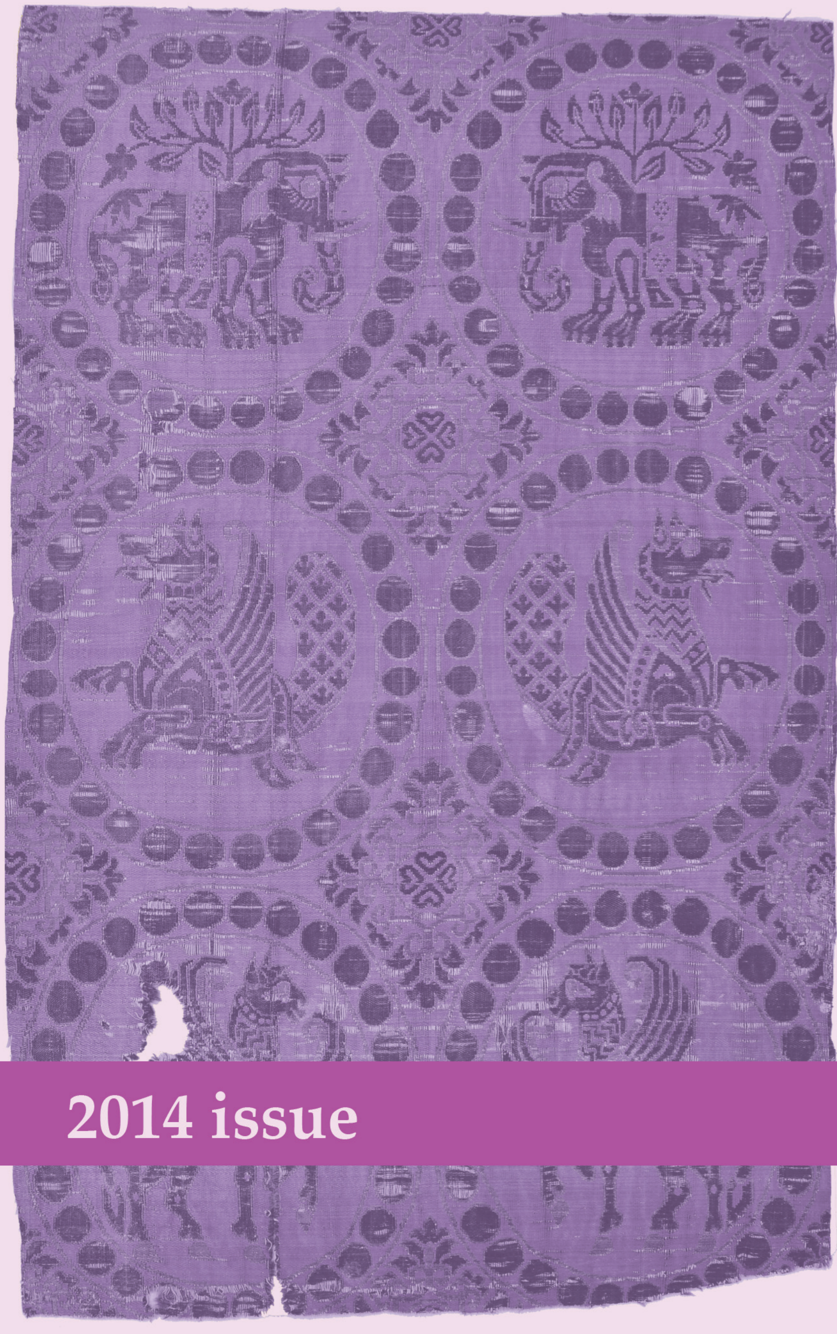
Nº 56

ARCHAEOLOGICAL TEXTILES REVIEW



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Editorial

2014 was a new milestone for the *Archaeological Textiles Review*. During the Annual General Meeting which was held in Hallstatt, Austria, during the NESAT XII symposium, the editors Margarita Gleba and Susanna Harris from the UK stepped down from their posts. Two new editors were appointed: Ursula Rothe from the UK and Karina Grömer from Austria. Further new members were added to the Scientific Committee, appointed for 2014-2017, which now includes John Peter Wild (UK), Lise Bender Jørgensen (Norway), Elisabeth Wincott Heckett (Ireland), Johanna Banck-Burgess (Germany), Tereza Štolcová (Slovakia), Heidi Sherma (USA), Claudia Merthen (Germany) and Christina Margariti (Greece). We thank the former editors for their great work and devotion to *ATN*/*ATR* and welcome the new members, and look forward to inspiring collaboration in the coming years. Likewise we would like to thank the many different reviewers who have helped with this issue. We highly appreciate their devoted work which ensures the high scientific quality of ATR.

Another great change was the closing of the webshop on the *ATN* homepage and its inclusion in the Copenhagen University webshop at www.webshophum-en.ku.dk/shop/archaeological-textiles-333cl.html. This was done in order to minimise costs and work procedures. We hope the members and many more will find their way to the webshop which is also sells other publications. For instance, the festschrift honouring Lise Bender Jørgensen can be bought via the webshop at www.webshophum-dk.ku.dk/shop/a-stitch-in-1068p.html. We are proud to announce that the *ATN* issues 1-45 will be available in spring 2015 as a print on demand solution from the webshop and issues 52 and 53 will soon be online at www.atnfriends.com together with the already available issues 46-51.

In the current issue readers are presented with a varied range of topics. Two articles focus on technical aspects of using different analytical techniques or equipment (Frank; Skals and Mannering). Several others examine the potential of studying textile tools (Orit Shamir and 'Ad Uzi) or other objects containing textile information (Ulrike Rothenhäusler and Antoinette Rast-Eicher; Julie Unruh). At the same time, the discussions in this issue of *ATR* of various textile finds from Greece (Christina Margariti and Alkistis Papadimitriou), Slovakia (Tereza Štolcová, Dorte Schaarschmidt and Sylvia Mitschke) and Iran (Julia Barbara Krug-Ochmann) provide new and fresh information in these regions as well. We are also continuing to list completed and ongoing PhD projects (Anna Rosa Tricomi, Julia Galliker and Maciej Szymaszek). Please keep sending us project descriptions and information on PhDs related to textile research. We hope through the selection of pieces in this issue readers will be able to enjoy the immense variety in textile research.

2014 was a busy year for the field of archaeological textiles, with many important conferences, exhibitions and publications. We bring you reviews of textile conferences held in Jordan, Spain, Denmark, England, Scotland, Austria and the USA. Please keep sending us reviews and news, and remember to keep up with events and news in textile archaeology on the *Friends of ATR* Facebook page: www.facebook.com/pages/Friends-of-Archaeological-Textiles-Review

The next Annual General Meeting for 2015 will be held on the 7th of May at CTR in Copenhagen, in connection with the conference "First Textiles. The Beginnings of Textile Manufacture in Europe and the Mediterranean" (www.ctr.hum.ku.dk/nyhedsliste/news_2014/first_textiles).

Please make sure to renew your membership at the beginning of the year. We encourage contributors to submit their articles throughout the year to spread the editing workload. The next deadline for contributions to ATR 2015 Issue 57 is the **1st of June**.

The Editors

Emily Frank

Documenting Archaeological Textiles with Reflectance Transformation Imaging (RTI)

Introduction

As interest in textile studies grows, we should re-examine current methods of documenting textile information. Documentation of the physical attributes of archaeological textiles is time-consuming. The detailed recording of such features as dimensions, raw materials, construction technique, condition, textile and yarn structures is often limited by the time and budgetary constraints of a project. Additionally, these analyses require significant object handling, which is undesirable from a conservation perspective. Bruselius Scharff and others propose detailed photo documentation as a way to quickly save information for later analysis and to decrease handling (Scharff 2007). Ræder Knudsen (2007) also suggests digital photography and enhancement in Adobe Photoshop as a desirable method of textile documentation (Ræder Knudsen 2007, 105). As technological capabilities increase, new ways of gathering and saving information and decreasing handling have become more readily available.

I examine the feasibility and effectiveness of Reflectance Transformation Imaging (RTI) as a way of documenting archaeological textiles preserved by imprint, mineralisation or carbonisation. RTI is a computational imaging technique that allows a researcher to relight an object from any direction and to mathematically enhance an object's surface and colour to reveal texture imperceptible during empirical examination (Earl *et al*. 2010, 1; Cultural Heritage Imaging 2014b). As such, it is an excellent way to document textured surfaces. The ability to manipulate the light source and enhance surface attributes in RTI expedites identification of important features of archaeological textiles from documentation. This is especially important for unstable material, such as carbonised textile remains, because access to the original material is often limited. I propose that RTI is a better way to document features of archaeological textiles and well worth the time, data, cost, and potential risk.

What is Reflectance Transformation Imaging?

Reflectance Transformation Imaging is a computational photographic imaging technique invented in 2000 by Tom Malzbender and Dan Gelb at Hewlett Packard (HP) Labs (Malzbender *et al*. 2000; Malzbender *et al*. 2001). It was originally called Polynomial Texture Mapping (PTM), and this original fitting algorithm creates .ptm files. In 2008, a second fitter that uses a slightly different algorithm and creates .rti files was developed under James Davis at the University of California, Santa Cruz (Schroer 2012; Wang *et al*. 2009). The technology uses multiple digital images, each with a different illumination direction (Fig. 1), that are compiled into an interactive file, buildable and viewable via free open-source software available online. The interactive file viewed with the software can provide a complex view of an object far more comprehensive and detailed than any of the individual digital screenshots shown as examples in this paper. Much of the benefit of RTI described in this publication cannot be shown in print. Please contact

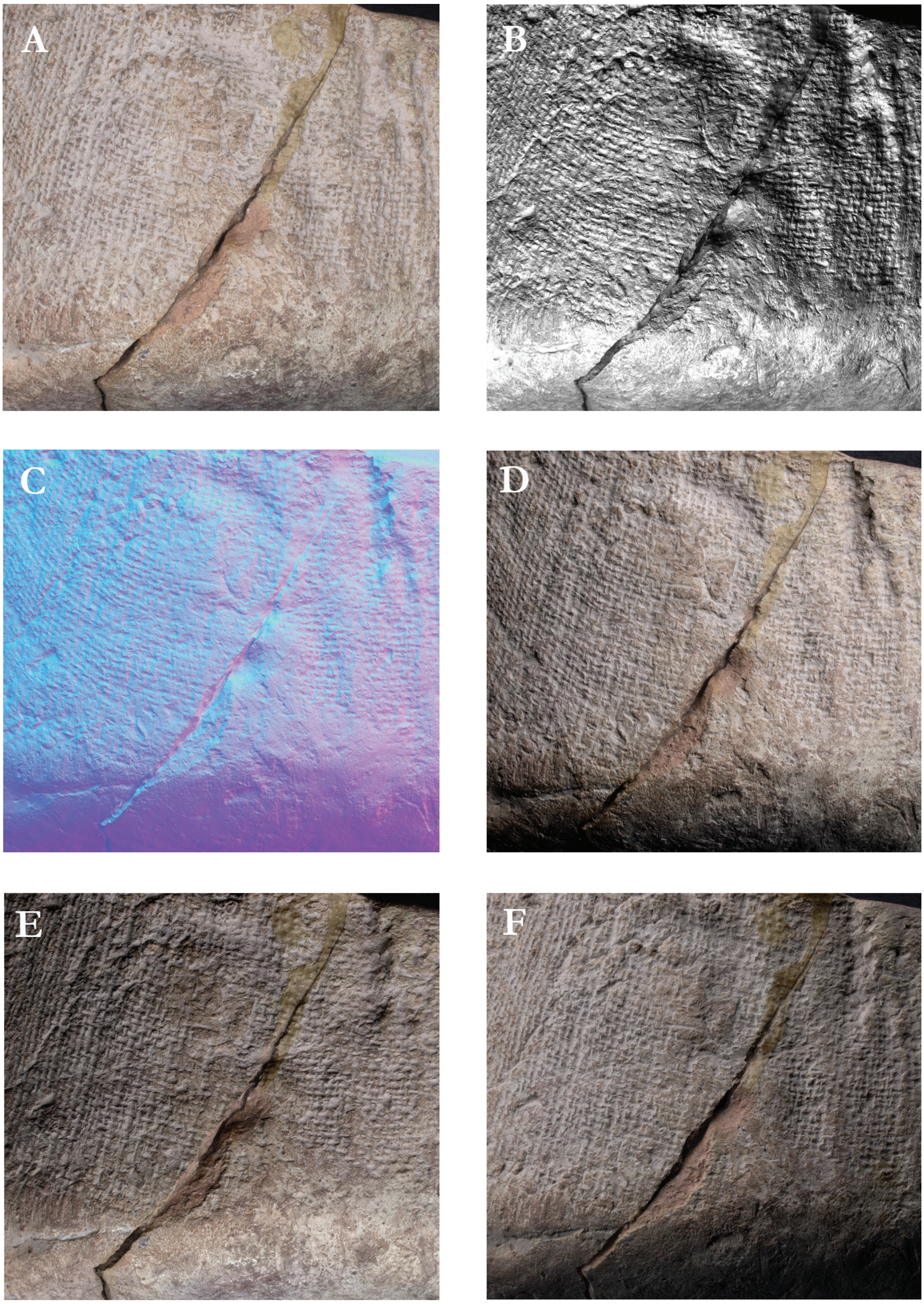


Fig. 1: Screenshots illustrating the range of individual images produced by RTI of a textile impression on ceramic (© University College London (UCL) Institute of Archaeology Collections). These and other digital images are compiled in an interactive file and viewed with RTI software. A) flat light; B) specular enhancement; C) normals visualisation; and D), E) and F) three images with different directional raking light.

the author if you wish to view the interactive .rti files discussed below.

