, Ethnological Museum, Berlin. Photo: Lena Bjerregaard).

Needle-looping

In ancient Peru needle-looping or 'cross knit looping' was used mainly in the Paracas/Nasca culture (500 BC–AD 500) (Paul 1974) (Fig. 4). The technique was used for making three-dimensional figures of the most elaborate kind. The most famous textile created in this technique is *The Calendar Mantle* now belonging to the Museo National de Archaeologia y Anthropologia in Lima in Peru (Fig. 5). The Ethnological Museum in Berlin also has several bands with colourful hummingbirds suckling at flowers made using needle-looping with camelid fibres, using S-plied yarns made from two z-twisted yarns (in the following referred to as S2z). Such bands were stitched to the neck and arm openings of the woven tunics of the early Nasca culture in southern Peru (AD 250–400) (Fig. 6). In Europe, needle-looping was most often used for making thick woollen winter mittens and socks (Fig. 7).

Knotting

Knotting was a technique used in Peru for fine hats and hairnets. The square knot and Larks' head knots were especially favoured:

The square knot (Fig. 8) was used to create the four-cornered hats of the Tiwanaku culture (AD 600-1000) (Young-Sanchez 2004) in highland Bolivia (Fig. 9). In the contemporary Wari culture (AD 600-1000) (Bergh 2013), similar four-cornered hats had cut pile from camelid fibres knotted into the square knots (Fig. 10 and 11). Some of the later central coast hairnets also added cut pile to their square knot mesh (Fig. 12).

The square knot was also extensively used in Europe. As an elaborate textile production technique, it is the basic knot in macramé (Priscilla 1923). Macramé is thought to originate from 13th-century Arab weavers (Knotter, Peter the 2012). They knotted the excess warps of hand-woven fabrics into decorative fringes on shawls and veils. The art was taken to Spain by the Moors, then to Italy, and from there spread through Europe.

Nineteenth-century British and American sailors made hammocks and fringes in macramé in spare hours while at sea, thus spreading the art to China and back to the New World. They called the process 'square knotting' after the knot they used most frequently. Macramé regained popularity during the 1970s and is still widely used for making decorative networks.

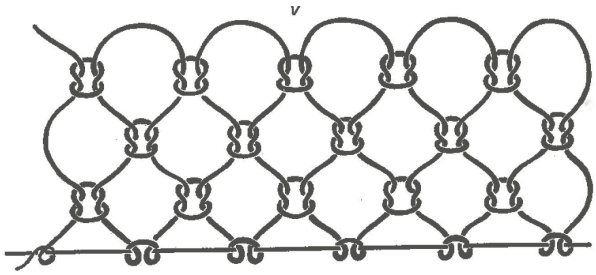

Fig. 8. Square knot network (after D'Harcourt 1975, fig. 77).

Fig. 9. Four-cornered hat from the Tiwanaku culture in highland Bolivia dated to AD 600–1000. It is made in a single piece (including the triangular points) with square knots in S2z camelid fibre yarns (VA 63996, Ethnological Museum, Berlin. Photo: Lena Bjerregaard).

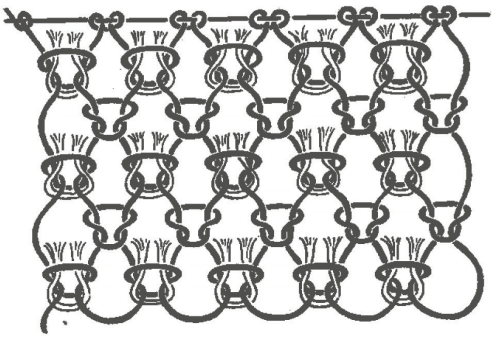

Fig. 10. Square knot network with pile (after D'Harcourt 1975, fig. 77).

Fig. 11. Four-cornered hat with cut pile from the Wari culture in the southern Peruvian highland dated to AD 600-800. It is made with square knots, partially with cut pile inserted in the knots and is made entirely of S2z camelid fibre yarns. The hat consists of a rectangular panel, 8 x 50 cm, sewn together on the short side to form a tube that is attached along the upper edge to a separately-made square, 7 x 7 cm, with four rolled squares stitched to the corners. Cut pile made of unspun camelid fibre is inserted into the knots of the rectangular panel and the corner peaks. The top lacks pile (VA 64271, Ethnological Museum, Berlin. Photo: Lena Bjerregaard).

Fig. 12. Hairnet from the central coast of Peru dated to AD 1200-1500. It is made in square knots in S2z camelid fibre yarns. Tufts of camelid fibres are stitched on for adornment. At the sides are two reed sticks, which have been wrapped with camelid fibre yarns, and tassels are fixed to their tops (VA 42350, Ethnological Museum, Berlin. Photo: Lena Bjerregaard).

Tatting

On the central coast of Peru from around AD 1300 until the Inca conquest in 1470 (Castro *et al.* 2013), women and men were wearing delicate little hairnets made from native plant fibre (*Furcreae andina*). The hairnets could be tightly or loosely knotted with square knots, while more elaborate hairnets were knotted with lark's head knots in a tatting-like technique (Fig. 13 A-E and 14). The Ethnological Museum in Berlin has 56 of these hairnets. Most of them have provenience in Pachacamac, where the central-coast Ychsma people lived. Hairnets are also depicted on figurative ceramics from the Chancay culture, and some are found in weaving boxes from the Chimu culture on the north coast (Rowe 1984). Some of the hairnets were painted with shellfish purple between the patterns to make the patterns stand out as light areas (Fig. 15) (Bjerregaard 2010).

In Europe the technique of tatting has mainly been used for producing white lace-like objects, imitating point lace (Fig. 16). Tatting in Europe dates to the early 19th century. German and Danish tatting is usually known by the Italian-derived word *Occhi/Orkis* (Hoare 1910/1988).

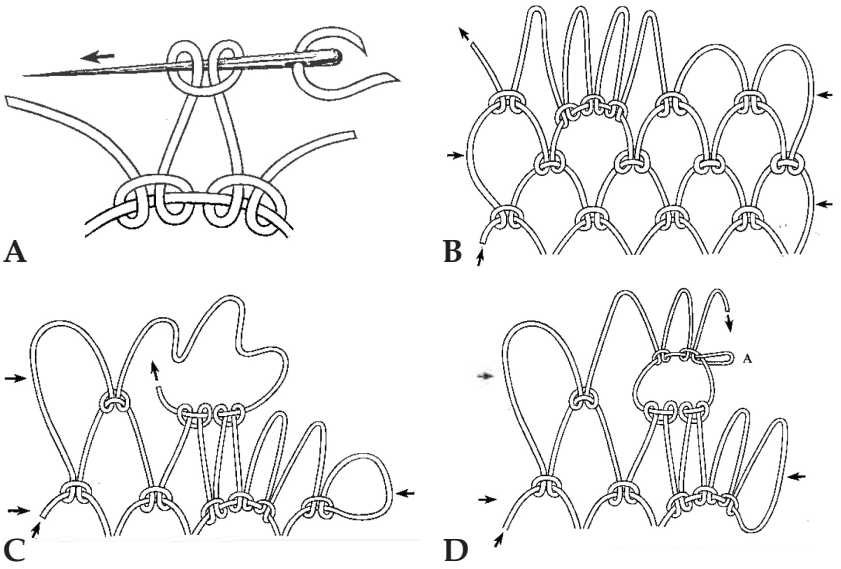

Fig. 13. A-E, The Peruvian tatting technique in five stages (after Bjerregaard 2010, Fig.18-22).

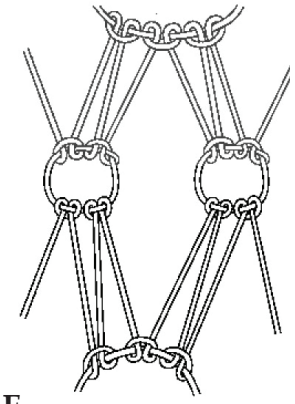

Fig. 14. Hairnet in tatting technique made from S2z plant fibre yarn (Furcrea andina). The tying strings were braided from 4-8 strands. Pachacamac, AD 1200–150 (VA 42663, Ethnological Museum, Berlin. Photo: Lena Bjerregaard).

Fig. 15. Hairnet in tatting technique with purple shellfish painting around the animal figures. Pachacamac, AD 1200–1500 (VA 42673, Ethnological Museum, Berlin. Photo: Lena Bjerregaard).

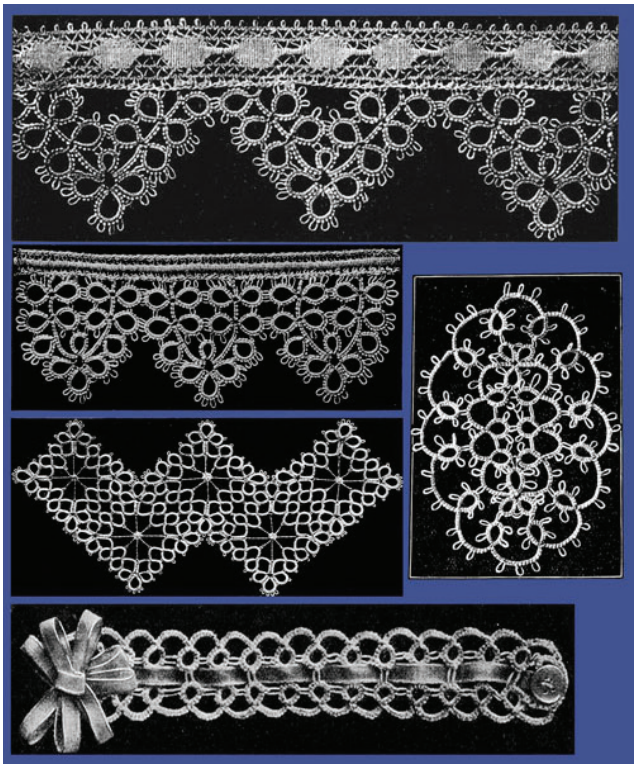

Fig. 16. Tatting patterns (after Beyers Håndarbejdsbøger 1915).

Sprang

In Peru textiles were only produced in sprang (Fig. 20) in the early pre-Columbian period, and only camelid fibre yarns were used for this technique (Fig. 17). Some were extremely refined double sprang textiles, like the head ornament from the Nazca Culture shown in Fig. 18, which has a fine tubular woven cord (Fig. 19) connecting the tassels.

The earliest surviving example of sprang in Europe is a cap from around 1400 BC that was recovered in a female oak coffin in Denmark (Fig. 21). The word *sprang* is of Swedish origin, and the technique possibly spread southward towards the Mediterranean during the Iron Age or possibly the late Bronze Age (Collingwood 1974).

Fig. 17. This fragment of a camelid-fibre sprang textile is from Ica in the southern part of Peru. It is dated to 300–100 BC, belonging to the Paracas Cavernas Culture. It is unknown what the textile was used for. It has two side selvedges, and was 34 cm wide; the length is unknown (VA 29449, Ethnological Museum Berlin. Photo: Lena Bjerregaard).

Fig. 18. Headgear with tassels in double sprang. This head ornament from the Nazca Culture, AD 400–600, has an unknown provenience, but it is probably from the south of Peru, where the Nazca people lived. The cord between the tassels was wound around the head and the tassels arranged to be at the two sides of the head. The artifact is made in S2z camelid fibre yarns. The tassels are made in double oblique intertwining (sprang). Two layers of warps (yellow and black) were stretched out on a frame over each other and then interworked in sprang technique. The double sprang was finished when there was about 10 cm loose warps left in the centre. The interworked warps were then fixed and the textile folded at the centre, sewn together at the sides, and the loose warps covered with loop-stitch embroidery. The 7.22 m-long cord connecting the sprang tassels is made in tube weave and has supplementary warp patterns (VA 65807, Ethnological Museum in Berlin. Photo: Lena Bjerregaard).

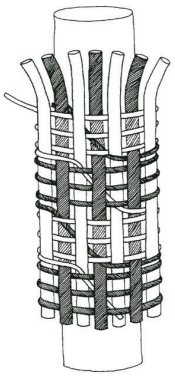

Fig. 19. Tubular plain weave with alternate warp order (after Cahlander 1980, Fig.1-20).

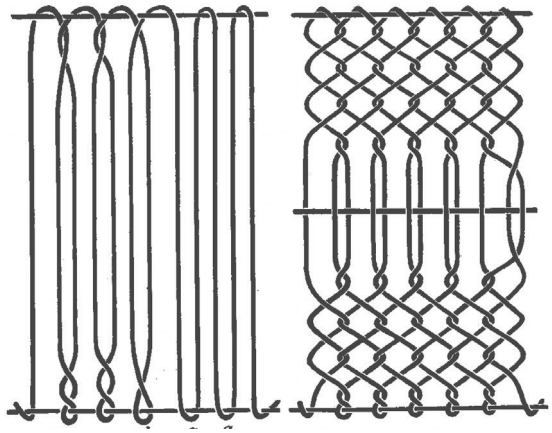

Fig. 20. Sprang (after D'Harcourt 1975, fig. 51).

Fig. 21. Sprang cap found in a female oak coffin from Borum Eshøj in Denmark dated to the Early Bronze Age period II, 1500-1300 BC (Photo: Roberto Fortuna).

Double embroidery

Another much-used technique for creating non-woven textile accessories in ancient Peru was wrapping bundles of yarn and then perpendicularly fixing the wrapping by double stem-stitch embroidery (Fig. 22). This technique was used at the end of the pre-Columbian era (AD 1400-1550) on the south coast of Peru. Female belts from Pisco on the Peruvian south coast are made in this technique and adornment pieces for bags from the same time and culture were also made in double embroidery (Fig. 23). I do not know of a similar technique used in Europe.