To build an RTI, the program must know or determine the direction of illumination in the source images (Payne 2012, 18; Malesevic *et al*. 2014, 3). Thus, RTI source images can be collected in two ways. They can be taken in an arc or dome, where the lights are mounted mechanically and the locations of the lights are programmed into the compilation software (Fig. 2a), or source images can be collected with a moveable light, if a specular sphere is captured in each image (Fig. 2b) (Payne 2012, 18). A highlight from the light source is created on the sphere in each image, and the compilation software can determine the light position from this highlight on the sphere (Mudge *et al*. 2007, 4-5; Earl *et al*. 2010, 150).

Inherent in the RTI, saved per pixel, is red-green-blue (RGB) colour information and the mathematical description of 'normal' values. Normals are vectors that are perpendicular to the object's surface at any given point (Payne 2012, 18; Cultural Heritage Imaging 2014c); they enable the computation of reflection in the RTI and allow the image to be artificially relit from different directions (Payne 2012, 18).

Once the RTI has been created, the viewer can alter light qualities using specular enhancement to better examine the feature of interest. Specular enhancement yields an artificially shiny surface that provides increased tonal contrast (Earl *et al*. 2010, 3) and gives surface information where it might otherwise be lost due to specular reflection (Mudge *et al*. 2005, 7).

Considerations before using Reflection Transformation Imaging for documentation

Before starting documentation, users should consider several important technical aspects: image quality and size, image processing protocols, digital archival processes, image back-up, and longevity of the .rti file format.

For RTI to be effective, source images must be shot at the highest image quality and saved as RAW or non-compressed files. These files are extensive, and a large memory card is needed for a full set of images (usually between 40 and 70 images), which can be combined to form an RTI file. After image processing, the source images are saved as digital negatives (.dng) with embedded raw files to provide transparency. These file types hold metadata detailing the capture of the images, essentially embedding image provenance in the file so future researchers can have confidence in the representation. The files are then re-saved in a separate folder as .jpeg images. The .jpeg images are used by the compilation program to create the .rti file, which is usually about 100 MB worth of data. Often the collective data from the RTI of an object (the .dng files, .jpeg files, and the finished .rti file) can be as big as one GB of data.

There are many ethical implications in image processing, especially considering the vast capabilities of Adobe Photoshop. When images are used as documentation, an object's appearance should not be altered in any way that might confuse the viewer's understanding of the object or misrepresent the object's appearance.

Institutions usually establish a specific image workflow and standard for digital documentation. Before beginning documentation, the researcher should consider how RTI files will fit into an institution's organisational system. Often digital photographs are saved as compressed files (.jpeg) or as both compressed and non-compressed versions in different locations.

A backup plan for the data should be established. With the rapid development of digital technology, digital documents are at risk of becoming obsolete if attention is not paid to periodically saving files in new formats to new storage media (Mudge *et al.* 2010, 21). As RTI is not as widespread as digital photography is at present, the researcher should consider saving some, or all, of the digital source photographs of the image in addition to the RTI. Should .rti become obsolete, or should the RTI viewing software cease to work with new computer operating systems, it is important to have backup in other formats that are, at present, more mainstream.

Additionally, the goals of the documentation should be considered prior to beginning imaging, as the setup and applicability of RTI may vary depending on the goals of the researcher. One advantage of RTI as documentation is the ability to revisit and analyse the specifics of textile features later. If the specific goals are undetermined when original documentation takes place, the knowledge that the object is of importance and will be studied or displayed in the future might be enough to justify the use of RTI.

Reflectance Transformation Imaging specifics: camera, setup and software used

I used the following RTI setup to document several examples of archaeological textiles. I based my setup on information from the two primary published RTI guides: *RTI: Guide to Highlight Image Capture,* published by Cultural Heritage Imaging (CHI), and *Multi-light Imaging for Heritage Applications*, published by English Heritage. These works are both user-friendly and they complement each other well, especially when used with CHI's *Reflectance Transformation Imaging: Glossary of Photographic and Technical Terms for RTI*.

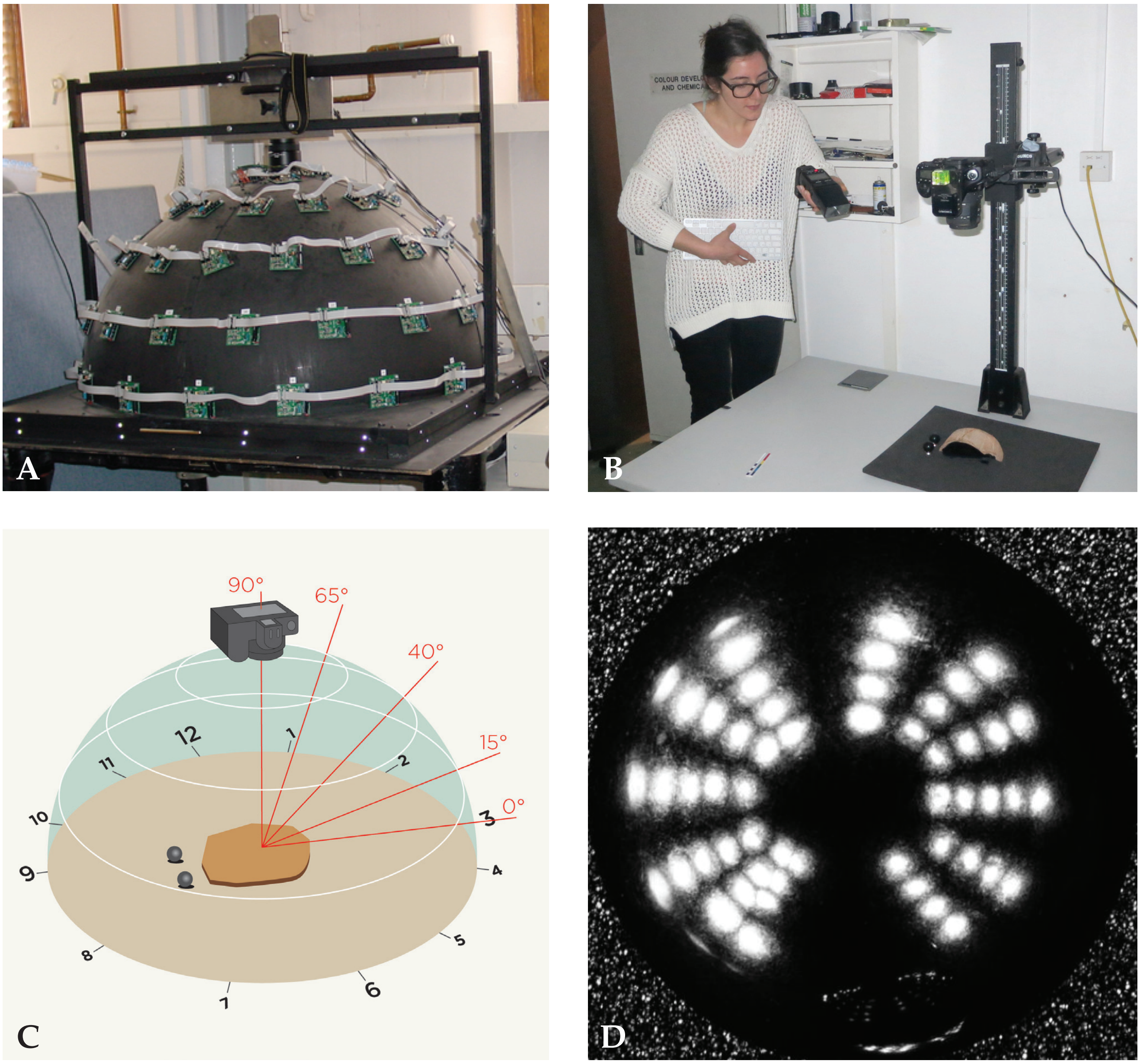


Fig. 2: A) RTI dome; B) RTI highlight capture set-up; C) virtual lighting dome centred around virtual clock: 12 images (approximately one at each hour) are taken around each white line (drawing: Charlotte Gudmundsson); D) blended image created by RTI Builder to determine light positions during highlight RTI.

Reflectance Transformation Imaging kit for documentation of archaeological textiles

Digital camera

Most digital single-lens reflex (SLR) cameras are acceptable for RTI.[1] For RTI, capturing accurate surface information is the priority, so the lens choice is also important. I used a Canon EOS 60D with a 50 mm macro lens and was pleased with the results. I found electrical tape useful to secure the lens focus; I noticed that after about 30 images the lens tended to drop focus as a result of the mechanical action of the shutter during photography. The mirror lock-up feature of the camera (where applicable) can also help to prevent the lens from dropping focus.

Computer

Any computer that can support the appropriate camera capture software will do. I used a Macbook Air.

Camera capture software
Camera capture software should be chosen based on the make of the camera. I used Canon Camera Capture.

Universal Serial Bus (USB) cable
A USB cable is used to connect the camera to the computer. In some cases, depending on the setup and size of the object, a USB extension cable is useful. Rubber bands and twist ties are useful as cable holders and are easy to procure. I used rubber bands secured with twist ties to attach the extra cable to the copy stand to avoid any shadow on the object during photography.

Two flat surfaces
The object should be placed on one surface and the computer on another. The two surfaces should be separated to avoid any vibration surrounding use of the computer. I used two tables.

Copy stand[2] or tripod
The camera should be securely suspended above the object. I used a copy stand. CHI suggests weighing down the feet of a tripod for extra stability.

Flash
The flash is the moveable light source. I used a Nikon Speedlight SB-24 and was satisfied with the results.

Two triggers
One trigger should be attached to the camera, and one to the flash. I used two Yongnuo Digital YN-622C E-TTL Wireless Flash Trigger Transceivers.

Level
This is used to ensure the camera is level before photography.

Specular Balls[3]
CHI suggests red or black specular balls. I used two ball bearings procured at a nearby bike shop.

String
The string is used to measure the distance of the light source from the object. It should be about four times the length of the object.

Chargers and batteries
Make sure all necessary chargers and batteries are easily accessible.

Scale
A scale should be included in at least one image for size, white balance and colour correction.

Wireless Bluetooth keyboard
I used a wireless Bluetooth keyboard as a substitute for a second person. Usually one person moves the light while another captures the image from the computer. With the Bluetooth-capable keyboard, I was able to capture the image while holding the light.

RTI Builder
Free software is available from HP and CHI. I used CHI's RTI Builder Version 2.0.2 for Mac, which is available on the CHI website: http://culturalheritageimaging.org/What_We_Offer/Downloads/Process/index.html

RTI Viewer
Free software is available from HP and CHI: I used CHI's RTI Viewer Version 1.1 for Mac, which is available on the CHI website: http://culturalheritageimaging.org/What_We_Offer/Downloads/View/index.html

Results and discussion
To illustrate the value of RTI for documentation of archaeological textiles, I have documented three examples: one imprint (Fig. 3), one mineralised (Fig. 4) and one carbonised (Fig. 5).
RTI is the most revealing and exciting when used on archaeological textile impressions. Specular enhancement clearly increases the legibility of dimensions (Figs. 3f, 3g, 3h), weave type (Figs. 3c and 3d), edge structure (Figs. 3c and 3d), irregularities (Fig. 3h) and condition (Figs. 3c, 3d, 3g, 3h). Perhaps most notably, specular enhancement allows the viewer to notice depth (Figs. 3c, 3d, 3g, and 3h) that is not obvious in raking light images. In Fig. 3, the weave is far more three-dimensional in the enhanced views, a feature that facilitates understanding of the original mat, not just the impression of it.
RTI is effective for documenting mineralised textiles, though the information that can be gained from the example in Fig. 4 by any technique is limited. The most information was gained by viewing the object with different sources of raking light. The 'z' spin direction of a few threads is visible under certain raking light conditions (Fig. 4f). Perhaps the weave type was more legible under specular enhancement, though that is debatable (Figs. 4c, 4d, 4g, and 4h). Information about dimensions and condition can also be obtained from the RTI image in Fig. 4.
RTI is effective in documenting features of carbonised textiles, but it may not provide more information than any single raking light photograph. However, the use of RTI can be justified because the ability to interact with the light source and move the direction of illumination offers a more coherent analysis experience than examining a few raking light images. The viewer can

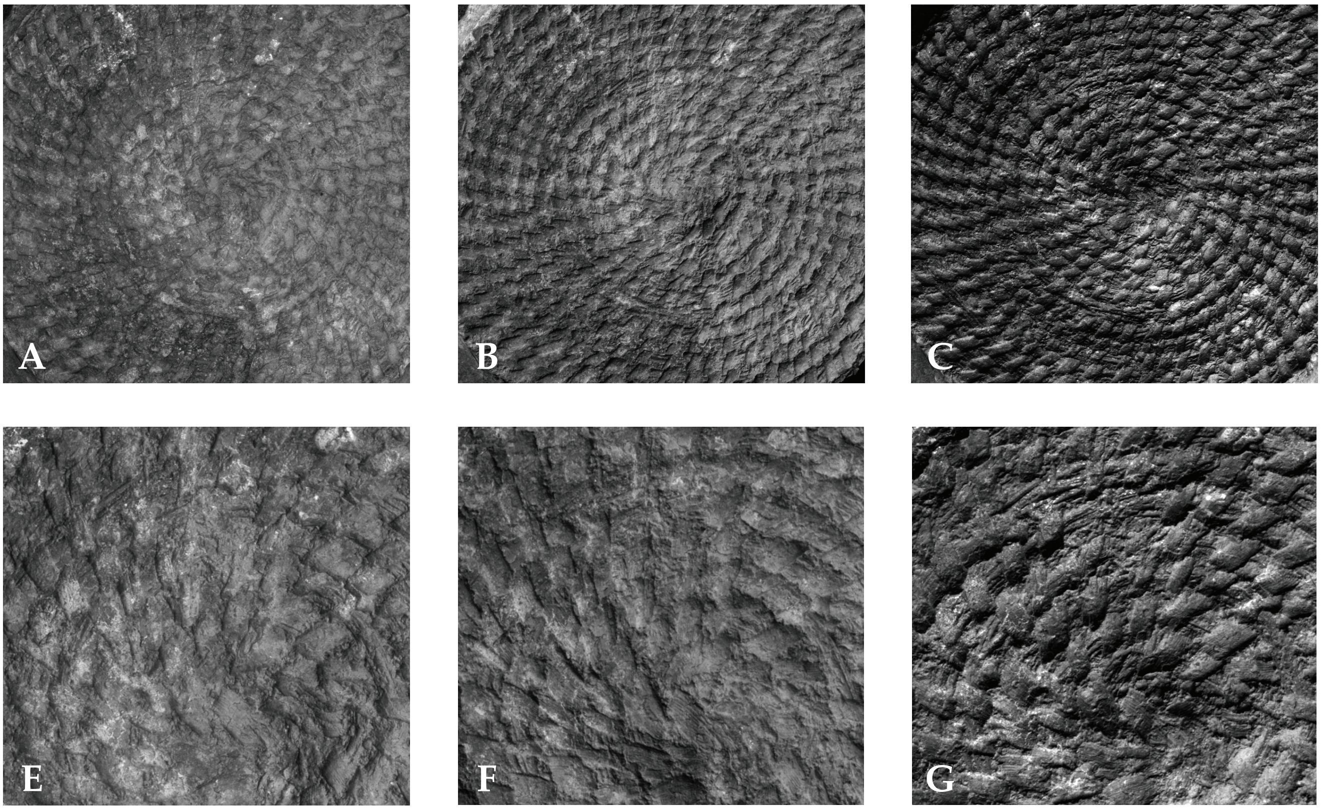


Fig. 3: Screenshots of RTI images of a textile imprint on a ceramic from Pakistan (© UCL Institute of Archaeology Collections). A) and E) flat light; B) and F) raking light; C), D), G) and H) two variations of specular enhancement.

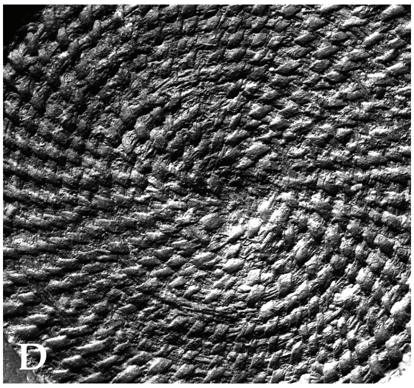
obtain information from Fig. 5 regarding dimensions, weave type, thread count and condition.

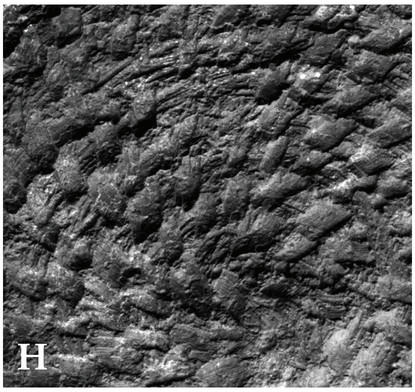
Though digital photographs gather and save much information about an object, RTI is superior because it allows contrast manipulation. By showing the surface behaviour under different illumination, RTI preserves previously inaccessible details (Malesevic *et al*. 2014, 3). RTI saves everything a digital photograph preserves, and in the context of archaeological textile remains, RTI provides more information than any one photograph can. It should be noted that high-resolution documentation photography is inherent in the RTI workflow.

The facility of use of the RTI viewer allows both informed and uninformed viewers to interact with final RTI files and to benefit from the information saved. Thus, RTI files are as accessible as photographs (with the minor stipulation that the viewer must download the free RTI viewer first). Furthermore, RTI source images can be captured without handling. The object suffers minimal contact during RTI; it is typically moved once to place the object on the surface, and once to return it to its packaging.

The cost of RTI is quite low, especially in institutions equipped for digital photography. CHI sells an RTI starter kit for 350 USD, which includes a range of sizes of specular balls and various hardware useful for constructing an RTI setup. Alternatively, the necessary tools can easily be compiled for little or no cost, with the exception of the computer, camera, lens, flash and camera capture software (all of which should be accessible in any lab equipped for digital photography and none of which are included in CHI's kit).

On the other hand, there are a few disadvantages to RTI. Processing images into RTI files may require minimal training. However, with the current knowledge of digital photography standard in archaeology and conservation, and improved software, this roadblock is easily overcome (Payne 2012, 18).





RTI retains some of the limitations of digital photography. For example, documenting curved surfaces is difficult, as seen in Fig. 4. Also, RTI provides only one fixed view of the object, though PTM object movies (POM) have been created (Mudge *et al*. 2006, 5) and will likely be relatively easy to create in the foreseeable future.

RTI is more time-consuming than digital photography, at least initially. By the third session though, I was able to take and process an image set in 40 min.

Long-term storage of RTI files is still problematic, and something that should be carefully considered before adapting institutional policies to include RTI as commonplace documentation.

Finally, researchers should consider the potential risks of any new documentation technique.

Risk assessment for Reflectance Transformation Imaging

A new application of any technique requires risk assessment. The main risks posed by RTI are those of electromagnetic radiation (light) and object handling (Payne 2012, 23-25). The heat output from flash bulbs is negligible, thus addressing any concern about temperature and relative humidity (RH) changes as a result of RTI with the setup described above. Additionally, there is no ultraviolet (UV) radiation emission in the setup.

I calculated the lux values associated with RTI and determined that they can reach 60,000,000 lux for periods of about one millisecond during RTI. Each shot is about 600 lx/sec. When multiplied by 50 shots (an average RTI session) and converted to lx/hr, the light levels are equivalent to 8.3 lux for one hour or 50 lux for about 12 minutes. Based on the Canadian Conservation Institute's (CCI) assessment of damage to highly sensitive and sensitive textiles, I calculate that at about 50 lx with no UV, an object must be exposed for 700 years or more for any damage to be observed (Michalski 2014). Thus, the light levels associated with RTI are well within the published appropriate exposure levels for unstable organic material.

As with any form of examination and documentation, object handling is a big threat. In cases where access to the material in conditions conducive to investigation is limited, documentation images of the object, or a digital artefact, can be studied instead (Galliker 2010, 48-49). With RTI files, the viewer can almost reproduce the experience of handling the object under ideal light conditions to discern texture.

Conclusion

Previously published work on RTI has examined applications of the technique to a range of archaeological and museum materials. The work presented above successfully applies the analytical capabilities of RTI to archaeological textile remains preserved through imprint, mineralisation and carbonisation. These capabilities, particularly when combined with the decrease in handling made possible by interactive RTI files, suggest that RTI can be very useful for investigation of textiles. RTI may be specifically illuminating for textile imprints, a material class that until now has been documented with photography. The detailed images produced could be beneficial for analysis and conservation, and could be used in a representative capacity in exhibitions and online. Considering the time, data, cost and potential risk, RTI is a promising and reasonable way to document archaeological textiles.

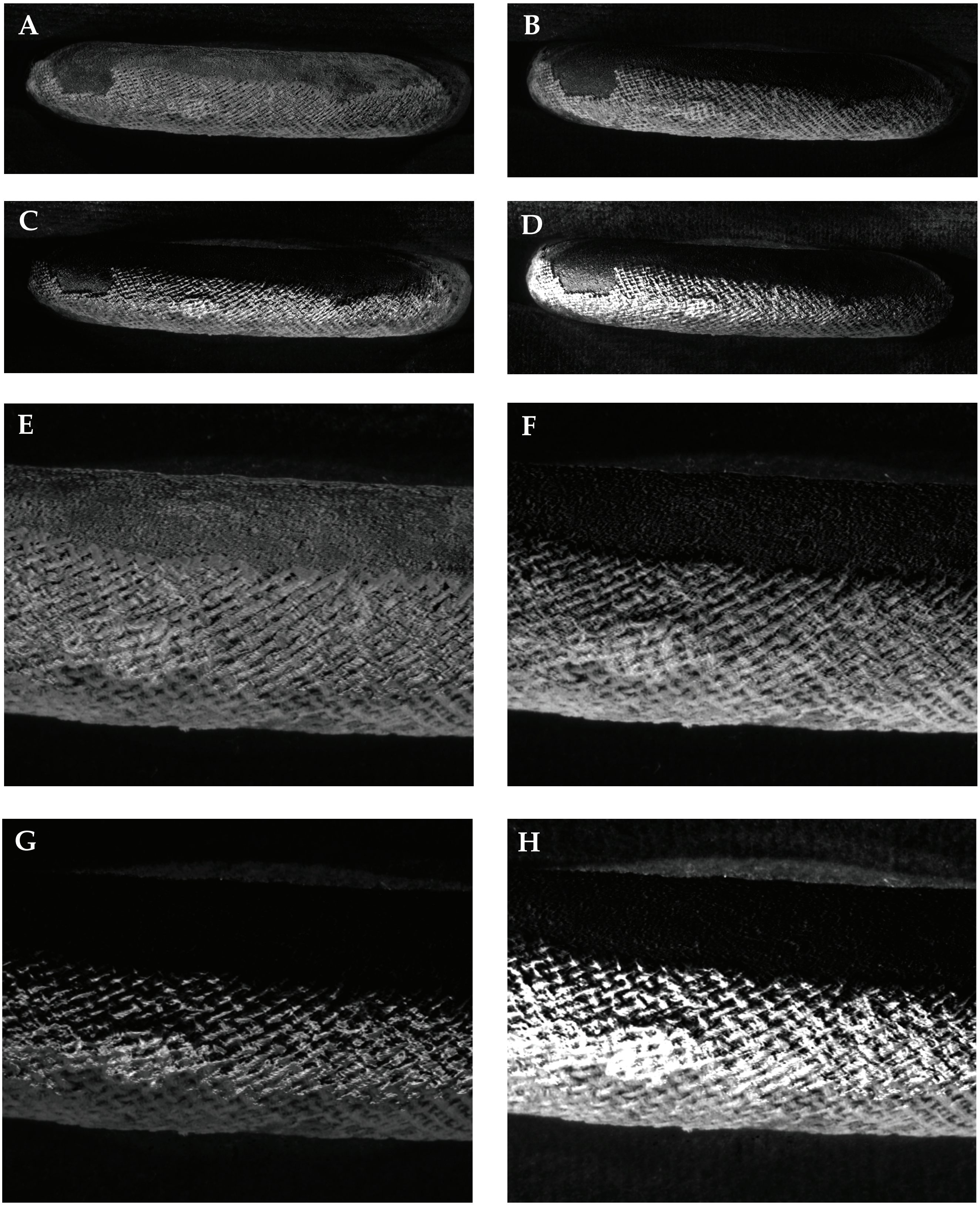


Fig. 4: Screenshots of RTI images of a mineralised textile on a bronze bracelet from Thailand (© UCL Institute of Archaeology Collections). A) and E) flat light; B) and F) raking light; C), D), G) and H) two variations of specular enhancement.