Fig. 22. Woman's belt in complementary embroidery from Pisco on the Peruvian south coast. The belt is dated to AD 1450-1550. The centre part of the belt (23 cm) is made by joining thick bundles of plied 2S-twisted cotton yarns and wrapping them with S2z camelid fibre yarns in a weft face weaving way. The edges of this centre piece are embroidered using stem-stich. The side panels (24 x 6 cm) are embroidered with S2z camelid fibre yarn in stem stitches perpendicular to a spiral cotton yarn wrapping. The area to be embroidered is flattened, instead of being left as a tube, and an embroidery yarn from the top side is exchanged with a yarn from the bottom side (of alternate colours) at intervals according to the pattern. Therefore, the llamas come out in alternate colours on the two sides of the belt. The tying cords are made in 8-strand plaiting, where the yellow and black S2z camelid fibre yarns alternately make up the core and the outer plaiting. At the cord ends, the loose yarns are tightly wrapped in various colours (VA 44702, Ethnological Museum in Berlin. Photo: Lena Bjerregaard).

Fig. 23. Bag with complementary double-embroidery ornament from Ica on the Peruvian south coast dated to AD 1450-1550. The bag is made from four pieces of llama leg fur sewn together lengthwise. At the bottom is an adornment piece made in double stem-stitch embroidery over a foundation of coarse cotton yarns in two layers. These cotton yarns are covered in stem-stitches in red on one side and yellow on the other. At intervals according to the pattern the red and yellow yarns cross to the other side of the embroidery and thus create two similar designs in alternate colours. At the edges the textile has a finer one sided stem-stitch design, and at the bottom an 18 cm-wide, red, camelid fibre fringe. All yarns are S2z (VA 29524, Ethnological Museum in Berlin. Photo: Lena Bjerregaard).

Fist-braiding

Fist-braiding was a technique used in Pre-Columbian Peru for making slings. It is an *upward* braiding technique (Fig. 24), contrary to most braids, which are braided *downwards*. Fist-braiding is done over the fist without any special tools. The technique employs groups of four yarns twisted together lengthwise and interworked horizontally with groups of two or four yarns likewise twisted (Bjerregaard 2011). To my knowledge this technique was and still is only practised in Pre-Columbian Peru and in Tibet (Bjerregaard 2015) (Fig. 25).

Fist-braided slings were used – apart from as herding and hunting tools – as ornaments wrapped around the head. They were special markers of the geographical identity of the wearer and probably also indicated status. In Inca times they were sometimes sewn together from several slings and served only as adornments; they could not be used for herding and hunting (Fig. 26-28) (Bjerregaard 2011, 2015).

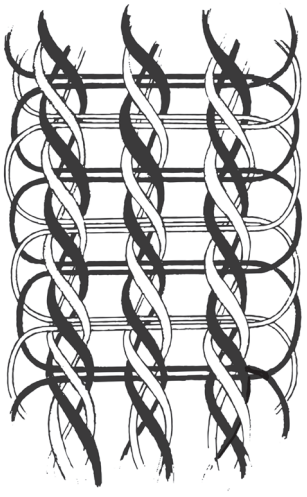

Fig. 24. Fist-braiding with one twining unit on the horizontal side and three units on the vertical side (after Bjerregaard 2011, fig. 8).

Fig. 25. Sling in fist-braiding from Ica on the Peruvian south coast dated AD 1200-1500. The material used is a S2z camelid fibre. The centre part cradle is wrapped and the flat side-bands extending from it are fist-braided with 2-floats braiding with SZ twist. They have one twining unit on the narrow side. The side cords are 4-braids at both ends with wrapping (VA 47185, Ethnological Museum in Berlin. Photo: Martin Franken).

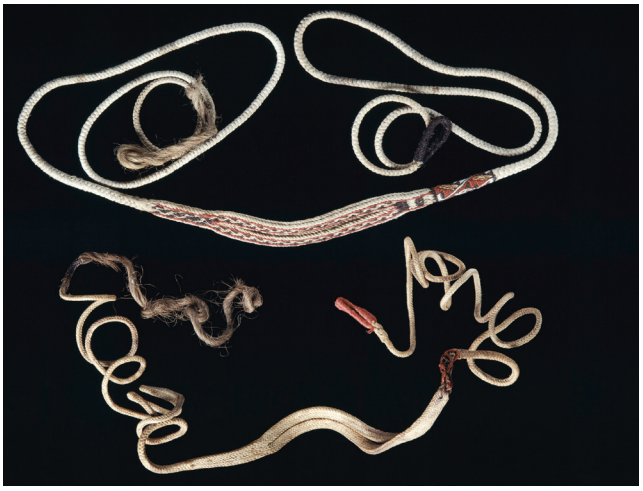

Fig. 26. These fist-braided slings are not flat (like Fig. 24) but have a rectangular form, due to the two twining units on the narrow side, which makes the shape rectangular. The slings are also from Ica on the Peruvian south coast, but are dated to the Inca period, AD 1450-1550. They are made in S2z plant fibre (Furcreae andina) and S2z camelid fibre yarn. The technique is fist-braiding with 2- and 3-span floats. The extending cords are 8-strand braids. The finger loop is wrapped (V A 47216 and V A 24216, Ethnological Museum in Berlin. Photo: Martin Franken).

Fig. 27. Four slings stitched together for a head ornament. The same pattern in two alternate colours is on the two sides of the artefact. From Ica, AD 1200-1500 (V A 47221 Ethnological Museum, Berlin. Photo: Martin Franken).

Fig. 28. Mummy bundle with a head ornament consisting of four slings joined together. Chuquitanta, AD 1200-1500 (V A 28464, Ethnological Museum, Berlin. Photo: Martin Franken).

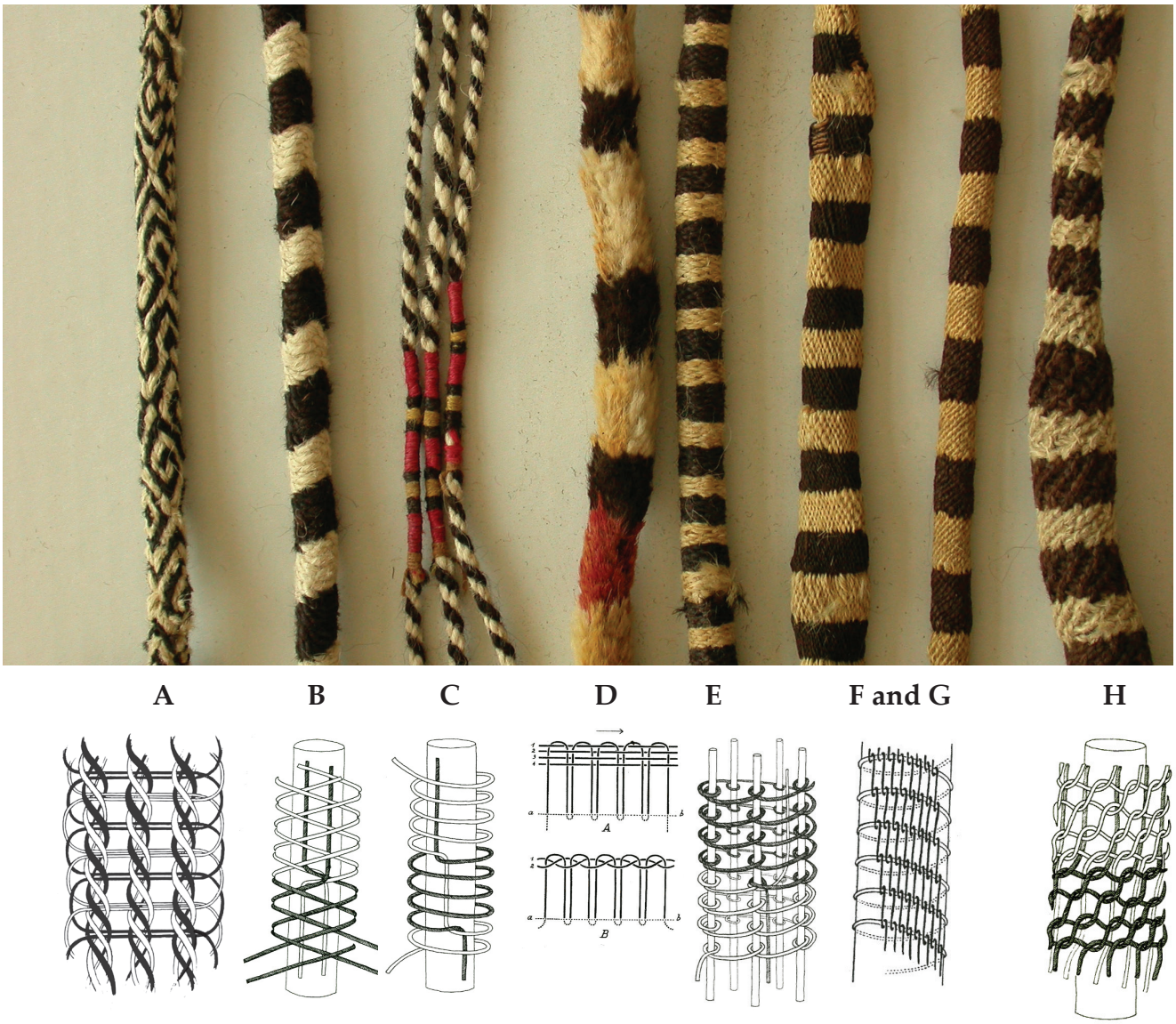

Fig. 29. Seven different techniques used for making black/white cords in Pre-Columbian Peru. (Ethnological Museum, Berlin. Photo: Lena Bjerregaard).
A. Fist-braiding (after Lena Bjerregaard 2011, fig.8)
B. Tubular braiding (after Cahlander 1980, fig. 1-14)
C. Spiral wrapping (after Cahlander 1980, fig. 1-12)
D. Wrapping with woven fringe (after D'Hartcourt 1975, fig. 83)
E. Wrapping around vertical elements (after Cahlander 1980, fig.1-18)
F and G. Wrapping around horizontal elements, stem-stitching (after D'Hartcourt 1975, fig. 93)
H. Spiral interlinking (after Cahlander 1980, fig. 1-16)

Cords

Cordmaking could fill a whole chapter of its own. In ancient and modern Peru very many techniques were and are still are used in order to make cords for slings and various headgear (Cahlander 1980). The extension cords of the slings could be made from skin or leather or could be interlinked, braided, wrapped, woven or embroidered. Even though they often look similar at first sight, the techniques are often totally different from one aother (Fig. 29 A-H).

Conclusion

Identical non-woven techniques have through time been independently invented and used in various parts of the world that were in no way connected. Non-woven techniques were sometimes used to produce large items like nets and cloth, but more often these techniques were used to create accessories or trimmings. Unlike woven textiles, their production was very time-consuming, and mostly needed no tools.

The non-woven techniques seem in all cultures to have been used for very specific items, which were always produced in the same technique. Some of these techniques were, in both the Old and New Worlds, used to produce the same types of items, such as fist-braiding for slings in Peru and Tibet, but in most cases they were used to produce different items. In Europe, for instance, tatting is still used for making white lace-like, cotton or linen placemats, while in ancient Peru it was used only to make hairnets in natural-coloured agave fibre painted with shellfish purple. Needle-looping was used to produce coarse winter hats and gloves in medieval Europe, but was used for making multi-coloured, three-dimensional flowers and hummingbirds for lace-like borders on Peruvian tunics. Likewise, the knotted Wari hats of Peru, which have a very similar surface structure to Persian carpets, were made in a completely different technique.

The above-mentioned non-woven techniques are only glimpses of the many ways threads can be interworked to create a textile item, but hopefully this brief record of non-woven techniques primarily in the New World will inspire others to work more closely on this subject.

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Chrystel Brandenburgh

Clothes Make the Man

Early Medieval Textiles from the Netherlands

Introduction

The dissertation *Clothes Make the Man – Early Medieval Textiles from the Netherlands* focused on the use of cloth and clothing in the area now defined as the Netherlands, in the period between AD 400 and 1000. Several authors have published textile finds from the Netherlands in the past (*e.g.* Schlabow 1974; Vons-Comis 1988; Bender Jørgensen 1992), but systematic research on these finds from the early medieval period (which in this region spans from AD 400 to 1000) had not previously been conducted. Where the surrounding countries have witnessed a development in which textile archaeology has become a fundamental part of archaeological research, a similar development has been lacking in the Netherlands. As a result, our knowledge of the production and use of textiles has mainly been derived from the surrounding countries, where more research has been carried out. This is the more lamentable because no objects are more closely related to the people from the past than cloth and clothing. Dress is not only functional, but it often expresses the identity or social position of its wearer. Moreover, it can be used to confirm or create an identity. This is vividly illustrated in the way Dutch professors dress themselves up for the public defence of a PhD. Foreign professors, such as Lise Bender Jørgensen who was supervisor of the PhD-study, are invited to join the Dutch academic community by wearing a black toga and ceremonial hat for the duration of the defence. Creating identities is also an issue in early medieval burials where people were buried fully dressed and where grave objects and clothing may have been selected to display the social status, age or gender of the deceased and as such were used to confirm or create his or her position (Kars 2011).

Research aims

The PhD study aimed to answer the following questions:

1. What textiles and clothing did people use during the period AD 400-1000 in the area now called the Netherlands?
2. Which differences and changes are visible in the area and period under investigation? Are differences visible between sex and age groups, types of settlements, different types of cemeteries (such as rural, urban, rich and relatively poor)?
3. How may the differences observed in the textiles be explained?
4. Which spheres of influence are visible in clothing and textiles in comparison to the surrounding countries?