Notes

1. To learn more, I suggest consulting Kathryn Piquette's blog entry "Choosing a Camera for Highlight RTI" at http://kathrynpiquette.blogspot.com/.
2. A copy stand is a device used in photography to stabilise the camera to "copy" information. The object is placed on a flat surface and the camera is mounted parallel to the surface above the object. The height of the camera can be adjusted.
3. Specularity refers to the reflective quality of a mirror. The two balls used in RTI capture should allow mirror-like reflection from their surface.

Acknowledgements

I would like to thank Stuart Laidlaw, Stacey Mandelbaum, Lindsay MacDonald, Kathryn Piquette, Margarita Gleba, Rachael Sparks, Ian Carroll, James Hales and Charlotte Gudmundsson for their support, time and help facilitating this project.

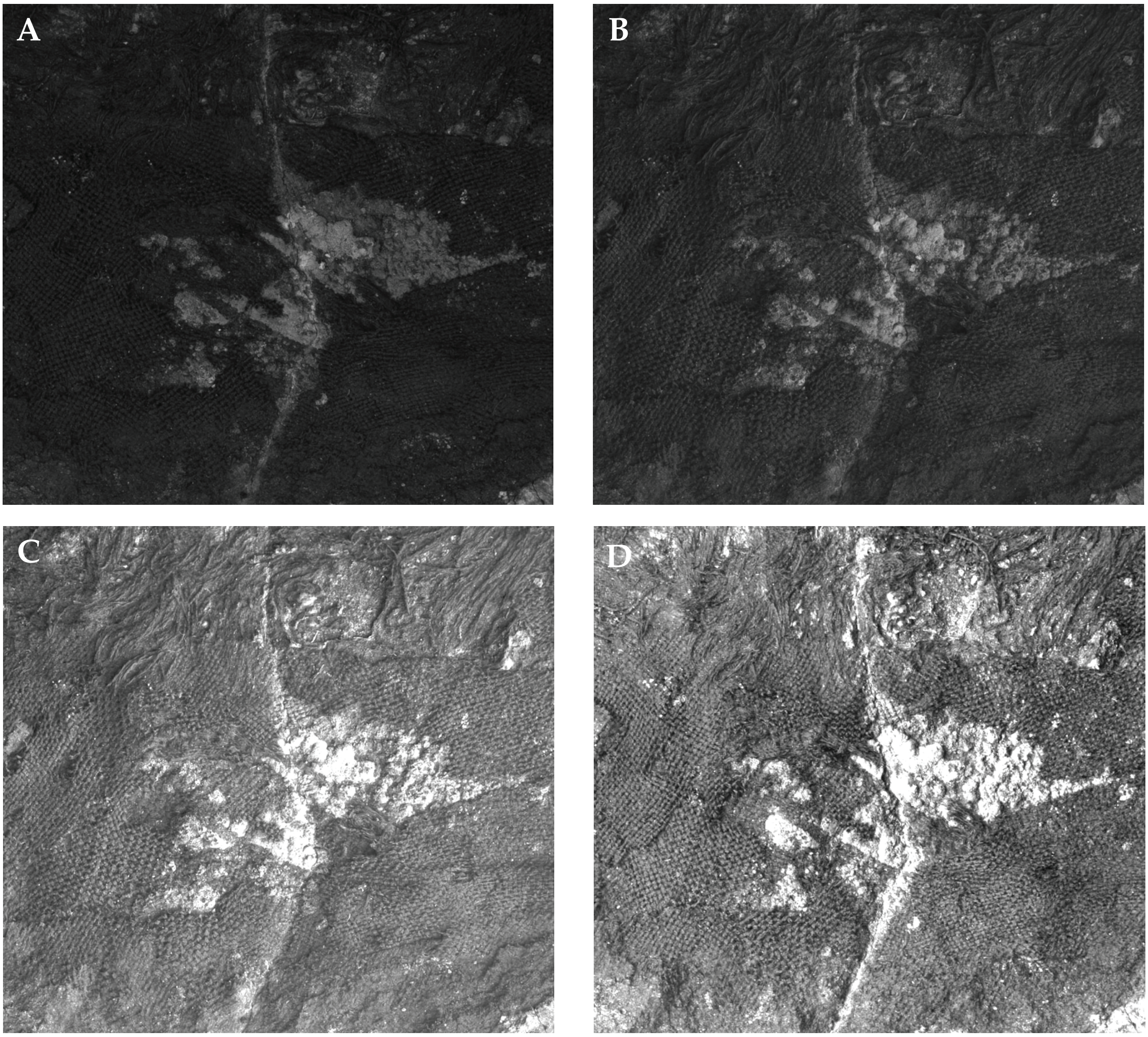


Fig. 5: Screenshots of RTI images of a carbonised textile on a bronze sheet from Ur (© UCL Institute of Archaeology Collections). A) flat light; B) raking light; C) and D) two variations of specular enhancement.

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Material Identification and Technological Analysis of a 7th-century BC Excavated Textile from Argos, Greece

Introduction

The name of the city of Argos is pre-Helladic (Pelasgian) and has remained the same since the beginning of the city's history. According to mythology, Argos, the son of Zeus and Niobe, was the founder of the city. It reached its peak during the Archaic period, under King Pheidon (7th century BC) (Pomeroy *et al.* 1999, 87). During that time, Argos was the centre of Argolis (today a prefecture), dominating the two major neighbouring cities, Tiryns and Mycenae. It was one of the most powerful and important Greek cities rivalling Athens and Corinth. It was caught in constant warfare with Sparta, which ended with Argos's defeat in c. 494 BC. Its refusal to fight in the Graeco-Persian Wars meant that Argos was shunned by most other city-states. It also remained neutral during the Peloponnesian War (5th century BC) between Athens and Sparta. Homer mentions Argos in the Iliad as the kingdom of Diomed and he frequently uses the alternate name Argives (inhabitants of Argos) for the Achaeans, one of the four main tribes of ancient Greeks, or Greeks in general, thus signifying the great importance the city had during that period (Kakridis 2009). The modern city of Argos is built on the site of the ancient one, which is common for the majority of Greek cities.

In April 2007, a rescue excavation run by the Hellenic Ministry of Culture – archaeologist in charge Dr Alkistis Papadimitriou – brought to light part of a cemetery of the early Archaic period (7th century BC), in the city of Argos (north-east Peloponnese). Among the oversized ceramic funerary vessels (pithoi) retrieved there was a much smaller, though very significant, copper vessel of a unique capsule shape. The two compartments of the vessel were held in place by iron pins. The copper vessel contained a substantial amount of textiles. It is a funerary vessel containing the incinerated bones of the deceased. The deceased's body would have been consumed in the pyre, the remains of the incinerated bones cleansed, wrapped in textile(s) along with fruit and placed in the vessel, which was subsequently sealed and buried in an upright position. Visual examination based on weave analysis revealed three different textiles present in the find. They were given the numbers Y1, Y2 and Y3.

Stereomicroscopy, ESEM and EDS, XRF, FTIR microscopy were applied to the textiles in order to get information on the technology and method of construction, material identification and state of preservation. More than one technique providing similar information were applied (*e.g.* EDS and XRF), since they are non-destructive, for comparison purposes.

Material

The main volume of Y1 textile consists of a mass of folded textile of a light brown colour (Fig. 1). Numerous smaller fragments have been preserved in light brown and white colour. Some fragments adhere to the Y3 textile, the deceased's bones and the fruit offerings. Pieces of the deceased's bones and fruit were found within the folds of the main mass. The unified folded mass seemed to rest on a layer of Y3 textile (maximum dimensions of the folded mass: 280 x 300 x 110 mm).

Textile Y2 consists of numerous brown, green and off-white-coloured fragments (Fig. 2). The majority of the fragments consist of multiple successive layers. Single-layered fragments adhered occasionally to the top surface of the unified mass of Y1 and on Y3 fragments (dimensions: fragments range from approx. $2mm^3$ to $50mm^3$).

Textile Y3 consists of numerous dark brown, green and black-coloured fragments (Fig. 3). The majority of the fragments consist of multiple successive layers. All three textiles have been preserved in association with copper (dimensions: fragments range from approx. $2mm^3$ to 80mm x 60mm x 60mm).

The bottom of the urn had degraded to such a degree that its contents were loosely spilled, hence they were collected in four aluminium foil trays. Tray I contained the main, more unified, volume of Y1; Trays II and III contained numerous textile fragments (Y1, Y2 and Y3) and a substantial amount of degraded organic material mixed with soil and powdered matter (?); and Tray IV contained mainly the largest preserved parts of the deceased's bones, the remains of a mineralised fruit (pomegranate), a mineralised, multilayered fragment of textile (Y3) and fragments of the degraded bottom of the copper vessel.

Methodology

Samples were chosen among the numerous loose, small-sized fragments present for each of the three textiles. In total, nine samples were removed from the find: 1) Y1 brown, 2) Y1 off-white, 3) Y2 brown, 4) Y2 green, 5) Y2 off-white, 6) Y3 brown, 7) Y3 green, 8) Y3 black, and 9) debris(?). Each of the nine samples were used for all analyses and then returned to the find intact. Visual observation revealed that some fragments carried evidence of the method of construction of the textiles. These were studied with the stereomicroscope but not chosen for further analyses.

A NIKON SM-5 stereomicroscope was used to examine the samples (magnification from 6.7 to 45 times with a 10x eyepiece). Samples were illuminated by natural sunlight. No sample preparation was necessary (Coho 1996, 73; Haerinck 2002, 248-252; Nowick *et al*. 2005, 837-842).

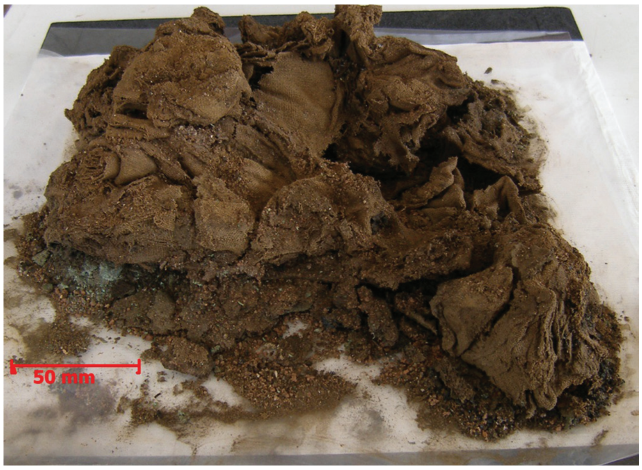

Fig. 1. Most of textile Y1 has been preserved in a unified, folded mass. Scale bar 50 mm (© authors).