For this purpose, textile remains from both settlements and cemeteries from different parts of the country were analysed: ranging from rural settlements in the north of the Netherlands to urban cemeteries in the south and rural cemeteries in both the centre as well as the south of the country. This geographical distribution, the large timespan of the dataset as well as the differences in site context result in a very varied picture of the use of fabrics in this period.

Fig. 1. Shield boss from the cemetery of Bergeijk with a large piece of 2/2 twill attached (Photo: Author).

Burial garment reconstruction

Using the textile remains from the Dutch cemeteries and evidence from studies from the surrounding countries it was possible to reconstruct, in a broad sense, the way people were dressed when buried. Men as well as women wore an undergarment covered by another garment such as a tunic or dress. These garments could be long, covering the legs, or shorter, reaching to the knee or higher. The undergarment was generally a thin and fine wool fabric and was either densely woven or slightly open. The garment worn above was often coarser, made of thicker threads and generally of a more open fabric. This outer garment was held in place by a belt. The legs were either covered in roughly woven hose or leg windings, which were tightened by a strap or garter with small buckles. Over the belt both men and women wore another garment or cloak. It is assumed that the brooches found in women's graves in the area of the hip were used to close this outer garment. Indications of veils or shawls made in thin and open tabbies are present on the front of several brooches. Veils or head coverings were on rare occasions decorated with gold-brocaded bands.

Gender differentiation

Pictorial evidence and archaeological finds from the surrounding countries show that men and women wore different types of garments (Owen-Crocker 2004; Walton Rogers 2007). However, men and women did not only distinguish themselves by the shape of their clothes. It has become clear that women wore clothes that were made from different fabric types than men and that the fabrics they used were often of a higher quality than those worn by men. There is however much local variability in these gender-related preferences. In Rhenen and Wijchen women were generally buried in tabby fabrics, with only very small amounts of twills. The men in Rhenen show more variability in textiles, with a preference for twills but also a large number of tabbies. In Lent-Lentseveld on the contrary tabby is completely lacking in women's graves and it only occurs in graves of men and children. Women in Lent-Lentseveld seem to have been buried solely in twills. Only in Bergeijk and Maastricht-Pandhof do the women's graves show more variability in textiles than the graves of men: here men were buried in twills and women in equal amounts of tabbies and twills.

Fig. 2. Headdress from the settlement of Dokkum-Berg Sion (left) and pillbox cap from the settlement of Leens (right). Six nearly complete hats and headdresses were discovered which enable a reconstruction of the shape, construction, techniques and colour of these garments. (Photo: National Museum of Antiquities, Leiden).

In the (early-Christian) cemeteries in Maastricht-St. Servaas church and Vrijthof differences between men and women were not observed. In Maastricht men and women were dressed uniformly in the same fabric type (tabby), which may be seen as a precursor of the use of death clothes and shrouds in (early) Christian burials.

Wrapping objects in the grave

A substantial amount of the textile finds was not used as clothing but had a different function in the graves. There is ample evidence in these burials for the custom of wrapping objects before or during the burial ceremony (Fig. 1). Weapons were covered by or completely wrapped in pieces of – often rather coarse – fabrics and were then positioned in the grave. This custom may have been part of the burial ceremony and, while the objects may have been there to impress the bystanders, the fact that they were deliberately removed from sight ensured that both these items and the funeral ceremony had a long-lasting impression on the spectators. Other textiles may have been used to cover the bottom of the grave, or were part of pillows or mattresses. There is no irrefutable evidence for the presence of shrouds, although several fabrics may have been used for this purpose.

Regional variability

There are considerable differences between the cemeteries in terms of textile types, textile quality and the preference of men and women for specific fabric types. The cemeteries of Leusden, Maastricht-Sint-Servaas church and Maastricht-Vrijthof show a similar distribution of textile types with a preference for tabbies and with twills occurring in smaller quantities. Posterholt also shows this preference, but here the differences between the numbers of tabbies and twills are smaller. In other cemeteries such as Lent-Lentseveld, Wijchen, Rhenen and Maastricht-Pandhof tabbies and twills are present in approximately equal numbers. Bergeijk is the only cemetery where twills seem to have been more popular than tabbies and this distribution pattern corresponds with the majority of settlements excavated in the north of the country.

Some of the cemeteries, such as Maastricht and Leusden contain remnants of fabrics that are generally of a higher quality than those found in other sites. However, when comparing the quality of textiles found in the Netherlands with those found in the surrounding countries, it becomes clear that although Maastricht has by far the finest remains found in the Netherlands it is 'quite average' compared to sites in Merovingian Germany (Bender Jørgensen 1992, fig. 87, 90, 92, 94).

The differences observed between the Dutch sites fit within regional textile traditions that extend far beyond the borders of the research area. The sites of Rhenen, Wijchen and Lent-Lentseveld fit the pattern observed in the northern parts of Germany. Maastricht and Leusden (and to a lesser degree Posterholt) are more comparable to Central Germany, Belgium and Normandy. Bergeijk does not fit any pattern but resembles the distribution of the younger settlement sites in the north of the country. It is yet unclear whether the observed patterns are the result of regional group affiliation that extended over larger areas in which people shared their textile preferences and production traditions or the result of being connected to specific trade networks.

Settlement textiles

The settlements in the north of the country have yielded a completely different set of fabric types and fabric qualities as opposed to the cemeteries (Fig. 2). There may be many reasons for this: settlements are removed from the cemeteries in time (they are younger) and space (north of the country as opposed to the burials in the central and southern areas) so we may be looking at completely different textile traditions. Moreover, there is a difference in the use of the textiles: settlements may have yielded larger shares of household textiles and everyday clothes as opposed to burial garments found in the cemeteries. It is however most likely that the higher quality textiles in the cemeteries were a part of the burial ritual and had a symbolic function.

Conclusion

The systematic study of the textile remains has greatly increased our knowledge regarding the use of textiles in the early Middle Ages in the Netherlands. It is obvious that this topic deserves more attention in Dutch archaeology than it has hitherto received. Even though textiles may have decayed considerably, it is still possible to reconstruct to a certain extent the way they were used which leads to an understanding of the variability in cloth and clothing in this period. The picture that emerges from this study is however far from complete and many questions relating to textiles, such as production, trade and use among social groups in this period have not been touched upon. Therefore, this study should be considered as a first overview, which further research can use as a starting point and continue to expand.

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The dissertation is available through Leiden University Press: www.lup.nl.

Julia Galliker and Ines Bogensperger

Ancient Design by Modern Hands

An Invitation to Textile Artists

Spiral Textile is an initiative to bridge the gap between historical textile researchers and the handweaving community. Collaborative exchange can help advance knowledge and expand the appreciation of textiles in history. To further this goal, we organised Spiral Textile as an *'open source' experimental archaeology project* to engage textile artists from around the world to reproduce a spiral design found on an ancient papyrus at Karanis, Egypt (Fig. 1). The papyrus (P.Mich. inv. 5143c) is now housed in the Papyrus Collection of the University of Michigan, Ann Arbor.

Spiral Textile
Ancient design
Modern hands

Fig. 1. Papyrus drawing with spiral pattern, P.Mich. inv. 5143c (© University of Michigan).

Object history

The papyrus spiral drawing is a unique artefact and the only known representational papyrus found in a secure archaeological context. The fragments were discovered in 1927 during the University of Michigan excavations at Karanis, a Roman town in the Fayum in Egypt (Wilfong 2014; Boak and Peterson 1931). The archaeological documentation of the site identifies the find spot as house C56b in the 3rd–4th-century-CE-era stratum. The finds from this house are comparatively rich with over 500 objects from daily life including textile fragments (Fig. 2), weaving materials (Fig. 3) and textile implements.

Analysis of the papyrus fragments shows that the repeating spiral pattern was drawn with a brush by a skilled hand. IR-microscopy has confired the use of iron-gall ink.[1] The condition of the papyrus suggests that the sheet was folded in half, then wrapped around an object with symmetrical areas of loss. Despite its fragmentary condition, the repeating spiral design is clearly visible.

Although we have examples of spiral designs on various media from Karanis, it is important to note that the motif is not confined to late-antique Egypt. During the course of our research, we have seen many objects with spiral designs in ancient and modern cultures from around the world. In a broad sense, Spiral Textile is a testimony to the importance and continuity of certain motifs over time.

About the project

We have framed Spiral Textile as a means to 'crowd source' research by reaching out to textile practitioners from around the world. Registered participants follow a set of guidelines pertaining to materials and techniques in common use in late Roman Egypt. Registration is open to all and the number of participants is unlimited.

The Spiral Textile guidelines are constructed to engage textile artists in historical research by presenting information about topics including fibre use, colour choice and evidence of production. Based on surviving textiles from the period, we have prescribed seven patterning techniques that may be used alone or in combination: tapestry (Fig. 4), flying thread brocading, pile weave, supplementary weft, taqueté, embroidery and resist-dyeing.

Our website includes images of archaeological textiles to serve as a guide and source of inspiration. To challenge participants, we have left technical choices such as yarn type and size, sett, weft density and finishing to their discretion. In addition to samples made according to the seven prescribed techniques, we will also accept 'modern' artistic interpretations

Fig. 2. Sprang bonnet patterned with S and Z twist yarns (Kelsey Museum of Archaeology, 02.2549, © Julia Galliker).

Fig. 3. Length of purple yarn with one end wrapped around the rest in the centre to form a 'butterfly' for weaving (Kelsey Museum of Archaeology, 02.2605, © Julia Galliker).

Fig. 4. Spiral pattern in tapestry technique, detail (Austrian National Library, Papyrussammlung, Vienna, inv. P.Vindob. Stoff 59 a–b, © Ines Bogensperger).

of the pattern. Registered participants may send in multiple samples. The final date for submission is 21st April 2017.

To record and analyse participant experience, we have constructed an online experimental archaeology survey to be completed as part of the sample submission process. This data is essential for historic textile research as we lack information from the weavers' perspective in ancient times. Data from this population of surveys will be interpreted to obtain a better understanding of ancient textile production, technology and craftsmanship. We will present our findings at international academic conferences.

Through this project, our goal is to build a community among interested persons from various backgrounds. We are inviting a number of individuals including academics and members of the handweaving community to write 'blog' posts for the website to inform and encourage multidisciplinary exchange. Project participants can also participate in discussions by joining our facebook group: https://www.facebook.com/groups/spiraltextile/.

Competition and exhibition

To showcase submitted samples, we have organised Spiral Textile as both a competition and an exhibition. Textile artists like a challenge, so the project includes a juried competition. We have defined a set of awards to encourage both artistry and experimentation. A category award will be given for each of the seven techniques. A special cross-category award will be presented for a sample that combines two or more techniques. An overall first prize will be awarded to the best sample in the competition. To encourage submission of 'less than perfect' samples that contain important experimental information, we will also award five experimental archaeology prizes. Award textiles will be gifted to the University of Michigan for teaching and display.

All samples that meet project specifications will be included in a travelling exhibition for display at various locations in North America and Europe. While we are still finalising details, we have received enthusiastic support from our proposed venues. The samples on display are intended for touch by visitors to encourage public appreciation for the tactile properties of textiles. We will also post images of the exhibition textiles on our website with an artist profile for prize-winning samples.

For more information please visit the spiraltextile.com website or contact us via email: info@spiraltextile.com.

Notes

1. Personal communication from Marieka Kaye, conservation librarian, 24 June 2016.

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Elham Ghassemi

History of Techniques in Ancient Iran: Case of Textiles and Cosmetics

27 May 2016, Oxford, UK

The half-day seminar *History of Techniques in Ancient Iran: Case of Textiles and Cosmetics* was held in May 2016 with the participation of Paul Collins, Karina Grömer, Robin J. Lane Fox (acting as a chairman), Lloyd Llewellyn-Jones and Massimo Vidale, and took place with the generosity of the Maison Française d'Oxford and the École Pratique des Hautes Études in Paris.

The idea for this seminar came to me when I was an academic visitor affiliated to the Faculty of Classics, University of Oxford, for six months in 2015-2016. During this work I became aware of the lack of work related to the history of techniques in ancient Iran, despite the existence of a great number of primary sources. Therefore, I decided to devote the subject of the seminar to this theme, which is also in line with my research topic as a PhD student in Art History in Ancient Iran at the École Pratique des Hautes Études (EPHE) in Paris.

With his paper 'The proto-historic roots of wet chemical processing in south-eastern Iran: what we can learn from ancient cosmetics', Massimo Vidale from the University of Padova (Italy) presented his recent archaeometric studies carried out on third-millennium BC cosmetics from Shahdad and Shahr-e Sokhteh, two sites from two provinces of the south and south-east of Iran, in the north of the Persian Gulf, Kerman and Sistan and Balouchestan. The sites point to a quite intricate processing technology of metal-based pigments, and present an unforeseen contribution of ancient Iran to the development of chemistry.

Paul Collins, curator of the ancient Near East at the Ashmolean Museum of Art and Archaeology (the University of Oxford's museum), presented a talk entitled 'Human animals – an ancient Iranian tradition in Mesopotamia', which addressed a fascinating subject on the tensions and relations between two distinct regions, ancient Iran and Mesopotamia, exploring the use of animal and composite animal imagery in Iran in the period 4500-2500 BC and their transmission to Mesopotamia highlighting the important roles they played in negotiating boundaries and explaining the 'other'.

Lloyd Llewellyn-Jones from the Department of Ancient History at Cardiff University (UK), presented the paper 'The Khal'at of the King: royal robes and the ideology of gift-giving in Achaemenid Iran' on Achaemenid 'robes of honour' from the point of view of Iranian identity, and the practice of gifting garments, one of the ancient customs of the Iranian royal court. The paper explored the significance of investiture and the political importance attached to the custom of Achaemenid royalty bestowing the **gaunaka* as a kind of 'robe of honour' onto worthy recipients, a practice that extended into the Islamic world where it was known by the Arabic term *khil'at* – or *khal'at* in a standard Persian pronunciation.

Another very important and exciting presentation was about the clothes of the salt mummies from Chehrābād, Zanjan province, in the north-west of Iran, presented by Karina Grömer from the Department of Prehistory of the Natural History Museum Vienna (Austria), entitled 'Working clothes for ancient miners. The salt mummies from Chehrābād and their textiles'. In this talk she introduced new insights into the textile technology of ancient Iran from the garments dating back to the Achaemenid period and the Sassanian period. A quote from her paper:

"Besides the fragments of fabrics with different raw materials, colours and pattern types, the most important items are the complete garments of the salt men, but also garments found in the mine. The technical details, how they were woven and tailored,

allow us new insights into the textile technology of ancient Persia. Besides that, complementary data from other available sources like written or pictorial sources, allows us to learn about the functionality of clothing. It has to be shown that the garments of the salt men are made to perfectly serve the needs of salt miners – both to support movement and to protect them during the work in the mine. Also some symbolic features can be traced, such as the use of red cords for the sleeves, openings and side seams."

It is planned that the presentations will be published in France as an English-language book in the next year.

Cecilie Brøns

VI Purpureae Vestes International Symposium. Textiles and Dyes in the Mediterranean Economy and Society

17-20 October 2016, Orto Botanico, Padova, Museo Archeologico Nazionale Atestino, Este, and Museo Archeologico Nazionale di Altino

The first Purpureae Vestes Symposium was held in 2002 in Ibiza, Spain and organised by Carmen Alfaro Giner. The idea was to create a Mediterranean counterpart to the North European Symposium for Archaeological Textiles (NESAT), which has taken place since 1981. The symposium has since travelled to Athens, Naples, Valencia and Montserrat. In October 2016 the sixth Purpurea Vestes symposium was held in Padua, Este and Altino in the region of Veneto. It was organised by Maria Stella Busana (Università di Padova), Margarita Gleba (University of Cambridge), Francesco Meo (Università del Salento), Mariolina Gamba (Polo Museale del Veneto) and Giovanna Gambacurta (Polo Museale del Veneto).

The 2016 symposium focused on the role of textile production and dyeing in the economic activities of

the ancient Mediterranean cultures with a particular focus on archaeological evidence relating to the textiles themselves rather than the more well-known sources consisting of written evidence, iconography and tools. The programme comprised 47 papers and about 20 posters, which illustrates the need for a forum addressing the ever-growing number of scholars working on ancient Mediterranean textiles. The ten sessions were as far as possible arranged according to chronology: from the Bronze Age to the Middle Ages and geography: moving from east to west and from Italy to Egypt and the Levant. There were, not surprisingly, many contributions focusing on the region of Veneto, including one by E. Bianchin Citton, who presented the spinning and weaving tools from the proto-historic settlement of Montagnana Borgo S. Zeno; G. Leonardi *et al.*, who discussed the visibility of textile manufacturing in Padua in the 1st millennium BC, A.R. Tricomi, presenting an overview of the results of her PhD dissertation on the textile tools from Roman Venetia (see ATR 56, 78-81), M.S. Busana and M. Gleba, presenting their work on textile production and consumption in Roman Venetia based on mineralised fibres and textiles, and M. Rigoni and M. Rottoli, presenting two cases of mineralised textile fragments from Veneto. In addition, M. Gamba and G. Gambacurta presented evidence of ancient looms and textile production in pre-Roman Veneto, while M. Ruta and M. Gleba demonstrated the evidence for ossuary dressing in funerary rituals in pre-Roman Veneto. Finally, M. Tirelli and M. Rottoli introduced bronze cases with traces of fabric from the sanctuary of the god of Altino. This preponderance of presentations of local material from Veneto was very inspiring, also since the conference took place mainly at local archaeological museums where it was possible to see several of the presented objects.

The posters included more than 20 contributions, presenting a wide range of textile-related research. Particularly interesting were the poster by F. Médard and F. Maeder re-evaluating a find from Pompeii which was previously thought to be sea-silk, but in fact turned out to be a bath sponge, and the poster by S. Cipriano, presenting the textile tools from the Sanctuary of Reitia in Este during the Roman period. All contributions, including the posters, will be published in the Purpureae Vestes series.

The conference included guided tours of the conference locations: the botanical garden of Padua, a unique UNESCO site, the Museo Archeologico Nazionale Atestino in Este and the recently opened Museo Archeologico Nazionale di Altino. In addition, at the end of the conference, a visit to Tessitura Luigi Bevilacqua in Venice was arranged. The workshop is owned and run by the Bevilacqua family and continues one of the most ancient traditions in Venice: textile manufacturing. They produce exquisite handmade velvets, brocades, damasks, lampasses and satins, using techniques and looms of the 18th century.

During the conference an anthology was presented with about 20 contributions in English, German, Italian and Spanish on the topic of textiles and dress in antiquity entitled *Vetus Textrinum. Textiles in the Ancient World. Studies in Honour of Carmen Alfaro Giner*. The volume is a homage to Professor Alfaro Giner on the occasion of her retirement this year. It is edited by Manel García Sánchez and Margarita Gleba and will be published in the Instrumenta series of Dr. Remesal at Barcelona University in 2017. We all congratulate Carmen Alfaro Giner.

Mikkel Nørtoft

Dyes and Spices

29th August 2016, Centre for Textile Research (CTR), Copenhagen, Denmark

The *Dyes and Spices* workshop was designed to deal with the vocabulary used for dyes, mordants and spices in the ancient world, comparing textual data with experimental archaeology and exploring the relationship between spices and dyes in texts.

The workshop started off with an introduction by Marie-Louise Nosch sketching the theme of the workshop and some of the new literary works and selected important literature on the subject.

Nosch then passed the word to Philippe Abrahami who presented some of the textile colours and spices mentioned in the Nuzi texts from northern Mesopotamia dated to ca. 1440-1330 BC with a total corpus of around 5000 texts. Abrahami made an attempt to disentangle the semantics of the dye terms in the Nuzi texts, which indeed is a bold venture. It seems that the word for wool itself is never really mentioned in these texts, and the colour terms often also denote not just the colour, but also imply 'x-coloured wool'. The colours also present problems in terms of specifying the dyeing agent, *e.g.* one word for 'blue' can in some cases be 'woad (*Isatis tinctoria*) blue', and in other cases be 'lapis lazuli blue'. In other cases, a word meaning 'blue' could also mean 'blue/purple'. Some of the terms for the colouring process sparked additional debate. For instance, it is not certain that what we today understand as 'to boil' was performed at the same temperature in ancient times. It could just have meant 'simmering', or more generally 'warming something up'. This debate became an underlying theme for several of the talks, underlining the possible lack of special textile knowledge of scribes copying terms from bilinguals, later interpreted by philologists, and discussed by linguists, copied from one dictionary to another, perhaps repeating mistakes in nuances of very specific craft terminology in a long gone past.

Next was Cécile Michel presenting colour and dye terms from a list of textile workshop personnel from the royal palace in Mari (modern-day Tell Hariri) and private archives of Kaneš. Here we learned that terminology does not always differentiate between natural and dyed wool colour. However, the use of dye was specified in some cases, and was sometimes even specified in combination with alum. Likewise it is not known if the word 'apple tree colour' means 'dyed with apples' or 'a colour resembling the colour of apple trees'. In the texts, the use of pomegranates as a dying agent occurs, and agents such as madder (*Rubia tinctorum*) seem to have been in very high demand.

Nicole Brisch talked about dyes and spices in Sumerian texts from 2100-2000 BC and showed that the dyeing of animal skins was a widespread practice, as well as the dyeing of linen. Brisch also highlighted the use of spices in dyeing, among others perhaps juniper, garden cress, pine seeds and maybe even safflower. 'Niglam-coloured' (red) garments could have been perceived as giving supernatural powers, for instance in a myth about a king wearing 'Niglam-coloured' garments that gave him so much speed that he could run from Ur to Nippur and back in one day (a distance of approximately 200 km).

Louise Quillien took us into the 6th century BC with a Neo-Babylonian technique known as 'double dyeing', featuring different combinations of coloured wool, alum and different secondary dyeing agents such as madder, woad and the mysterious kašu-plant (which may have been mustard, cuscuta or perhaps more likely safflower). The difference between local and imported madder was also specified in the text. Again, the topic of boiling came into discussion. Wool is not boiled, and madder will turn brown at too high a temperature. These texts mention a verb translated by ancient scribes as 'boil' in the process of dyeing animal skin. However, skin cannot withstand heating at all when dyed. Instead, tannins are used in a longer and very smelly process. So when using the word 'boil' for dyeing animal skin, we must either translate

something in the line of 'soak' or we are perhaps not dealing with animal skin.

Peder Flemestad kept the pot going with the connections between "Pigments and Poison", *e.g.* the wide semantic field of Greek *φάρμακον*/*farmakon* used for medicine, dye, mordant and even connected to magic. Flemestad also noted the semantic connection between 'dyeing' and 'deceiving' in Greek, and the possibility of a certain colour to be semantically (and perhaps also in reality) connected to a certain smell.

Giovanni Fanfani presented Greek words connected to saffron-dye (extracted from the *Crocus sativus*) with Greek *κρόκος*/*krokos* derived from a root in Greek alternating between *κερκ-* and *κρεκ-* 'sharp, pointed object (producing a sharp noise)'. The flower and colour of this plant also played a role in myths of abduction and seduction with the goddess Demeter and were used for dresses, especially for goddesses.

Isis Sturtewagen leaped forward in time to the dyes and dyeing terminology in the dyers' guilds of 13th-16th-century Bruges in Belgium. In this town, the dyers were strictly separated into different guilds, some working with red dyes, others with blue dyes, while inspecting the quality of the dyed fabrics of one another. The guilds used kermes, madder, woad and alum, but refrained from using copper, vinegar and the like because that allegedly would not give a proper quality. At the same time, there were also other female dyers, the so called 'sock entrepeneurs', who used dyes and ingredients prohibited by the dyers' guilds. In this period, certain colours were connected to certain crafts, *e.g.* bakers wearing blue clothes and archers wearing red and blue.

The next presenter, Corinne Thebaut-Cabasset, painted the picture of South American cochineal cultivation in the 1600-1800s, and a document describing dyes and dresses in Mexico in the early 18th century.

Eva Andersson Strand tied the knot on the first day of the workshop with an alternative method of dyeing wool using lactic acid and plants. This method, inspired by fermentation of vegetables, uses lactic acid and water on wool and dyeing plants, adding a pinch of salt (1-1.5 % of the solution) at a temperature of only 20-22 degrees Celsius, lowered to 15 degrees after a few days, letting it stand in a pot with a lid for a total of 10-14 days. Strand tried this method in 1989 experimenting with birch leaves, indigo, madder etc., and the colours of the otherwise often fading yellow colour (birch leaves) are still strong today. They will start work on refining this dyeing method in the future. The prospects of this method are vast, because with traditional dyeing methods, it takes vast amounts of firewood to keep the pot at the right temperature. Using the method of fermentation at low temperatures is a much more economical dyeing method. It could certainly have been used in small households, far away from the industrial scales of dyeing in the early Mediterranean and Middle Eastern empires.

The second day of the workshop took place in Lejre with several experiments on the dyeing techniques discussed on the first day, seen in the photos below.

The discussions and presentations from this workshop show how much can be gained by putting researchers from various scientific fields, *e.g.* philologists, archaeologists, historical linguists, historians etc. together in the same room to enlighten each other and ignite new ideas to the already vibrant field of textile research. Hopefully we will see more of this in the future.

Marie-Louise Nosch

Archaeology of Textile: Production and Contexts in the 1st Millennium BCE

11-12 February 2016, Rome, Italy

Textile research in Italy has become a theme of discussion for Italian scholars in recent years with initiatives such as Margarita Gleba's 2008 pioneering monograph on *Textile Production in Pre-Roman Italy*, the 2012 textile atlas edited by Margarita Gleba and Ulla Mannering, with significant contributions on archaeological textiles found on the Italian Peninsula by Marta Bazzanella, Lise Ræder Knudsen, Annemarie Stauffer and Margarita Gleba, and the *Treasures of the Sea* conference in Lecce in 2014 convened by Hedvig Landenius Enegren and Francesco Meo (see *ATR* 55, 117), and the important monograph of Sanna Lipkin from 2012. Major impetus has come from the ERC-funded PROCON 5-year project (see *ATR* 54, 104). This large-scale investigation has a special focus on pre-Roman Italy. In Italy, research initiatives have come from the TRAMA project in Padua and Francesco Meo's important monograph on textile production in Herakleia and surrounding villages in the 4th-2nd centuries BCE, and Romina Laurito's international Marie Sklodowska Curie project TexSEt (see *ATR* 57, 111-113).