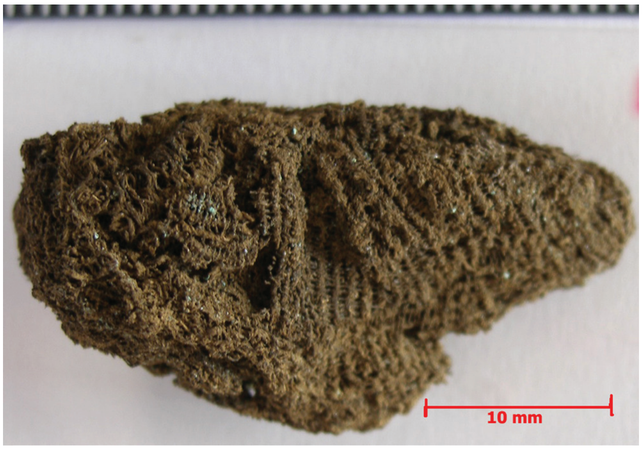

Fig. 2. Textile Y2 has been preserved in multi-layered fragments. Scale bar 10 mm (© authors).

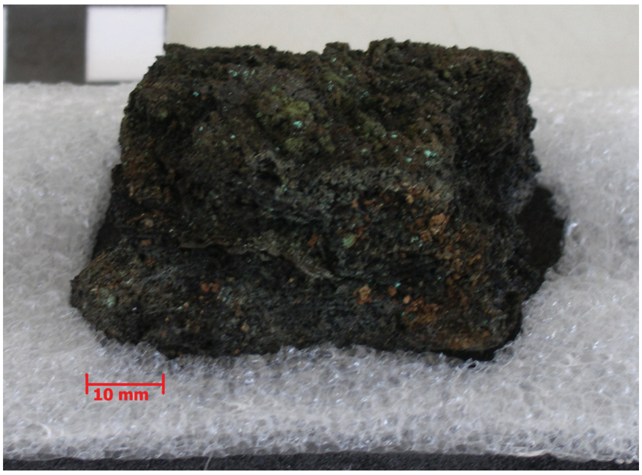

Fig. 3. Textile Y3 has been preserved in multi-layered fragments. Scale bar 10 mm (© authors).

Table 1. Stereomicroscopy results.

Textile	Element	Weave type	Weave count/cm^2	Twist	Yarn diameter
Y1	warp	plain	16	2-ply, S	0.8± 0.2mm
	weft		16	2-ply, S	0.8± 0.2mm
	selvedge		22 warps x 7 wefts	2-ply, S	0.8± 0.2mm
	starting edge	plait	6 turns/cm	2-ply(?), S	1.5± 0.2mm
Y2	warp	open plain	16	single-ply, Z	0.3± 0.1mm
	weft		48	single-ply, Z	0.1± 0.05mm
	selvedge		16 warps x 48 wefts	single-ply, Z	warps 0.4± 0.1mm wefts 0.2± 0.1mm
Y3	warp	weft-faced	7	single-ply, Z	0.8± 0.1mm
	weft		27	single-ply, Z	0.4± 0.1mm
	starting/side edge	6 warps wrapped by 1 weft		single-ply, Z	

A PHILIPS XL30 Environmental Scanning Electron Microscope (magnification up to 50,000) was used. The water vapour flooding the chamber gas prevented charging of organic specimens, hence coating was not necessary. The samples were inserted into the chamber secured to aluminium stubs with double-sided adhesive tape. Accelerating voltage of the beam was kept at 15keV to minimize the risk of localised damage to the samples caused by heating. Magnification was at 400 times. No sampling preparation was necessary. The high-magnification images produced enabled identification of the fibres by their morphology (Jakes and Sibley 1989, 239; Coho 1996, 73-76; Moulhérat *et al.* 2002, 1395; Bertrand *et al.* 2003, 388; Müller *et al.* 2004, 178-179; Garside and Wyeth 2006, 90; Joosten *et al.* 2006, 170;).

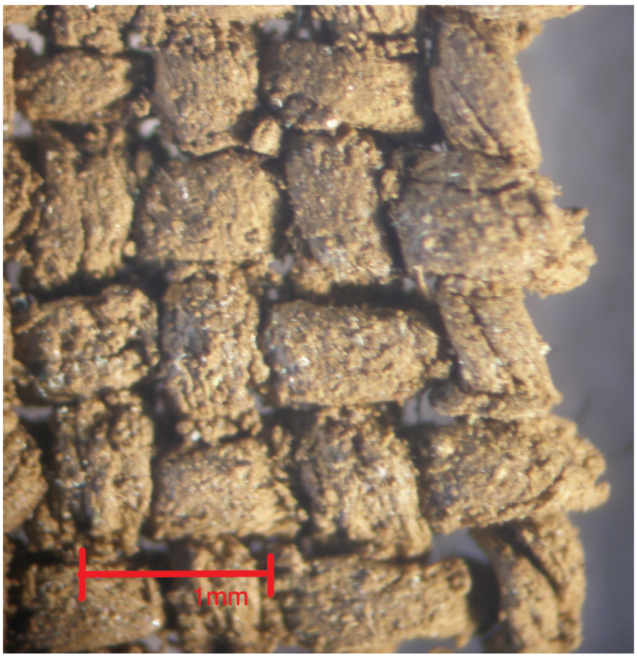

Fig. 4. Textile Y1 is a balanced plain weave fabric. Scale bar 1 mm (© authors).

The PHILIPS XL30 ESEM was coupled with an x-ray microanalyser (EDAX CDU LEAP Detector, using the eDX© software), which allowed qualitative elemental analysis of the sample simultaneously with the microscopic imaging. Three measurements were taken from different areas of each sample. In order for the analysis to be performed, the working distance was reduced to 10 mm. Spot analysis was carried out, and a minimum of 600 counts acquired. In each case the x-ray spectrum between 0 and 14 keV was recorded. The aim of this analysis was to perform qualitative elemental analysis of the samples that would provide evidence of the type of preservation and/or enhance information for fibre identification.

As with EDS analysis, the objective of XRF examination was also to confirm the type of preservation and enhance fibre identification by qualitative elemental analysis of the samples. A BRUKER portable XRF (AXS Tracer III-V) was used for the analysis. This is a versatile instrument that offers a specified elemental range of Z=19 and above in air (and Z=11 and above in vacuum) with detection limits similar to SEM-EDS, using a rhodium anode operating at 40 kV. Samples were placed on the window of the instrument in air, and each one analysed for 60 seconds. The S1P-XRF© software was used to process the spectra, while MS Excel© was used to further process the numerical data. Although the hardware itself seems ideal for the convenient elemental analysis of all manner of textiles, the associated software proved less user-friendly. An unspecified autogain varied amongst spectra, so that the apparent counts registered for an element in one

Fig. 5. A starting edge of Y1 in a plait shape. The weave changes from balanced plain weave to weft-faced plain weave for 1 cm width before the plait. Scale bar 1 mm (© authors).

Fig. 6. An example of a Y1 fragment where stitching is shown connecting two selvedges. This could indicate that narrower strips of fabric were connected to produce a larger piece. Scale bar 1 mm (© authors).

spectrum could not be compared directly with that in a second spectrum. In an attempt to normalise the data, the spectral counts for each element were ratioed to that of rhodium in every spectrum. The Rh peak (Lα_1 2.70 keV) arises from the primary x-rays, which are generated inside the x-ray tube and then scattered by the specimen.

FTIR spectroscopy was applied to enable fibre identification, by comparison of the characteristic peaks for the major organic polymers present in the spectra of the samples, with those of reference samples (Jakes and Sibley 1989, 240; Gillard *et al*. 1994b, 187; Chen *et al*. 1996, 222; Bertrand *et al*. 2003, 391; Edwards and Wyeth 2005, 310; Margariti *et al*. 2010, 162). The spectral range of the technique applied is expressed in wavenumbers (cm^{-1}) from 700 to 4000 cm^{-1} (Skoog *et al*. 1998, 404).

A Perkin-Elmer FTIR Spectrum One instrument attached to an optical microscope in reflectance mode was used. Samples were scanned 32 times with a resolution of 4 cm^{-1}, resting on a microscope slide with a gold mirror base. The microscope apperture was adjusted to 70 x 100 µm. Grams AI v8© software was used to process the spectra produced. No sample preparation was necessary (Margariti *et al*. 2011, 525).

Results

Stereomicroscopy

Stereomicroscopy clearly showed the method of construction of the fabric and the yarns (Emery, 1994) (Table 1). Textile Y1 is a balanced plain weave fabric (Fig. 4) with several technological features, such as selvedges, starting edges and stitching (Figs 5, 6). It is constructed from more than one narrow piece of textile, stitched together along their selvedges.

The starting edge is the end of a woven fabric where weaving has commenced (Hoffmann, 1964, 420). There are two main methods used for starting edges: 1) weaving, where the band is first woven and then transferred to the loom when the wefts become the warps, creating a starting border (Hald 1980, 157-158; Hoffmann 1964, 151, 154, 420), and 2) sewing or otherwise attaching, where the warps are attached to the loom from the beginning, creating a heading cord (Hoffmann 1964, 419).

Textile Y2 is a very fine fabric of open plain weave (Fig. 7), where selvedges have also been kept (Fig. 8). Textile Y3 is a weft-faced plain weave fabric (Fig. 9) with certain technological features such as starting/side edges (Fig. 10). The starting/side edges have been kept. No selvedges were identified.

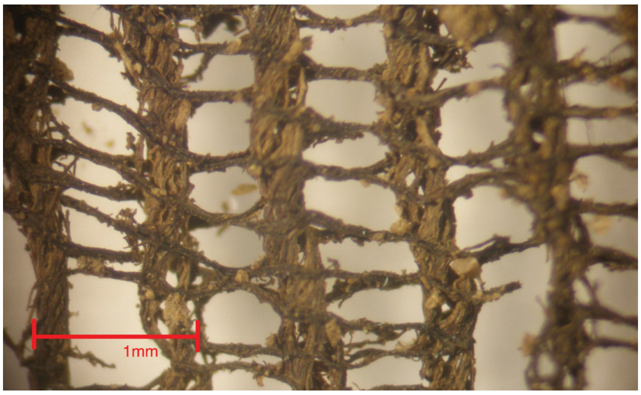

Fig. 7. Textile Y2 is a very fine fabric of open plain weave. Scale bar 1 mm (© authors).

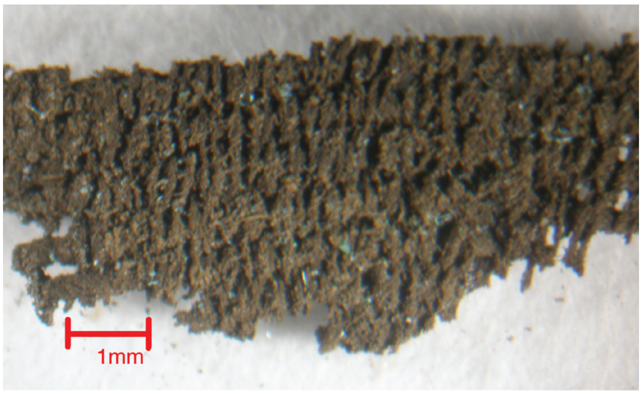

Fig. 8. Textile Y2 selvedge. Scale bar 1 mm (© authors).

ESEM

ESEM examination provided some indication of the morphology and dimensions of the fibres of the three textiles. Although significantly masked by degradation products, the Y1 textile fibres (warps and wefts are the same) seem to have a cylindrical shape and average diameters 15 to 20μm, which is indicative of flax fibres (Margariti *et al*., 2011) (Fig. 11). This is also the case for Y2 and Y3 warp fibres. The Y2 textile weft fibres seem to have pronounced striations along their length and a seemingly triangular, compact cross-section, indicative of wild silk fibres (Good 2010; Good *et al.* 2009; Sawbridge and Ford 1987; The Textile Institute 1975) (Fig. 12). The Y3 textile weft fibres seem to have been preserved as negative casts, on the inner surface of which, a pattern indicative of the epithelial scales of wool fibres was observed (Sawbridge and Ford 1987; The Textile Institute 1975) (Fig. 13). It was also confirmed that the debris present in large amounts in all three trays mainly consists of fragmented fibres.