This conference follows the two international workshops *The Fabric of Life* and *Weaving the Past* (Rome 2015 and Athens 2016 respectively - see *ATR* 57, 133-134 and this issue) and was organised by Romina Laurito (Centre for Textile Research, University of Copenhagen/SAR-LAZ) and Margarita Gleba (University of Cambridge). The first day of the workshop was dedicated to a survey of all the pertinent textile material from pre-Roman Etruscan Italy, both the textile finds and their contexts. This endeavour represented *la pièce de resistance* in the conference, since the total number now reaches a body of some 150 textiles, thus making Italy leave the category of having no textiles preserved. Many of these textile presentations were made in a collaboration between the excavator and a textile archaeologist. They include the sites of Caere/Cerveteri, presented by Rita Cosentino and Romina Laurito; textiles from *Tomba dell'Aryballos sospeso* in Tarquinia presented by Alessandro Mandolesi and Margarita Gleba; textile remains from Cumae presented by Margarita Gleba, Ilaria Menale and Carlo Rescigno; from the burial site of Cavallerizza a Ordona (Herdonia) presented by E. Catalli, M. Corrente, A. Di Giovanni, M. R. Giuliani, M. Laurenti and M. Pastorelli. Evidence for textile production, textile remains and textile tools from Ripacandida and Ascoli Satriano, from both burials and settlement, were presented by Christian Heitz. Francesco Meo and Maria Rosaria Luberto presented textile tools from Caulonia in Calabria. Moreover, Joanne Cutler presented a technical and contextual analysis of 7th- and 6th-century BCE textile tools from Murlo.

Other papers focused on the cultural, technical and intellectual context of textile tools, such as the exciting attestations of inscribed textile tools, especially in Etruscan contexts in the 7th and 6th centuries, presented by G. Bagnasco Gianni, M. Cataldi and G.M. Facchetti. Giovanna Gambacurta presented the textile cultures interwoven with the cult in the sanctuary of the goddess Reitia at Este. Alessandro Quercia took Torre di Satriano (Lucania) as a test case to discuss more general aspects of textile production and technological changes in the archaic societies of Magna Graecia, and especially the role of textile tools in gendered societies. Helga di Giuseppe gave an overview of the iconographical sources of the use of the textile tool *epinetron*, spindle and distaff, especially from vase

paintings. Flavia Carraro attempted to describe the relationship between ancient textile artisan and the textile experts and scholars today, and how to approach concepts such as tradition and innovation. Alessio De Cristofaro and Alessandra Piergrossi presented the historical and anthropological framework for the interpretation of female funerary costume, especially of the elite, of the 8th to 7th centuries BCE in central Italy and its Etruscan and Faliscan contexts.

Another important theme of the conference came from representatives of museums in Italy with presentations of new initiatives and reflections on how to exhibit and understand textiles of the past. This was already stated in the inaugural address by the superintendent of Lazio and southern Etruria, Alfonsina Russo. Valentino Nizzo, representing the Direzione Generale Musei, presented a *tour de force* of reflections on how textiles and textile production are represented in Italian and European museums, and the theoretical framework of how we understand textiles, especially in their funerary context. Simona Carosi from the Superintendence of Lazio and Southern Etruria presented the new plans for exhibition and the place of textiles in the new structure of the Museo Nazionale del Castello dell'Abbadia di Vulci, as well as recent finds.

A third theme of the conference was how to use new methods stemming from the natural sciences and experimental archaeology. Clearly, the field of research is fuelled by these new methods, either from new excavations or from reviewing old finds, and yield new exciting data. It now remains the task of the textile scholars to reexamine how far these new data corroborate our traditional interpretative frameworks of textiles – production, consumption, distribution, techniques, symbolism – and to what extent new interpretations and new sets of theories are required. Within this theme, Vanessa Forte and Cristina Lemorini presented their ongoing, systematic examinations of traces on clay textile tools, a research performed in close collaboration with craftspeople. Elena Ciccarelli and Assunta Perilli presented their applied study of spinning tests with numerous technical parameters: spindle whorls of 3, 19 and 20 g, with different diameters, were used to spin both flax and wool, and the results documented and discussed.

Several papers presented a synthesis of the overall interpretation of textile cultures in ancient Italy. Especially Margarita Gleba presented the characteristics of textile from the Italian peninsula: twills, spin patterns, and tablet-woven borders. This gives Italy close cultural and technological ties with eastern Hallstatt cultures. In Greece, tabbies and weft-faced fabrics are more common. This Greek weave type is possibly attested in the Greek colonies in Southern Italy. A hybrid version is found in the weft faced tabbies with tablet woven borders, *e.g.* as found in Ripacandida, and makes weft-faced fabric a cultural marker. With Romanisation, the Romans implanted the Greek tradition of weft faced tabbies and supplanted the indigenous Italic weave tradition.

The Italian Iron-Age finds were contextualised in their European textile cultures in presentations by Stella Spantidaki on finds from Greece, Hrvoje Potrebica on finds from Croatia, Karina Grömer on finds from Austria, Fabienne Médard on finds from France and Ulla Mannering on finds from Denmark.

The conference achieved to place Italy on the textile map and presented a wealth of information to the archaeological community. It will certainly make an impact on future directions in archaeology. The conference is planned for publication in 2017 as a special volume of the Italian archaeological periodical *Origini*, published by the Sapienza University in Rome.

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Ulrikka Mokdad

Pre-Columbian Textiles

31 May – 3 June 2016, Centre for Textile Research (CTR), Denmark

In May/June 2016, a conference on pre-Columbian textiles was organised by Lena Bjerregaard, guest-researcher at the CTR. Lena Bjerregaard is former conservator at the Ethnologisches Museum in Berlin, and the author of several books on pre-Columbian textiles. Thirty-eight scholars from several countries were invited to speak at the conference, including keynote speaker Elena Phipps from the US who gave a talk on 'Andean Textile Traditions: Material Knowledge and Culture'. Most of the presentations were given in English, while some were in Spanish. Unfortunately, three of the speakers – Jeffrey Splitstoser, Rommel Angeles Falcon and Luis Pena Callirgos – were not able to come to Copenhagen, but their presentation papers were carefully read by some of the other participants.

The first two days of the conference were hosted by CTR at the University of Copenhagen and were dedicated to the rich corpus of textile finds from the Andean region. Papers treated a variety of aspects such as: 'Headdresses of the men and women of the Wari Kayan' (Ann Peters), 'Nasca-textiles of south Peru' (Daniela Bierman), 'A new textile style from the north-central coast of Peru' (Ann Rowe), 'Structure, design and gender in Inka textiles' (Blenda Feminias) and 'The ties that bind – Inca miniature tupu cords' (Colin McEwan). Several papers addressed the iconography of the textiles including 'Lambayeque iconography on textiles and its continuity in Chimu and Inca culture' (Yvonne Fleitmann and Alisa Baginski) and 'The divine image in old Peruvian textiles' (Uwe Carlsson).

The third day of the conference was hosted by the National Museum of Denmark, located in the centre of the town. This part of the conference was dedicated to methods of textile conservation, textile analysis and the reconstruction of archaeological textiles. The first talk was given by Maria Ysabel Medina Castro that looked at education in textile conservation at the Universidad de San Marcos in Lima. Subsequently, Karin Margarita Frei presented the method of conducting strontium isotope analysis. This method can help to identify trade routes as well as human and animal mobility in prehistory. Next, Anna Javer explained how the Paracas textiles from the Museum of World Cultures in Gothenburg, Sweden were analysed before they were returned to the collections of the National Museum of Archaeology, Anthropology and History in Lima, Peru. Also the question of how to recreate archaeological textiles was treated in two papers, the first by Rebecca Stone and Shelley Burian, the second by Carol James.

In the afternoon several guided visits to the Ethnographic Collections and the exhibition of Danish Prehistory where organised.

The last day took place at the CTR and was entirely devoted to the textile remnants of Mesoamerica. In this region, unlike the Andean area, only very few textiles have survived to this day due to climatic conditions. Therefore archaeological textiles from Mesoamerica are quite limited. Most of the surviving fragments have been found in dry caves in northern Mexico, but recently also carbonised funeral textiles from southern Mexico have been excavated. Leonardo Lopez Lujan presented the most important textile discoveries made by the Instituto Nacional de Antropologia e Historia's Temple Mayor and Tlatelolco Projects. The paper given by Davide Domenici and Gloria Martha Sanchez described how the excavation of a dry cave in Chiapas, Mexico led to the discovery of one of the most important finds of pre-Hispanic textiles

in Mesoamerica; the mummified bodies of eleven children wrapped in textiles bundles. Jesper Nielsen dealt with a collection of Aztec spindle whorls from the 15th and 16th centuries that may offer new insights into the religious significance of the iconography used for the decorations. Finally, Claudia Rocha Valverde concluded the conference with her paper on the ritual use and the symbolism of the *quexhquemitl* in the clothing of the Teenek Indians in Huasteca Potosi.
The conference was exceptionally well organised, and we are looking forward to the publication of the conference papers, which is scheduled for 2017.

Antoinette Rast-Eicher

Dominique Cardon Awarded *Chevalier de la Légion d'Honneur*

29 April 2016, Lyon, France

In spring 2016 Dominique Cardon was awarded the distinction of *Chevalier de la Légion d'Honneur* in France. After the director of the *Musée des Tissus,* Maximilien Durand, had welcomed to his museum the guests, family and friends of Dominique who had arrived from all over the world, Nicole Bériou, herself *Chevalier de la Légion d'Honneur*, presided over the ceremony (Fig. 1). She traced all the different threads Dominique Cardon had spun with passion to form her professional net: after studies in history she learned weaving and the application of natural dyes in Ireland and Peru, both important experiences giving a wonderful practical background for her later more theoretical academic work, connecting first historical texts with textiles and wools. In 1999 her book about medieval drapery was published (*La draperie du Moyen-Âge - Essor d'une grande industrie européenne*), and she became head of research in the CNRS at the CIHAM (*Histoire et Archéologie et Littératures des Mondes Chrétiens et Musulmans Médiévaux*). The analysis of archaeological textiles and dyes was the next step, leading to her very important book about natural dyes (*Les teintures naturelles)* from 2003, which was published in English (*Natural Dyes*) in 2007. Dyes have led her to another major field, the application of natural dyes in modern industry. As co-organiser of the *ISEND* conference she has brought together chemists, historians and artists – and was awarded the UNESCO medal for "Thinking and Building Peace" in 2006.
Thank you Dominique for all your hard work and enthusiasm!

Fig. 1. Nicole Bériou, Dominique Cardon and a guest congratulating (Photo: Antoinette Rast-Eicher).

Agata Ulanowska

Tradition and Innovation in Textile Technology in Bronze Age Europe and the Mediterranean

3 September 2016, EAA, Vilnius, Lithuania

Textile production, with its complex technology and socio-cultural significance was a key craft in the societies of Bronze Age Europe and the Mediterranean. Although complex, socially and economically important, textile technology has often been considered rather traditional and non-innovative throughout the centuries of the Bronze Age. Thus the conference session 'Tradition and Innovation in Textile Technology in Bronze Age Europe and the Mediterranean' was aimed to examine textile technology in search of its traditional and innovative elements. It was organised by Agata Ulanowska from The Centre for Research on Ancient Technologies at the Institute of Archaeology and Ethnology, Polish Academy of Sciences, Poland, and Małgorzata Siennicka from The Danish National Research Foundation's Centre for Textile Research at the University of Copenhagen, Denmark, during the 22nd Annual Meeting of the EAA in Vilnius, Lithuania. The conference consisted of 11 oral and five poster presentations. The variety of evidence of archaeological textiles, textile tools and their changes over time, the botanical and faunal environment, textual records and the imagery of textiles and clothes were discussed in relation to changes in textile technology and its organisation in Bronze Age Europe and the Mediterranean. The Late Neolithic and Early Iron Age were also referred to as periods transitional to the Bronze Age.

The session was opened with a short introduction presented by the organisers. Serena Sabatini, Sophie Bergerbrant and Karin M. Frei discussing Bronze Age wool economy in Europe, *i.e.* production, trade, environment, husbandry and society, based on the material from Benta Valley in Hungary and northern Italy. Johanna Banck-Burgess focused on recognising manufacturing traditions in the archaeology of textiles from the Neolithic to the Iron Age in Central Europe. Textile impressions on ceramics from the Late Neolithic to the Early Iron Age in Central Europe were analysed in the social context of the Bronze Age settlement of Bruszczewo in Poland by Stefanie Schaefer. Agata Ulanowska presented a diachronic approach to investigating traditional and innovative elements in weaving technology in Bronze Age Greece. Małgorzata Siennicka discussed textile tools from Early Bronze Age Greece searching for tradition and innovation in textile manufacturing in this period. Melissa Vetters made an attempt 'to compare the incommensurate' in her presentation on Middle Bronze Age textile tools from Aegina-Kolonna in Greece and Çesme Baglararasi in Turkey. The alternative uses of twisted fibre suggested by the impressions of threads, string and rope in clay and in wallpaintings in Akrotiri in Greece was discussed by Sophia Vakirtzi in collaboration with Fragoula Georma and Artemis Karnava. The complex iconography of Minoan female dress in Mycenaean Greece was addressed by Urlich Thaler in a question: 'does anybody still wear that?. Dominika Kofel discussed bioarchaeologicalevidence from the site of Hala Sultan Tekke in Cyprus with regards to dyeing activity. The appearance of spinning bowls was analysed in relation to innovations in the processing of flax in the northwest of the Iberian Peninsula by María Irene Ruiz de Haro. Finally,

Małgorzata Grupa presented unique wool textiles from a site in Grudna, Poland dated to the period of Roman influence.
The poster section comprised the following presentations: 'Biconical ceramic spindle whorls from Maleva mogila near Veselinovo village, Bulgaria' by Todor Valchev; 'The fabric of Bronze Age society: a pilot study on Bronze Age textile production in Hungary' by Viktória Kiss and Judit Pásztókai-Szeőke, Gabriella Kulcsár and Vajk Szeverényi; 'Bronze Age (1800–500 BC) textile craft in Estonia bas archaeological sources' by Riina Rammo; 'Hallstatt textiles from Poland. Analysis of textile finds from the bi-ritual cemetery in Świbie' by Joanna Słomska and Łukasz Antosik and 'Comb or a vertical loom? Attempt to interpret of the decoration on the urn from Szemud, Poland' by Magdalena Przymorska-Sztuczka.
The proceedings of this conference will be published in 2018 in the peer-reviewed journal *Fasciculi Archaeologiae Historicae* issue 31.