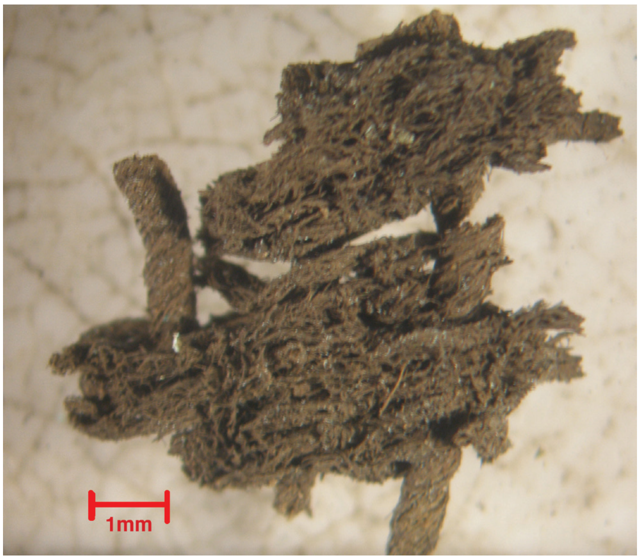

Fig. 9. Textile Y3 is a weft-faced plain weave fabric. Scale bar 1 mm (© authors).

EDS

In textile Y1, copper was detected, but its signal was not intense, suggesting that the Y1 textile was not in close contact with the copper vessel. In textile Y2, copper gave an intense signal in the case of certain samples, especially those taken near the selvedge areas, but was only detected in trace amounts in others. These results suggest that textile Y2 was closer to the copper vessel than textile Y1. In textile Y3 the copper signal was intense in all samples (Fig. 10), suggesting that textile Y3 was more in contact with the copper vessel than the other two textiles. Sulphur was detected in the Y3 weft sample, suggesting the presence of wool fibres (Tímár-Balázsy and Eastop 1998, 48-55).

XRF

High amounts of copper are present in all samples, especially Y2 and Y3, consistent with their preservation by copper impregnation and mineralisation. Both white samples of Y1 and Y2 appeared to have a lower copper content. However, XRF was unable to confirm fibre identification of the Y3 weft fibres (which could possibly be wool fibres as ESEM indicated). This could be in part because a larger area analysis was performed (so that a lower sulphur count would be expected), but more likely relates to the altered autogain due to the high copper content, such that signals at low energy were of much reduced intensity.

Fig. 10. **Starting/side edge of textile Y3. The warps have the characteristic green colour of copper oxidation products, whereas the wefts have a brown colour. Scale bar 1 mm (© authors).**

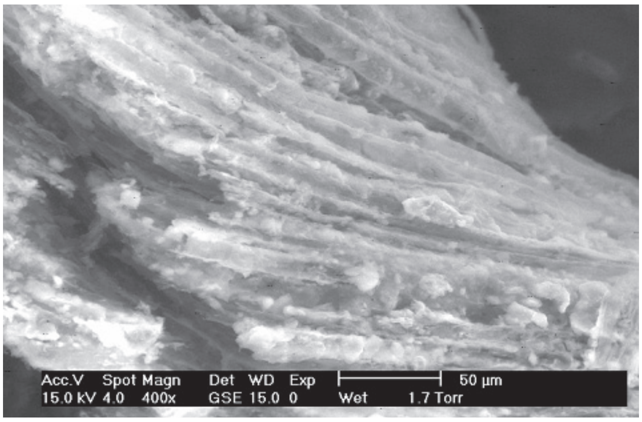

Fig. 11. Scanning electron micrograph of Y1 fibres. Fibre diameter ranges from 15 to 20 μm (© authors).

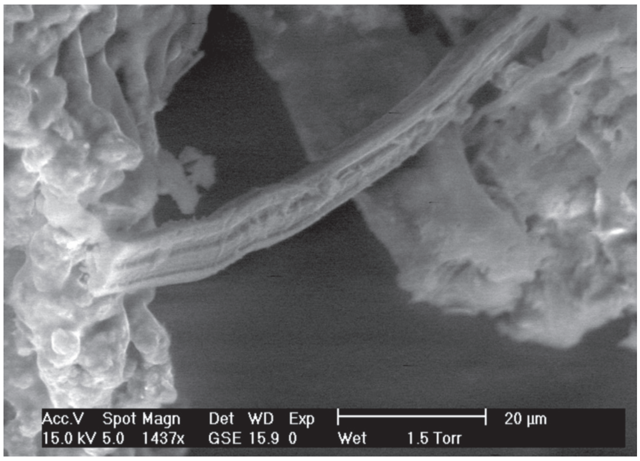

Fig. 12. Y2 weft fibres imaged in the ESEM. The fibre protruding from the degradation products has pronounced striations along its length and a seemingly triangular, compact cross-section (© authors).

FTIR microspectroscopy

The textile Y1 warp and weft fibres gave similar spectra, characteristic of an organic material. Comparison of Y1 spectra with those of the references suggests a plant fibre (Fig. 14), the signature peaks of cellulose were evident, although somewhat shifted towards the higher end of the spectrum (*i.e.* 2927 cm^{-1}, 1657 cm^{-1}, 1162 cm^{-1} and 1124 cm^{-1}). The Y2 warp and weft fibres gave almost identical spectra, which were more suggestive of proteinaceous than cellulosic fibres (Fig. 15). Although tentative, identification as silk seems more likely than wool as there are peaks in common with the copper oxohydroxide treated silk spectrum (1663 cm^{-1}, and 1260 cm^{-1}). The patterns of the textile Y3 wefts are once again indicative of proteinaceous rather than cellulosic fibres, although the distinction between silk and wool is not clear (Fig. 16).

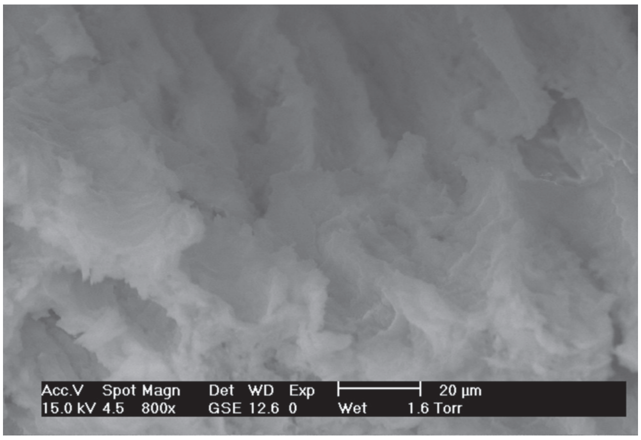

Fig. 13. Scanning electron micrograph of Y3 weft fibres. Negative casts of the fibres seem to have been preserved. A pattern indicative of the epithelial scales of wool fibres is observed (© authors).

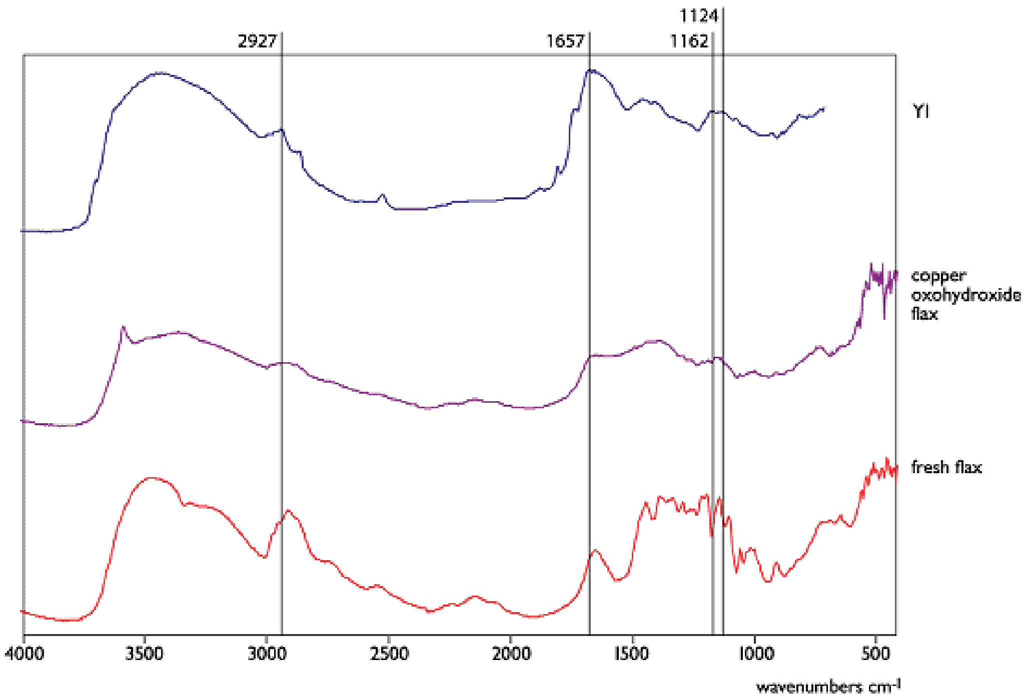

Fig. 14. FTIR microscope reflectance spectra of Y1 (top), and the reference samples: a) copper oxohydroxide treated flax (middle), b) 'fresh' flax (bottom) (© authors).

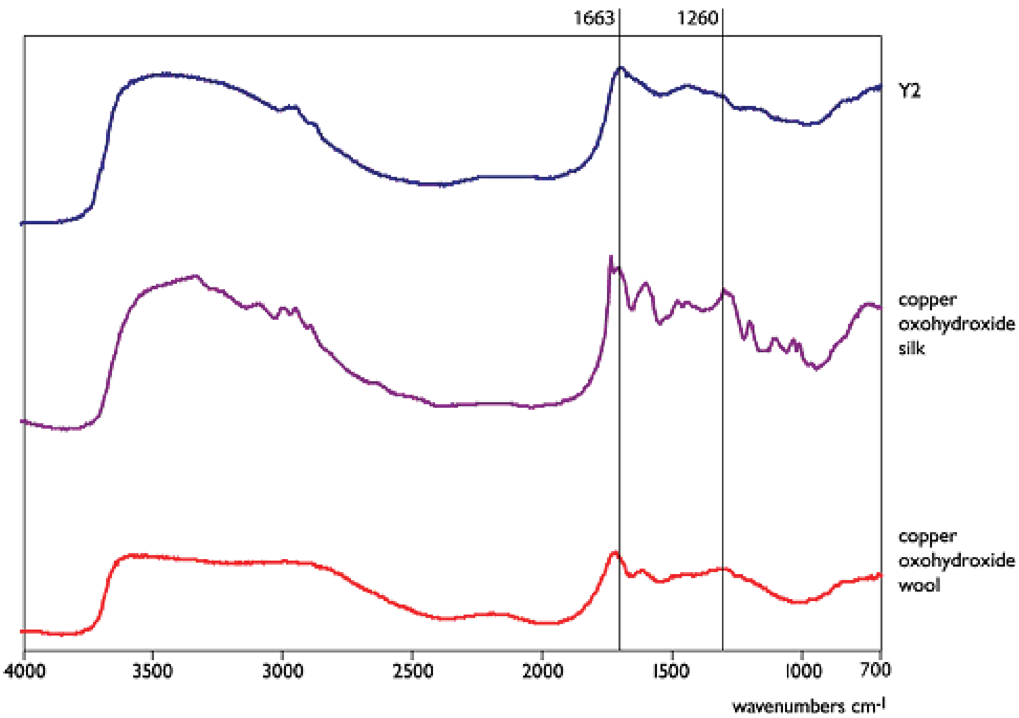

Fig. 15. FTIR microscope reflectance spectra of Y2 (top), and the reference samples: a) copper oxohydroxide silk (middle), b) copper oxohydroxide wool 1 (bottom) (© authors).

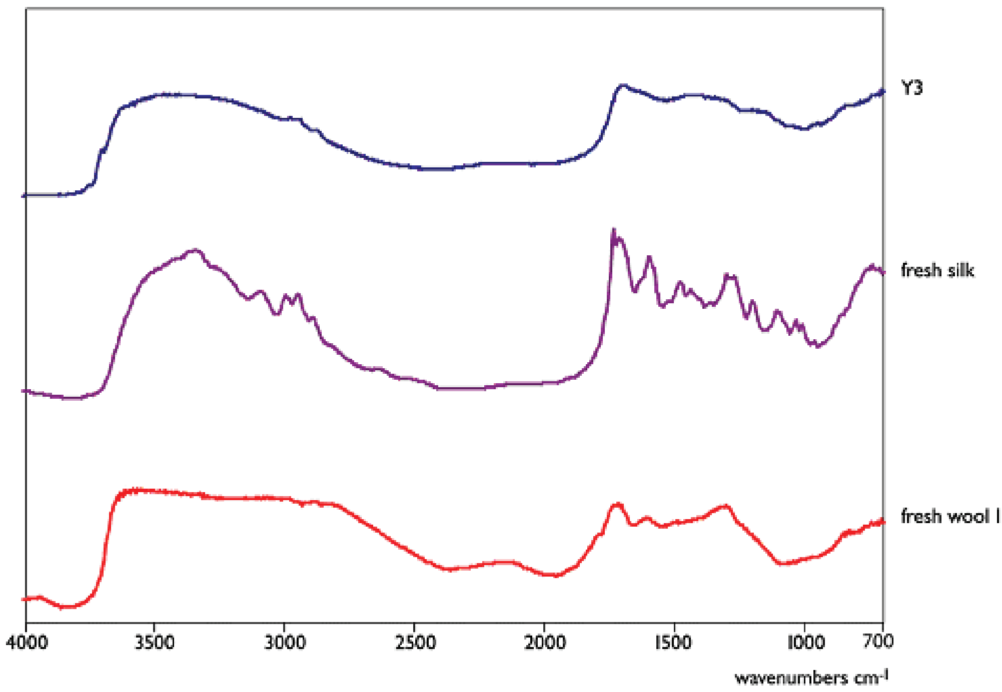

Fig. 16. FTIR microscope reflectance spectra of Y3 (top), and the reference samples: a) 'fresh' silk (middle), b) 'fresh' wool (bottom) (© authors).

Discussion

The application of stereomicroscopy was useful in identifying the method of construction of the three textiles and their yarns. Selvedges and starting edges have been retained. It is constructed from more than one narrow piece of textile, stitched together along their selvedges. Textile Y2 is a very fine fabric of open plain-weave. Selvedges have also been retained. Textile Y3 is a weft-faced plain-weave fabric with evidence of starting/side edges, but none of selvedges.

The ESEM provided much higher magnification and allowed examination of the whole surface of the samples. It therefore provided some indication on fibre identification and much information on the characterisation of the condition of the fibres. Textile Y1 (both warps and wefts) and the warps of textiles Y2 and Y3 are possibly made of cellulosic, probably bast fibres. The wefts of textile Y2 could be made of wild silk fibres, and the wefts of textile Y3 were possibly made of wool. A more comprehensive reference collection would be necessary for conclusive fibre identification.

The outcomes of ESEM-EDS and XRF were consistent and characterised the type of preservation. Both techniques showed that copper and iron were mainly responsible for the preservation of the Argos find. ESEM-EDS further aided fibre identification in the case of the Y3 wefts, by detecting sulphur, which is indicative of wool fibres. Sulphur could, of course, arise from a source of contamination; nevertheless, it was only detected in the Y3 weft fibres and in no other fibres or the debris.

FTIR microscopy provided information on the characterisation of the condition of the textiles by indicating that they were heavily masked and/or impregnated by degradation products but there were organic remains still present. Fibre identification results were inconclusive, yet consistent with the ESEM results, thus complementing fibre identification conclusions.

In general, the results from all techniques were consistent. Consistency was very important since no one technique was sufficient to provide reliable results, especially as far as fibre identification was concerned. For example, ESEM analysis indicated textile Y1 was made of cellulosic, probably bast fibres, which was further suggested by FTIR analysis. Similarly, ESEM revealed a pattern reminiscent of wool epithelial scales in Y3 weft fibres, which was consistent with the detection of sulfur by ESEM-EDS analysis.

Conclusion

The information drawn from these analyses could be used to better illustrate the way the textiles had been placed in the funerary vessel. A significant number of Y3 fragments are green-coloured, which, as analysis showed, means that they are impregnated/masked by copper degradation products. In addition, the Y3 fibres seem to be mainly preserved as negative casts. Iron, which was present in the vessel, is generally responsible for the creation of negative casts of textile fibres (Gillard *et al*. 1994a, 133, 137-138; Coho 1996, 70; Janaway 1989, 21). These results indicate that Y3 was the textile most likely to have been in direct contact with the degrading metals of the funerary vessel, and therefore it is reasonable to deduce it must have been the textile laid at the bottom of the copper vessel.

The main mass of Y1 consists of multiple layered folds of cloth, which also contain the fruit offered and the bones of the deceased. There are very few Y1 fragments impregnated with green copper degradation products, hence this textile must have not been in direct contact with the funerary copper vessel. Therefore, Y1 is most likely to have been the textile used to wrap the both the deceased's bones remaining from the pyre (and possibly ashes) and the fruit offered at its funeral, and then placed on Y3.

The Y2 single-layer fragments were detected adhered to the top surface of the Y1 unified mass. On the other hand, three-dimensional Y2 fragments, consisting of multiple single layers, have been found around the edges of the Y1 unified mass. The bottom side of several of them, along with certain selvedge fragments, had a bright green colour, indicative of impregnation and hence direct contact with the copper corrosion products. Therefore, the fine, semi-transparent Y2 textile may have been laid on top of Y1 to cover it, the remaining width, gathered around the edges of the folded Y1, coming in contact with the sides of the copper funerary vessel.

Although the quality of these analytical results might be hindered by the poor condition of the specimen and/or limited sources of reference, the combination of the results from all techniques applied revealed information on the find that should be useful both to the conservator and the archaeologist and textile historian.

Acknowledgements

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Articles

Irene Skals and Ulla Mannering

Investigating Wool Fibres from Danish Prehistoric Textiles

Introduction

Analysis of prehistoric textile fibres by means of a transmitted light microscope or a scanning electron microscope is a method used for identifying fibre materials, distinguishing characteristic features in the surface structure of fibres and determining the degree of degradation of a textile. The study of wool fibre fineness by measuring fibre diameter is an additional possibility for characterising fibres. The latter method was developed by the wool industry. It was adapted to the study of prehistoric fibres by Michael L. Ryder from the 1960 to the 1980s and further applied by, among other scholars, Penelope Walton and Jerzy Maik (Bender Jørgensen and Walton 1986; Maik 1998; Ryder 1969; 1983; Walton 1990). By comparing the measurements from prehistoric wool fibres, in particular to the so-called primitive sheep breeds, Ryder was able to draw conclusions about ancient sheep breeds and determine the fleece types of prehistoric sheep. Wool samples from several of the prehistoric Danish textiles were used to qualify the kind of fleece available at the time.

Recently, systematic investigations of wool fibres from prehistoric Danish textiles have been undertaken by the Danish National Research Foundation's Centre for Textile Research as part of a project studying Danish Bronze and early Iron Age textiles. This has resulted in a large amount of new information, for instance regarding the production, provenance and design of the textiles. In collaboration with the National Museum of Denmark, analysis of wool fibre diameters began with the early Iron Age bog textiles. It was planned not only to follow the standards developed by Ryder, who used statistical calculations of a minimum of 100 measurements from each yarn and plotted these into histograms to distinguish fleece types (Ryder 1969; 1983, 45-49), but also to implement the method developed by Antoinette Rast-Eicher which uses a new categorisation system to interpret the processing of the raw wool (Rast-Eicher 2008, 153-155).

Rast-Eicher's system is based on a categorisation of sheep's wool developed in the late 19th and early 20th centuries (Stieger 1888; Frölich *et al*. 1929) with a distinction between four main wool types, and a classification of wool qualities such as underwool, medium fibres and hair or kemp based on the percentages of fibre types. By looking at parameters such as the number of fine fibres, the uninterrupted range, the mode and the maximum measurements, Rast-Eicher has introduced a classification system containing 11 different categories. The categories are labelled using different combinations of capital letters, AAA being the group with the highest percentage of fine fibres and F the group with the lowest (Rast-Eicher 2008, 155).

The first results from the Danish early Iron Age bog textiles were surprising, not so much because of the fleece type that the histograms illustrated but because of the fineness of the fibres measured and the extent of homogeneity. The measurements differed from previous reports (Bender Jørgensen and Walton 1986; Ryder 1990; Walton 1990) and initiated a study of the methodology, with crosschecking of the results using different methods and different magnifications of capturing images resulting in an increased interest in analyses of fibres from different archaeological contexts (Skals *et al.* forthcoming). Textiles from Roman Iron Age burials were added to the analyses and an extensive analysis of the textiles from the Bronze Age is in its final stages. Altogether this has yielded invaluable information about the wool available for garments from roughly 1500 BC to AD 400.

The methodology and the results from the investigation of the different ways of capturing images are described in detail elsewhere and the focus in this article will be on the interpretation of the results (Skals *et al.* forthcoming). It should be noted that in some of the analyses the photos were captured at 40x magnification whereas it was at 100x magnification in others. The measurements can be made with greater precision and are generally higher by a few microns at higher magnification but this does not make any difference to the extent of homogeneity. Plotted in the histogram the curve of the peaks from the results at low magnification will be positioned slightly more to the right on the x-axis (Fig. 1).

An important parameter extracted from the fibre measurements is whether the statistical mode, i.e. the most commonly occurring diameter measurement, is below or above 20 microns. The reason why this is important is because wool from the wild ancestor of sheep had a fleece consisting of many very fine fibres with a mode below 20 microns and bristly kemp fibres which could measure more than 100 microns. The evolution of sheep and their fleece has shown that wool fibres gradually became more uniform and the coarse kemp disappeared, which resulted in a coarsening of the mode. The mode is therefore an indication of how closely related the sheep that provided the wool for the textiles were to their wild ancestors (Ryder 1969; 1983, 45-49; 1990; Rast-Eicher 2008, 121-122).

Another important parameter is the range of the measurements. Each histogram will, expressed in percentage terms, have a coherent range consisting of the majority of the fibre measurements, but can also have outliers which will show up as small peaks along the x-axis. The peak heights are determined by the percentage measurements calculated in two micron intervals (Fig. 2). The quantity of the outliers and their position on the x-axis are a further indication of the wool type, but are also indicative for the interpretation of the way it was processed. As the mix of very coarse fibres measuring more than 100 microns and even fibres measuring more than 60 microns with the very fine fibres would have made spinning more difficult, the number of coarse fibres in the textile samples is interpreted as reflecting attempts to deliberately remove the coarse hair before spinning (Rast-Eicher 2008, 123).