Beatriz Marín-Aguilera

Weaving the Past: The Archaeology of Textiles and Textile Production in Greece in the 1st Millennium BCE

18 March 2016, Athens, Greece

In March 2016 the second international regional workshop of the *PROduction and CONsumption: Textile Economy and Urbanisation in Mediterranean Europe 1000-500 BCE* (PROCON) project was held at the British School of Athens, Greece (see *ATR* 57, 133-134 for a review of the first PROCON workshop held in Rome, Italy in February 2015). The workshop was jointly organised by Margarita Gleba and Joanne Cutler from the University of Cambridge, and Christina Margariti from the Hellenic Ministry of Culture. Fifteen scholars working at Greek, Cypriot, British and Danish institutions were invited to Athens to present their research on textile production in the final Bronze and Iron Ages Greece.
PROCON is a 5-year project funded by a European Research Council Starting Grant. Drawing on archaeological textiles, textile tools, palaeobotanic and archaeozoological evidence, as well as iconographic and literary sources, the project seeks to explore the importance of textile production and consumption

for the development of urban centres in the northern Mediterranean between 1000 and 500 BCE.

In this regard, the main goal of the *Weaving the Past* workshop was to gather specialists from a wide range of disciplines to discuss the different and innovative methods and approaches to study textiles in ancient Greece, one of the regions in which the PROCON project is focused on.

There was a pre-workshop guided visit to the Hellenic Directorate of Conservation and to the Kerameikos Museum hosted by Christina Margariti and Leonidas Bournias, to have a close look to the archaeological textiles currently under conservation and study by Christina Margariti and her team. It was a great opportunity for the organisers and the speakers to gain insight into the issue of textile conservation and its challenges.

In his opening speech at the workshop, John Bennet, the Director of the British School at Athens, emphasised the need for interdisciplinary work in archaeology, and congratulated the organisers and the speakers for an interesting and innovative workshop on textile production in Greece. The one-day academic workshop was divided into four different sections to cover different aspects of textiles in Greece in the first millennium BCE.

The first session explored textile conservation and methodology, in which Christina Margariti started her paper by underlying that the majority of textiles in Greece are yet to be analysed, in spite of their importance for the understanding of ancient Greek society and economy. She presented four different cases of study from the 7th till the 1st century BC, including a possible Roman sail. Margarita Gleba focused on the value of textiles for the ancient economy, and made a meaningful comparison between Greek and Italian textiles for the final Bronze and early Iron Ages. The third speaker, Stella Spantidaki, aimed at providing an overview of textile technology in Classical Athens based on her PhD dissertation, recently published by Oxbow Books. She explained the different materials, techniques, decoration and dyes used in the city of Athens and its hinterland. Dimosthenes Kechagias strove particularly to identify textiles in funerary contexts in Macedonia in the 6th-4th centuries BCE. Interestingly, there is enough evidence in that area to associate specific clothing with socio-economic status.

In the second session speakers gave special attention to raw materials, whether this was based on archaeobotany (Evi Margaritis), archaeozoology (Valasia Isaakidou and Paul Halstead) or dyes (Francesco Iacono and Ioannis Karapanagiotis). The first two talks assessed the use of plant and animal fibres for textile production and trade according to farming and animal husbandry in Bronze- and Iron-Age Greece. The last two papers focused on the *chaîne opératoire* of purple dye production and, from the chemical point of view, on the identification of organic dyes and their uses in ancient Greece.

The third session of the workshop dealt with textile tools, always present in the archaeological remains during the first millennium BCE in Greece. Iris Tzachili stressed that all techniques were connected to one another in the Aegean, metallurgy, textile production, pottery making, etc. Eva Andersson Strand presented the CTR methodology and experiments applied to the Aegean Bronze Age, where they studied over 8400 textile tools with the goal of offering a better comprehension of textile production in the region. Drawing on the methodology developed by the CTR, Joanne Cutler brought to light considerable and interesting differences and changes in textile tools between the Bronze Age and the Iron Age in Greece. Moving further north, Bela Dimova illuminated the discussion on textile production in Iron Age Thrace, relying on textiles, archaeological textile tools, and on textual and iconographic sources.

The fourth and last session of the day was dedicated to textual and iconographic evidence. Nancy Bookidis presented her stimulating study on fabrication marks and inscriptions on loom weights and *kalathoi* at Corinth between the 6th and 3rd centuries BCE. Susanna Harris showed an innovative methodology to analyse the Greek Archaic costume based on a detailed examination of statues of *korai*. Finally, Hans van Wees greatly complemented the discussion on Greek textiles by accounting for literary sources in combination with archaic iconography.

The papers will be published in English in the journal *Arachne* edited by the Centre for Research and Conservation of Archaeological Textiles (ARTEX) in Athens.

Lena Bjerregaard

International Conference on Comparative Mummy Studies

7-9 April 2016, Hildesheim, Germany

In April 2016 the Roemer- und Pelizaeus-Museum hosted an international conference on comparative mummy studies with two parallel sessions. Session A was dedicated to the study of Egyptian mummies, while Session B concentrated on South American and European mummies and their conservation and exhibition. The papers were mostly based on newer natural science methods of investigating mummies like computed scanning topography.

The Egyptian mummy session was divided Into papers about mummies from Pharaonic Egypt and thosenof the Graeco-Roman period. The keynote speaker was Salima Ikram from the American University in Cairo, who talked about 'Trials, Tribulations, and Triumphs in Egyptian Mummy Studies'.

In the non-Egypt session the keynote speaker Frank J. Rüli from University of Zürich talked about the Iranian salt mummies. These mummies were people living around 300 BC who were buried alive in a salt mine accident. The mummies were wearing well-preserved clothing, which are now being studied and analysed within an Iranian/European research project.

Amongst the European mummy studies were papers on The Tyrolean Iceman by Albert Zink from the Institute for Mummies and the Iceman, EURAC European Academy of Bolzano/Bozen, a section on Canary Island mummies presented by Oliver Gauert from the Roemer- und Pelizaeus-Museum, Hildesheim and Daniel Miguel Méndez-Rodríguez from University of La Laguna, and a paper by Naoko Wolze and Waldemar Wolze from University of Göttingen, who talked about a religious sect in Japan whose members practiced self-mummification.

The South American session illustrated the many different mummification techniques in pre-Columbian Peru, from the earliest (AD 700) Chinchorro mummies over the later desert coast mummies to the rainforest and the frozen mummies of the Incas.

An interesting research project presented by Gerhard Hotz from the Naturhistorisches Museum in Basel involves an 'Inca' mummy bundle (Fig. 1). The mummy bundle, which is wrapped in a beautiful Inca military mantle, is probably false, *i.e.* assembled from different pre-Columbian objects including a mummified child's body. Altogether, this assemblage is not pre-Columbian in nature which is also clear from the textiles. The mummy came to Germany in 1920, and was probably put together by a Peruvian grave robber or an art dealer in Germany, which is not an unknown phenomenon.

The Roemer- und Pelizaeus-Museum has a large and fine Egyptian collection and a smaller pre-Columbian collection on permanent display, and has a mummy collection as a non-permanent exhibition which also contains European crypt mummies. Excellent guided tours through all the exhibitions were offered to the conference participants.

Recent publications

***CHIC! Mode im 17. Jahrhundert.* Begleitbuch zur gleichnamigen Ausstellung im Hessischen Landesmuseum Darmstadt vom 15.07.-16.10.2016 (2016) by Wolfgang Glüber, Johannes Pietsch and Jutta Reinisch. Darmstadt: Schnell und Steiner**

Der großzügig bebilderte Band bietet eine Geschichte der Mode des 17. Jahrhunderts anhand eines weltweit einzigartigen Bestands im Hessischen Landesmuseum Darmstadt. Achtzehn original erhaltene Wämser und Mieder, dazu Schuhe und Accessoires führen die Entwicklung der Kostümgeschichte von 1610 bis 1670 vor Augen. Ein Muss für alle Modebegeisterten!

Was ‚chic' war im 17. Jahrhundert, wie modisch (oder auch nicht) sich vor allem die bürgerliche Oberschicht kleidete, erfährt man fast ausschließlich aus bildlichen Darstellungen. Originalkostüme haben sich nur vereinzelt erhalten. Eine der bedeutendsten und umfangreichsten Sammlungen weltweit befindet sich im Hessischen Landesmuseum Darmstadt. Die insgesamt 18 Kostümoberteile, entstanden zwischen 1610 und 1670 und einst getragen von wohlhabenden Damen und Herren der Kölner Gesellschaft, gehören zu den absoluten Raritäten der Kostümgeschichte. Der Bestandskatalog, Begleitbuch zur gleichnamigen Ausstellung im Hessischen Landesmuseum 2016, stellt neben einem Essay zur Modegeschichte alle Wämser und Mieder vor, ebenso die Sammlung von Schuhen und seltenen Accessoires.

ISBN: 978-3-7954-3094-8
Price: € 24.95
http://www.schnell-und-steiner.de/artikel_8681.ahtml

***Das Bild vom Kind im Spiegel seiner Kleidung. Von prähistorischer Zeit bis zur Gegenwart* (2015) edited by Annette Paetz gen. Schieck and Isa Fleischmann-Heck. Regensburg: Schnell und Steiner**

Bis heute ist das Thema Kinderkleidung wenig erforscht, obwohl Schnitt und Konstruktion weitreichende Einblicke in die Wahrnehmung von Kindern in einer Gesellschaft bieten. Vierzehn Wissenschaftlerinnen aus Archäologie, Kunstgeschichte, Ethnographie und Erziehungswissenschaften haben ausgewählte Beispiele untersucht und eine Entwicklung in der Kinderkleidung von der Steinzeit bis heute nachvollzogen.

Kinderkleidung kann einengen und den Körper disziplinieren, sie kann aber auch elastisch und bequem gearbeitet sein. Darin spiegeln sich Erziehungskonzepte, die Stellung der Kinder in Familiengefügen und Gesellschaftssystemen der jeweiligen Zeit wider, denen in diesem Tagungsband (initiiert vom Deutschen Textilmuseum Krefeld) auf den Grund gegangen wird. Nicht nur in der Verschiedenheit der Herangehensweisen besteht die Besonderheit dieses Bandes – denn so wurde Kinderkleidung bislang nicht betrachtet –, sondern auch in der Materialauswahl und fachlichen Ausrichtung der Autorinnen. Vertreterinnen von Archäologie und Kunstgeschichte, Bekleidungsforschung, Ethnologie und Erziehungswissenschaften analysieren archäologische Fundkontexte sowie Objekte und Gemälde aus Museumssammlungen. Bei der Zusammenstellung der exemplarischen Betrachtungen ergeben sich spannende Erkenntnisse, beispielsweise über die Bekleidungskonventionen von Kindern der Ober- und Unterschichten des 15.-19. Jahrhunderts, die die Forschung auf eine neue Grundlage stellen.

ISBN: 978-3-7954-3021-4
Preis: € 34.95
http://www.schnell-und-steiner.de/artikel_8569.ahtml

***Clothing the Sacred. Medieval Textiles as Fabric, Form and Metaphor* (2015) edited by Mateusz Kapustka and Warren T. Woodfin. Textile Studies 8, Berlin: Edition Imorde**

At their most basic level, liturgical vestments and textiles serve to differentiate the sacred and the profane, the clergy and the laity. Not only are they sacred objects in their own right, being consecrated for holy use, but they point beyond themselves to historical parallels – to events in the life of Christ or to the furnishings of the Jerusalem Temple – or to anagogical symbolism of the heavenly graces.

ISBN: 978-3-942810-20-3
Price: € 29.90
https://www.reimer-mann-verlag.de/controller.php?cmd=detail&titelnummer=300050&verlag=3

***Designing Identity: The Power of Textiles in Late Antiquity* (2016) by Thelma K. Thomas, Jennifer L. Ball and Edward Bleiberg. Princeton: Princeton University Press**

Ideals of character and beauty, and conceptions of self and society, were in flux during late antiquity, a period of extensive dramatic cultural upheaval for the Roman world, as the extraordinary growth of Christianity eclipsed paganism. Textiles from late antiquity document transformations of cultural traditions and societal values at the most intimate level of the individual body and the home. These textile artefacts are fragile, preserved only in arid conditions, often in fragments, and only rarely intact.

The textiles selected for the exhibition *Designing Identity* at New York University's Institute for the Study of the Ancient World present an aesthetic of vibrant colours, fine materials, technical virtuosity of professional production and variations on designs that display personal identity in the clothing of men, women and children, as well as hopes for prosperity and protection in the textile furnishings of households. Prized for their artistry since the earliest discoveries beginning at the turn of the 19th century, such textiles were eagerly collected by designers, artists, scholars, museums and captains of industry. This exhibition catalogue explores the parallel histories of ancient textile production and consumption, and the modern business of collecting late antique textiles.

ISBN-10: 069116942X
ISBN-13: 978-0691169422
Price: € 26.94
https://doboshd.wordpress.com/2016/09/17/designing-identity-the-power-of-textiles-in-late-antiquity-by-thelma-k-thomas-downloads-torrent/

***Dress and Society – Contributions from Archaeology* (2016) by T. F. Martin and R. Weech. Oxford: Oxbow Books**

While traditional studies of dress and jewellery have tended to focus purely on reconstruction or descriptions of style, chronology and typology, the social context of costume is now a major research area in archaeology. This refocusing is largely a result of the close relationship between dress and three currently popular topics: identity, bodies and material culture. Not only does dress constitute an important means by which people integrate and segregate to form group identities, but interactions between objects and bodies, quintessentially illustrated by dress, can also form the basis of much wider symbolic systems. Consequently, archaeological understandings of clothing shed light on some of the fundamental aspects of society, hence the intentionally unconditional title of this book. *Dress and Society* illustrates the range of current archaeological approaches to dress using a number of case studies drawn from prehistoric to post-medieval Europe. Individually, each chapter makes a strong contribution in its own field whether through the discussion of new evidence or new approaches to classic material. Presenting the eight papers together creates a strong argument for a theoretically informed and integrated approach to dress as a specific category of archaeological evidence, emphasising that the study of dress not only draws openly on other disciplines, but is also a sub-discipline in its own right. However, rather than delimiting dress to a specialist area of research, we seek to promote it as fundamental to any holistic archaeological understanding of past societies.

ISBN-10: 1785703153
ISBN-13: 978-1785703157
Price: £ 36.00
https://www.amazon.com/Dress-Society-contributions-archaeology-Martin/dp/1785703153

***Spinning Fates and the Song of the Loom: The Use of Textiles, Clothing and Cloth Production as Metaphor, Symbol and Narrative Device in Greek and Latin Literature* (2016) edited by Marie Louise Nosch, Mary Harlow and Giovanni Fanfani. Ancient Textiles Series 24, Oxford: Oxbow Books**

Textile imagery is pervasive in classical literature. An awareness of the craft and technology of weaving and spinning, of the production and consumption of clothing items, and of the social and religious significance of garments is key to the appreciation of how textile and cloth metaphors work as literary devices, their suitability to conceptualise human activities and to represent cosmic realities, and their potential to evoke symbolic associations and generic expectations. Spanning mainly Greek and Latin poetic genres, yet encompassing comparative evidence from other Indo-European languages and literatures, these 18 chapters draw a various yet consistent picture of the literary exploitation of the imagery, concepts and symbolism of ancient textiles and clothing. Topics include refreshing readings of tragic instances of deadly *peploi* and fatal fabrics situate them within a Near Eastern tradition of curse as garment, explore female agency in the narrative of their production, and argue for broader symbolic implications of textile-making within the sphere of natural wealth. The concepts and technological principles of ancient weaving emerge as cognitive patterns that, by means of analogy rather than metaphor, are reflected in early Greek mathematic and logical thinking, and in archaic

poetics. The significance of weaving technology in early philosophical conceptions of cosmic order is revived by Lucretius' account of atomic compound structure, where he makes extensive use of textile imagery, whilst clothing imagery is at the centre of the sustained intertextual strategy built by Statius in his epic poem, where recurrent cloaks activate a multi-layered poetic memory.
ISBN: 9781785701603
Price: £ 38.00
http://www.oxbowbooks.com/oxbow/spinning-fates-and-songs-of-the-loom.html

***Die frühbyzantinischen Textilien des Römisch-Germanischen Zentralmuseums* (2016) by Petra Linscheid. Kataloge Vor- und Frühgeschichtlicher Altertümer, Band 48. Mainz: Verlag Römisch-Germanisches Zentralmuseum Mainz**

Textilfunde aus Ägypten sind unsere wichtigste Quelle zur Erforschung frühbyzantinischer Kleidung und Ausstattungstextilien. Das Römisch-Germanische Zentralmuseum besitzt über 200 meist fragmentarische, aber auch zahlreiche vollständige Textilien dieser Zeit.
Als wissenschaftlicher Bestandskatalog werden sie hier mit ausführlichen einleitenden Kapiteln und einem detaillierten Katalogteil vorgelegt. Besondere Beachtung finden dabei Herstellungstechnik und Funktionsbestimmung der Stücke. Das Wissen um Aussehen und Verwendung der verschiedenen Tuniken, Manteltücher, Kopfbedeckungen sowie Decken, Polsterstoffe, Behänge und textilen Gerätschaften machen diese Objekte über die Textilkunde hinaus zu archäologisch und historisch relevanten Zeugnissen.
ISBN 978-3-88467-250-9
Price: € 55.00
http://shop.rgzm.de/de/neuerscheinungen

***Fibres: Microscopy of Archaeological Textiles and Furs* (2016) by Antoinette Rast-Eicher. Budapest: Archaeolingua**

Fibres used in the manufacture of archaeological textiles are full of information. Unfolded microscopically, analysis of such textiles and furs has become an important field of archaeological study. Fibre type and even fibre processing may become visible. Scanning electron microscopy has made analysis of metal-replaced and charred finds possible, something that was not determinable by light microscopy. Examination under the SEM has enabled a new world to become visible and is so presented in this book. A variety of archaeological examples and their modern day counterparts are assembled as well as a chapter devoted to the historical background of each fibre and its use in Europe.
ISBN-13: 978-9639911789
Price: € 54.00
https://www.amazon.de/Fibres-Microscopy-Archaeological-Textiles-Furs/dp/963991178X

***Lederfunde der vorrömischen Eisenzeit und römischen Kaiserzeit aus Nordwestdeutschland* (2015) by Julia Gräf. Studien zur Landschafts- und Siedlungsgeschichte im südlichen Nordseegebiet 7. Rahden/ Westfalen: Verlag Marie Leidorf**

Die Moorgebiete NW-Deutschlands enthüllten im Laufe der über 100 Jahre ihrer Ausbeutung und Untersuchung zahlreiche Lederfunde der vorrömischen Eisenzeit und Römischen Kaiserzeit. Diese Studie wirft anhand der Funde einen umfassenden Blick auf das Material Leder und seine Verarbeitung und Verwendung im Barbaricum. Neben technischen Untersuchungen tritt eine Studie zur Entwicklung des Gerberhandwerks. Trotz der geringen Anzahl an einzelnen Funden werden fast sämtliche Bereiche des menschlichen Lebens wie Kleidung, Transport, Bewaffnung und Siedlungsabfall abgedeckt. Der Fokus liegt dabei auf der chronologischen Einordnung sowie ihrer Verbreitung im Vergleich zu Gebieten wie Dänemark, den Niederlanden und dem Römischen Reich. Anhand umfangreichen Siedlungsabfalls der Wurtensiedlung Feddersen Wierde gelang es mit Hilfe von Strontiumisotopenanalysen, die Herkunft der Tiere festzustellen, deren Haut als Leder verwendet wurde. Den Abschluss bildet eine Gegenüberstellung mit zeitgleichem Textilhandwerk, um herauszuarbeiten, wie weit entwickelt das Lederhandwerk in der vorrömischen Eisenzeit und römischen Kaiserzeit in NW-Deutschland war.
ISBN 978-3-86757-337-5
Price: € 54.80
https://www.jpc.de/jpcng/books/detail/-/art/julia-graef-lederfunde-der-vorroemischen-eisenzeit-und-roemischen-kaiserzeit-aus-nordwestdeutschland/hnum/8495125

***Medieval Clothing and Textiles 12* (2016) edited by Robin Netherton and Gale R. Owen-Crocker. Woodbridge: Boydell**

The studies collected here range through art, artefacts, documentary text and poetry, addressing both real and symbolic functions of dress and textiles. John Block Friedman breaks new ground with his article on clothing for pets and other animals, while Grzegorz Pac compares depictions of sacred and royal female

dress and evaluates attempts to link them together. Jonathan C. Cooper describes the clothing of scholars in Scotland's three pre-Reformation universities and the effects of the Reformation upon it. Camilla Luise Dahl examines references to women's garments in probates and what they reveal about early modern fashions. Megan Cavell focuses on the treatment of textiles associated with the Holy of Holies in Old English biblical poetry. Frances Pritchard examines the iconography, heraldry and inscriptions on a worn and repaired set of embroidered 15th-century orphreys to determine their origin. Finally, Thomas M. Izbicki summarises the evidence for the choice of white linen for the altar and the responsibilities of priests for keeping it clean and in good repair.
ISBN: 9781783270897
Price: £ 35.00
https://boydellandbrewer.com/medieval-clothing-and-textiles-12-hb.html

***Neolithische und bronzezeitliche Gewebe und Geflechte. Die Funde aus den Seeufersiedlungen im Kanton Zürich* (2015) by Antoinette Rast-Eicher and Anne Dietrich. Monographien der Kantonsarchäologie Zürich 46. Zürich**
Bis ins Jahr 2006 wurden im Kanton Zürich 1031 neolithische und bronzezeitliche Gewebe und Geflechte aus den feuchten Schichten von 30 Ufersiedlungen dokumentiert. Die meisten Funde stammen aus neolithischen Schichten, die von der Egolzwiler Kultur (ca. 4300–4000 v.Chr.) bis in die Schnurkeramik-Kultur (ca. 2750–2400 v.Chr.) datiert werden. Nur wenige Objekte, nämlich 36, sind spätbronzezeitlich. Aus der Frühbronzezeit liegt bisher nur ein Objekt vor, womit eine grosse Lücke zwischen den jüngsten neolithischen und den spätbronzezeitlichen Funden besteht. Dieser Fundkorpus ist einmalig in ganz Europa und stellt die grösste Menge so früher Textilien in einer derartigen chronologischen Breite dar. Die technischen Veränderungen bei den beiden grossen Gruppen, den Maschenstoffen und den Zwirngeflechten, sind an diesen Objekten sehr gut zu belegen. Der Fundbestand dokumentiert die Herstellung und die Funktion von Geweben und Geflechten und ist somit Bestandteil dieser frühen Kulturen. Er bietet damit wichtige Grundlagen zu einer Geschichte textiler Techniken. Als Materialien dominieren die Baumbaste, allen voran Linden- und Eichenbast; Lein kann von den ältesten Funden an nachgewiesen werden. Insgesamt geht die Entwicklung der Textilien im Neolithikum langsam voran. Erst mit dem Aufkommen der Schafwolle als Rohstoff für die Bekleidung in der Bronzezeit ändert sich Grundsätzliches: Fell als Wärmeschutz und Bastmäntel als Wetterschutz machen gewebter Wollbekleidung Platz. Wolle war zudem leichter zu verarbeiten und spätestens ab der Mittelbronzezeit war sie auch als weisse, färbbare Faser erhältlich. Bei den Kleidern waren Farben seitdem nicht mehr wegzudenken.
ISBN 978-3-906299-00-6
Price: CHF 65.00
http://www.are.zh.ch/internet/baudirektion/are/de/archaeologie/archaeologie/

***Symbols of Power: Luxury Textiles from Islamic Lands, 7th–21st Century* (2015) by Louise W. Mackie. Cleveland: Cleveland Museum of Art**
For centuries, luxury textiles were symbols of status, wealth and power at Islamic imperial courts from the Atlantic to the Indian Ocean, setting standards for beauty and fuelling prosperous, urban economies. This book offers an unparalleled examination of Islamic luxury textiles, drawn from the Cleveland Museum of Art's exemplary collection as well as from museums on four continents. Leading scholar Louise W. Mackie offers a generous overview of the cultural significance of these textiles, as well as descriptions of primary motifs and patterns, and explanations of various techniques used in their production. With singular insight into distinctive artistic characteristics of wealthy dynasties and periods, the text – complemented by more than 450 sumptuous illustrations – pinpoints luxury textiles as a vital link between art, culture and history in the Islamic world. This book offers a much-needed contribution to scholarship on both textiles and Islamic art, and paves the way for further study and appreciation of these objects.
ISBN-10: 0300206097
ISBN-13: 978-0300206098
Price: $ 59.84
http://www.abebooks.de/9780300206098/Symbols-Power-Luxury-Textiles-Islamic-0300206097/plp

***The Art of Prehistoric Textile Making. The Development of Craft Traditions and Clothing in Central Europe* (2016) by Karina Grömer. Veröffentlichungen der Prähistorischen Abteilung (VPA) 5. Vienna: Natural History Museum**
Traditional textile crafts such as spinning, weaving and sewing have accompanied humanity since the Stone Age. Until a few hundred years ago, textile crafts occupied a huge portion of the daily workload in addition to the acquisition of food.
Textile crafts, and weaving in particular, have contributed much to the overall development of

technology. Looms were invented in the Neolithic and represent the first 'machines' of human history. Essential goods for daily use, especially clothing, as well as utilitarian textiles, ostentatious objects for display and luxury items were produced with this craft.

Textiles were valuable, as can be inferred from the recycling of fabrics. Worn out garments were used as binders, packaging and even as a dressing material in prehistoric times. Clothing, however, not only offered protection against the elements – even in prehistoric times textiles and jewellery were more than just simply means to dress – they are an essential feature of every culture. In the past as well as today, clothing represents an important non-verbal means of communication and conveys aspects of identity about the wearer such as age, gender, social status and group memberships.

This book is of interest to historians, costume designers, archaeologists and anyone interested in handcraft and artisanship. The temporal and geographical scope of this investigation is the Neolithic to late Iron-Age Central Europe, which is the period before the introduction of writing. The book ends with the Roman occupation of Central Europe. Austrian finds and sites as well as those of neighbouring countries are the primary focus.

ISBN: 978-3-902421-94-4

Price: € 35.00

http://www.mediahistoria.com/the-art-of-prehistoric-textile-making.html

http://www.nhm-wien.ac.at/verlag/wissenschaftliche_publikationen/einzelwerke

***The Roots of Asian Weaving: The He Haiyan Collection of Textiles and Looms from Southwest China* (2016) by Eric Boudot and Chris Buckley. Ancient Textiles Series 23, Oxford: Oxbow Books**

This ground-breaking book documents the weaving traditions and textiles of one of Asia's most ethnically diverse areas, placing them in a regional context. Based on more than a decade of first-hand study in the field, the authors record the traditions of Miao, Yao, Buyi, Dong, Zhuang, Maonan, Dai and Li weavers from Guizhou to Hainan Island. They describe the looms and techniques of these groups, including diagrams, descriptions and photographs of the weaving processes and woven structures. Each tradition is illustrated with outstanding examples of textiles, drawn from the He Haiyan collection in Beijing, including many 19th-century examples.

The authors present a novel analysis of loom technology across the Asian mainland, using techniques derived from linguistics and biology. They use these to chart the evolutionary history of looms in Asia, demonstrating that all the major traditions are related in spite of their apparent diversity. The results have far-reaching implications, for example shedding light on the development of the Chinese Drawloom and showing how key patterning features were derived from Tai-Kadai looms.

The book is a visual delight as well as a resource for scholars, collectors and curators. The fieldwork in this book is a primary, while the looms and techniques will be essential reading for those interested in weaving and textile history, as well as contemporary weavers and designers wishing to learn how to reproduce traditional patterns and methods. The account of the development and links between weaving cultures will be a revelation for those interested in cultural evolution and the diversity of mankind.

ISBN: 9781785701474

price: £ 30.00

http://www.oxbowbooks.com/oxbow/the-roots-of-asian-weaving-48916.html

***Textiles, Text, Intertext. Essays in Honour of Gale R. Owen-Crocker* (2016) edited by Maren Clegg Hyer and Jill Frederick. Woodbridge: Boydell Press**

This book consists of essays centred round the representation of weaving, both real and imagined, in the early middle ages.

The triple themes of textile, text and intertext, three powerful and evocative subjects within both Anglo-Saxon studies and Old English literature itself, run through the essays collected here. Chapters evoke the semantic complexities of textile references and images drawn from the Bayeux Tapestry, examine parallels in word-woven poetics, riddling texts, and interwoven homiletic and historical prose, and identify iconographical textures in medieval art. The volume thus considers the images and creative strategies of textiles, texts and intertexts, generating a complex and fascinating view of the material culture and metaphorical landscape of the Anglo-Saxon peoples. It is therefore a particularly fitting tribute to Professor Gale R. Owen-Crocker, whose career and lengthy list of scholarly works have centred on her interests in the meaning and cultural importance of textiles, manuscripts and text, and intertextual relationships between text and textile.

ISBN: 9781783270736

Price: £ 60.00

https://boydellandbrewer.com/textiles-text-intertext-hb.html

***Woven Threads* (2015) edited by Maria C. Shaw and Anne P. Chapin. Ancient Textiles Series 22, Oxford: Oxbow Books**

Woven textiles are produced by nearly all human societies. This volume investigates evidence for patterned textiles (that is, textiles woven with elaborate designs) that were produced by two early Mediterranean civilisations: the Minoans of Crete and the Mycenaeans of mainland Greece, that prospered during the Aegean Bronze Age, c. 3000–1200 BC, contemporary with pharaonic Egypt.

Both could boast of specialists in textile production. Together with their wine, oil and art, Minoan and Mycenaean textiles were much desired as trade goods. Artistic images of their fabrics preserved both in the Aegean and in other parts of the Mediterranean show elaborate patterns woven with rich decorative detail and colour. Only a few small scraps of textiles survive but evidence for their production is abundant and frescoes supply detailed information about a wide variety of now-lost textile goods from luxurious costumes and beautifully patterned wall hangings and carpets, to more utilitarian decorated fabrics. A review of surviving artistic and archaeological evidence indicates that textiles played essential practical and social roles in both Minoan and Mycenaean societies.

ISBN: 9781785700583

Price: £ 38.00

http://www.oxbowbooks.com/oxbow/hyphanta.html

***The Dyer's Handbook: Memoirs of an 18th Century Master Colourist* (2016) by Dominique Cardon. Ancient Textiles Series 26, Oxford: Oxbow Books**

Persian blue, pomegranate flower, spiny lobster, wine soup, pale flesh, dove breast, golden wax, grass green, green sand, rotten olive, modest plum, agate, rich French gray, gunpowder of the English... These are just some of the colour names of old fabric to fire the imagination. *The Dyer's Handbook* concerns a unique manuscript from the 18th century: a dyer's memoirs from Languedoc, containing recipes for dyes with corresponding colour samples. It is an exceptional document, hugely rare and of great significance not only to textile historians but dyers and colourists today, as thanks to the information in the manuscript the colours can be reproduced exactly, with the same ingredients, or reproduced using modern techniques by matching the colour samples. To the English translation of the text, together with facsimile pages reproduced in colour from the original manuscript, are added essays meant to situate it in its historical, economic and technological contexts. For those historians who have long been fascinated by the change in scale and the amount of innovation that occurred in woollen cloth production in Europe during the 17th and 18th centuries, *The Dyer's Handbook* brings first-hand insight into the daily preoccupations and tasks of a key actor in the success story of the Languedocian broadcloth production specially devised for export to the Levant. Even non-specialists may be interested in understanding the clever management and technical organisation that made it possible for the author to produce, dye, finish, pack and export up to 1,375 pieces of superfine broadcloth per year, representing nearly 51 km of cloth.

ISBN: 9781785702112

Price: £ 48.00

http://www.oxbowbooks.com/oxbow/the-dyers-handbook.html

***Weben und Gewebe in der Antike / Texts and Textiles in the Ancient World: Materialität – Repräsentation – Episteme – Metapoetik / Materiality – Representation – Episteme – Metapoetics* (2015) by Henriette Harich-Schwarzbauer. Ancient Textiles Series 23, Oxford: Oxbow Books**

Texts and Textiles in the Ancient World: Materiality – Representation – Episteme – Metapoetics presents 12 papers arranged under the four headings of the title which focus on the process of textile manufacture, the weaving process itself and the materiality of fabric. Contributions address the problematic issues of cognitive archaeology, consumer research, literary theory and themes addressing both philosophical history and the history of reception of ideas and practice.

The contributions seek both to close the critical gaps with respect to weaving, a broad and complex field in the area of ancient cultural techniques, and to identify new themes. Accordingly, the submissions expand our focus into late antiquity, to integrate texts such as letters written on papyrus detailing the everyday correspondence of an Egyptian family or to spotlight the meaning of textile terms and the history of misunderstandings associated therein. Frequently overused analogies between writing and weaving are also examined in terms of their legitimacy as well as their limits. The papers presented here result from an international and interdisciplinary conference under the same title held in Castelen, near Basel in 2012.

ISBN: 9781785700620

Price: £ 35.00

http://www.oxbowbooks.com/oxbow/weaving-and-fabric-in-antiquity-weben-und-gewebe-in-der-antike.html

***Textile Production in Classical Athens* (2016) by Stella Spantidaki. Ancient Textiles Series 27, Oxford: Oxbow Books**

Textile technology is older than any other ancient craft and is an instance of cognitive archaeology that provides vital information about society. In ancient Greece, textiles were considered to be amongst the principal and most fundamental cultural expressions. Athena, the goddess of the city, of intelligence and of skill was also the patron goddess of weaving. She taught the craft of textile production to women, thus making them conduits of civilisation. During Classical times, textile production was a fundamental part of the economy and was practised also by men in both the domestic and artisanal spheres. The resulting technological sophistication is reflected in depictions of discrete or elaborate patterns, in the rich diversity of textile implements and in the variety in the quality of the extant textiles. In *Textile Production in Classical Athens*, Stella Spantidaki provides the first synthesis of the available evidence from textual, iconographic and archaeological sources on textile production in 5th- and 4th-century BC Athens, employing an interdisciplinary perspective that sets the frame for future research in the field. As such, this study is of especial importance to textile specialists, ancient history scholars, historians of technology and students, and will lead to a better understanding of ancient Greek textile production and Classical Athenian society. It also presents a detailed consideration of the historical and social context of textile production in classical Athens, and examines evidence for the equipment, materials, processes and techniques employed at each stage of the full production sequence. Finally, it discusses the organisation of textile production and trade.

ISBN: 9781785702525
Price: £ 38.00
http://www.oxbowbooks.com/oxbow/textile-production-in-classical-athens.html

***Iconic Costumes: Scandinavian Late Iron Age Costume Iconography* by Ulla Mannering. Ancient Textiles Series 25, Oxford: Oxbow Books.**

This handsomely illustrated book presents a selection of the rich and varied iconographic material from the Scandinavian Late Iron Age (AD 400-1050) depicting costumed human figures, from an archaeological textile and clothing perspective. The source material consists of five object categories: gold-foil figures, gold bracteates, helmet plaques, jewellery and tapestries, and comprises over 1000 different images of male and female costumes that are compared with the present record of archaeological textiles. The study also explores in which way the selected images complement the archaeological clothing sources. A new analytical tool developed to compare the object categories, is used to record and analyse the numerous details of the iconographic costumes. This facilitates a clear and easy description which enhances our interpretation and understanding of the Late Iron Age clothing tradition. The majority of the costumes depicted are known from the Scandinavian archaeological textile record, and constitute a reliable source for the study of both iconographical costume and archaeological clothing. The book gives a new perspective to regional and chronological differences in clothing traditions from ca. AD 400 to the Viking Age.

ISBN: 978-3-7954-3021-4 ISBN: 978-1-7857-0215-0
Price: £38.00
http://www.oxbowbooks.com/oxbow/iconic-costumes.html

PhDs

Tina Boloti was awarded a PhD by the University of Crete, Greece for her dissertation "Υφάσματα και ενδύματα σε τελετουργίες της ύστερης Εποχής του Χαλκού στον αιγαιακό χώρο. Λειτουργία και συμβολισμοί» (Textiles and Garments in Aegean Late Bronze Age Rituals: Function and Symbolism).

Chrystel Brandenburgh was awarded a PhD by Leiden University, the Netherlands for her dissertation 'Clothes Make the Man. Early Medieval Textiles from the Netherlands'.

Faith Pennick Morgan was awarded PhD in Classical and Archaeological Studies in 2015 by the University of Kent at Canterbury for her dissertation "Dress and Personal Appearance in Late Antiquity; the Clothing of the Middle and Lower Classes".

Alexandra Makin was awarded a PhD by the University of Manchester, UK for her dissertation 'Embroidery and its Context in the British Isles and Ireland during the Early Medieval Period (AD 450-1100)'.

Websites

On the webpage of the College de France you can view and enjoy three papers on textiles from a conference on the archaeology of the Eastern Desert in Egypt held in Paris 30-31 March 2016.

https://www.college-de-france.fr/site/en-jean-pierre-brun/symposium-2016-03-31-09h00.htm
https://www.college-de-france.fr/site/en-jean-pierre-brun/symposium-2016-03-31-09h30.htm
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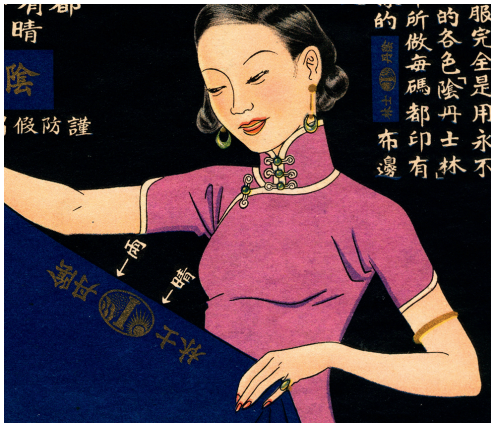

PERSPECTIVE

actualité en histoire de l'art

1 | 2016 (june 2016)

Textiles

This issue of *Perspective*, created in association with the Mobilier National (Paris), focuses not only on textiles in various times and places of production and use, but also on the notion of textility: the conceptual, metaphorical and material embodiments of the ornament, the weaving or the fabric. The articles discuss current research on various subjects such as veils, medieval Islamic textiles and dressed prints… with contributions by, amongst others, Birgitt Borkopp-Restle, Tim Ingold, Rémi Labrusse, Jean-Paul Leclercq, Lesley Miller, Estelle Thibault and Tristan Weddigen.

The online version of the issue can be accessed onward at: https://perspective.revues.org/6179

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The ATN aims to provide a source of information relating to all aspects of archaeological textiles. Archaeological textiles from both prehistoric and historic periods and from all parts of the world are covered in the ATN's range of interests.

1. Contributions can be in English, German or French.

2. Contribution may include accounts of work in progress. This general category includes research/ activities related to archaeological textiles from recent excavations or in museums/galleries. Projects may encompass technology and analysis, experimental archaeology, documentation, exhibition, conservation and storage. These contributions can be in the form of notes or longer feature articles.

3. Contributions may include announcements and reviews of exhibitions, seminars, conferences, special courses and lectures, information relating to current projects and any queries concerning the study of archaeological textiles. Bibliographical information on new books and articles is particularly welcome.

4. References should be in the Harvard System (*e.g.* Smith 2007, 56), with bibliography at the end (see previous issues). No footnotes or endnotes.

5. All submissions are to be made in electronic text file format (preferably Microsoft Word) and are to be sent electronically or by mail (a CD-ROM).

6. Illustrations should be electronic (digital images or scanned copies at 600dpi resolution or higher). Preferred format is TIFF. Illustrations should be sent as separate files and not imbedded in text.
Colour images are welcome.

7. All contributions are peer-reviewed by the members of scientific committee.

8. The Editors reserve the right to suggest alterations in the wording of manuscripts sent for publication.

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