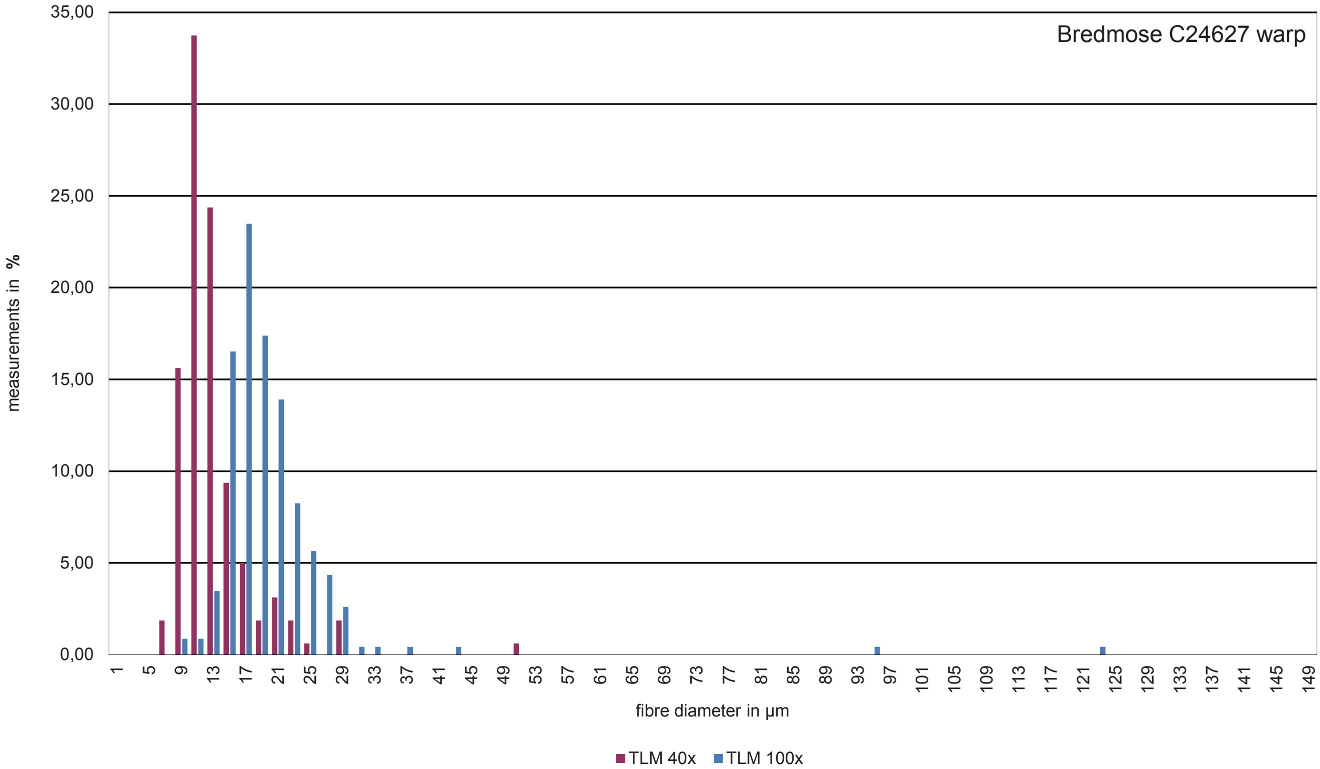

Fig. 1. Two separate pieces of the same yarn sample from a Danish early Iron Age bog textile was analysed at 40x and 100x magnification. The coherent curve from the measurements using low magnification is slightly to the left of the one from measurements using high magnification. The difference in the amount of outliers is due to the fact that different parts of the yarn sample were analysed.

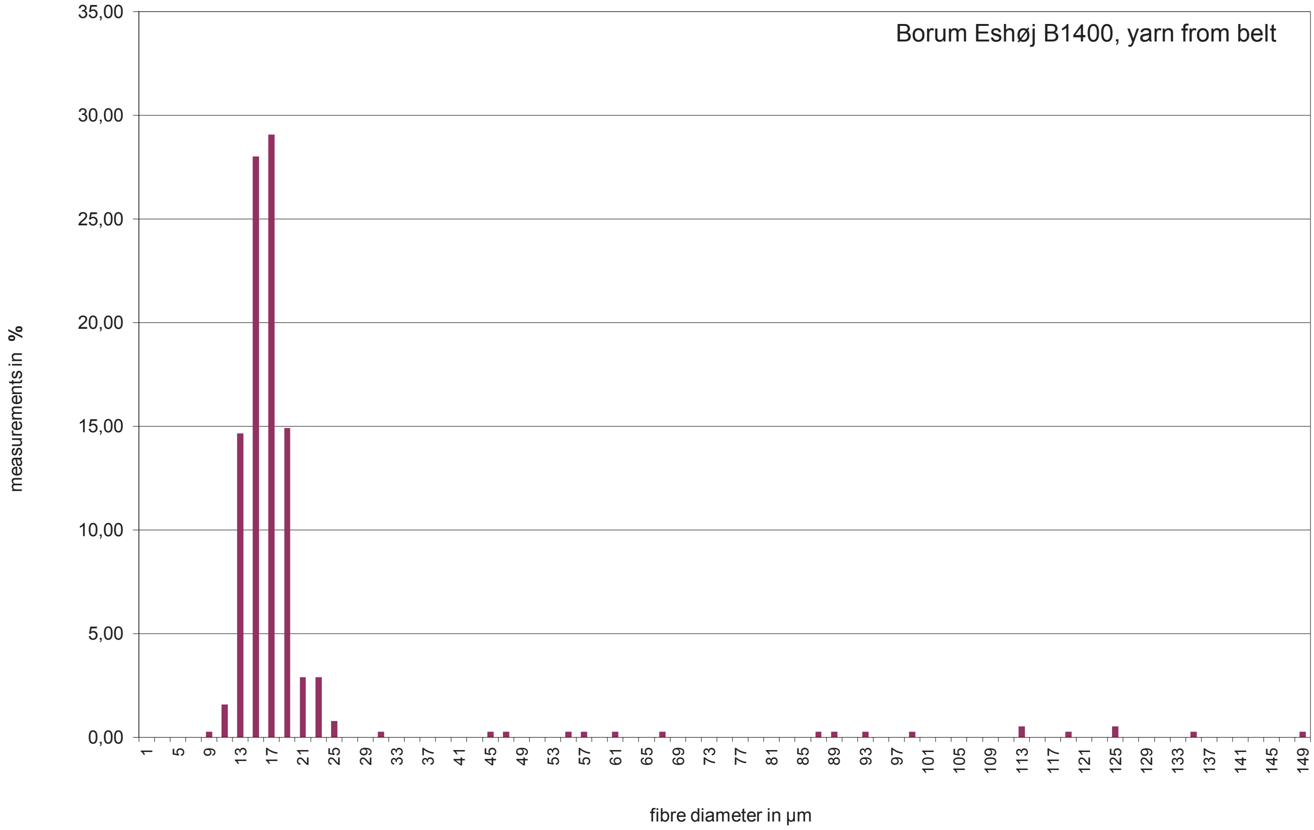

Fig. 2. This histogram shows the distribution of wool fibres in a Danish early Bronze Age textile. The fibre distribution with many fine fibres is indicated by a narrow coherent range while the many coarser outliers are spread along the x-axis.

The fibre analyses of several contemporary sheep fur garments preserved in the Danish bogs have shown that these furs do not represent a standard textile fleece with a mix of fine and coarse fibres but appear to have been chosen for their special fibre qualities and with a specific use in mind (Mannering and Gleba forthcoming). Although the fibre diameter measurements from the textiles show a clear connection between the wool in the textiles and the furs, the furs do not represent the unprocessed prehistoric wool, but were selected specifically for their fine and soft appearance (Ørsted Brandt *et al.* 2014). On this basis it must be concluded that the amount of coarse fibre in the original raw wool used for the Danish prehistoric textiles is still not known. An evaluation of the way the fibres were processed is thus best assessed by comparing the ranges of the diameter measurements and the amount of outliers in the yarn samples.

Fibres in Danish early Iron Age bog textiles

Many of the Danish early Iron Age bog textiles have patterns of checks and stripes in different colours and 26 of these textiles were selected for fibre analysis with the aim of covering a period from c. 800 BC to AD 400, representing different types of garments, weaves and qualities. This has resulted in analyses of samples from 68 yarns. Two samples from each type of yarn in the textiles were picked at random. The fibres were measured on digital images captured using transmitted light microscopy and the results from the two yarn samples were combined to secure maximum statistical significance.

The calculations of the mode turned out to be below 20 microns in all samples with a large majority at 13 microns (Fig. 3). This is not only an indication of a significant homogeneity in the wool but also explains the extreme softness of these textiles, as this depends on the fineness of the fibres. It should be borne in mind that the exact position on the x-axis of the mode can vary up to a few microns depending on the method of fibre measurement and the magnification used for capturing the fibre images, but nevertheless it is evident that the Danish early Iron Age wool was very fine (see Fig. 1) (Skals *et al.* forthcoming).

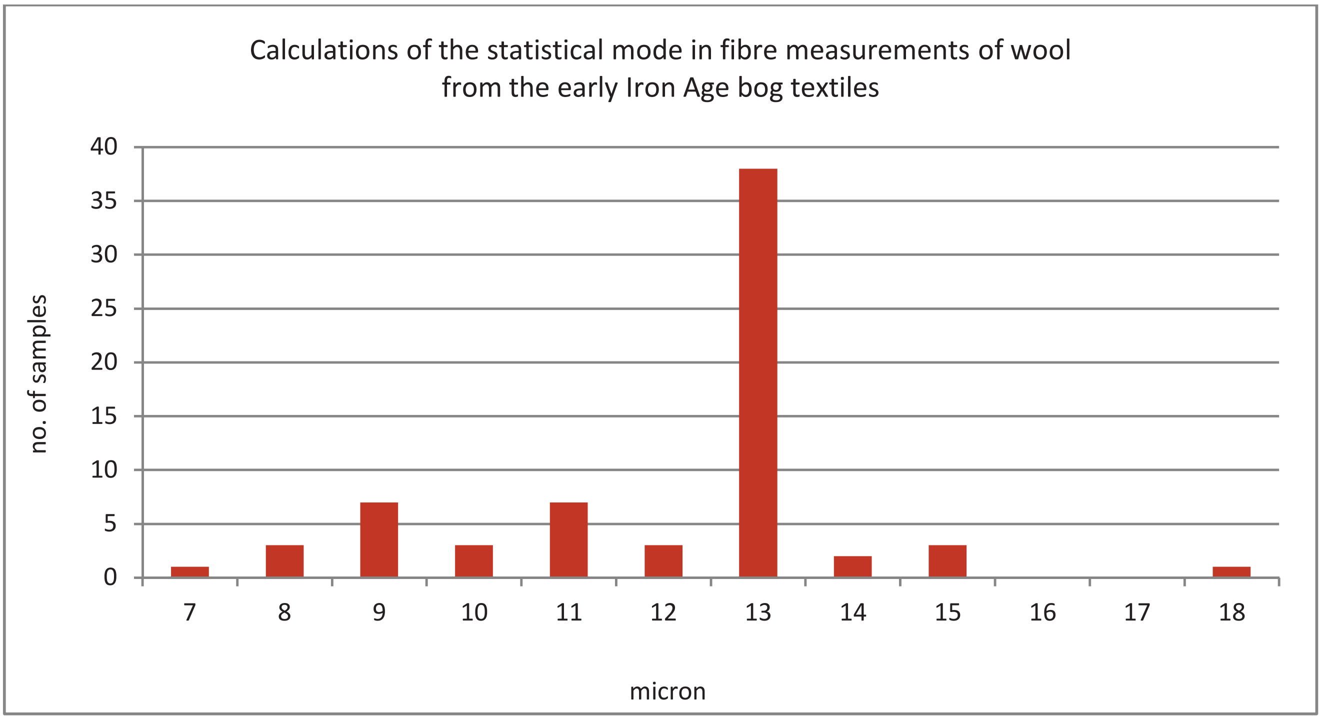

Fig. 3. The wool from the Danish early Iron Age bog textiles appears very fine and homogeneous and the statistical mode is in most cases 13 microns. These results were obtained using 40x magnification and referring to Fig. 1 they can be slightly higher using a higher magnification but would still be below 20 microns.

We found similar homogeneity in the range of fibre measurements and the amount of outliers. In 32 of the 68 samples the fibres measured less than 30 microns and in a further 15 samples only one outlier was detected (Table 1). This makes it possible to characterise the wool processing method solely by the number of outliers above 30 microns. In the categorisation system the coarseness of the outliers as well as their amount determine the assignment of the category and the characterisation of the wool will appear slightly different (Fig. 4). In the present investigation, 35 samples are categorised as AAA according to Rast-Eicher's system representing samples with only 1% of the measurements above 30 microns and none above 40 microns. The categories AA, A and AB are samples with increasing amounts of outliers between 40 and 60 microns and represent a very small number of samples.

The second largest group of 18 samples are assigned to category B. The fibre combinations in these samples are 99-94% of the fibres measuring less than 25 microns and 1-6% measuring more than 60 microns. It is not because of a decrease in the number of fine fibres but because of the coarseness of the outliers that the samples are categorised as B. In this case, the borderline of 60 microns for the coarse fibres is more important than the high number of fine fibres. This distinction is made because fibres measuring more than 60 microns are generally defined as 'hair' and above 100 microns as 'kemp', but in the case of these wool samples it seems that category B fails to give the proper impression of the fineness of the wool. The same applies to the remaining ten Danish early Iron Age textile samples, which are categorised as CD, D and E. All of these have very high percentages of fine fibres (above 90%) and 1-6% of outliers measuring more than 60 microns.

An additional factor that has complicated the use of the known categorisation systems is the fact that during our investigations it became apparent that the coarse fibres were very unevenly distributed in the yarns. We found that two separate analyses of fibres cut from the same yarn sample could give quite different results (Skals *et al*. forthcoming). This illustrates the

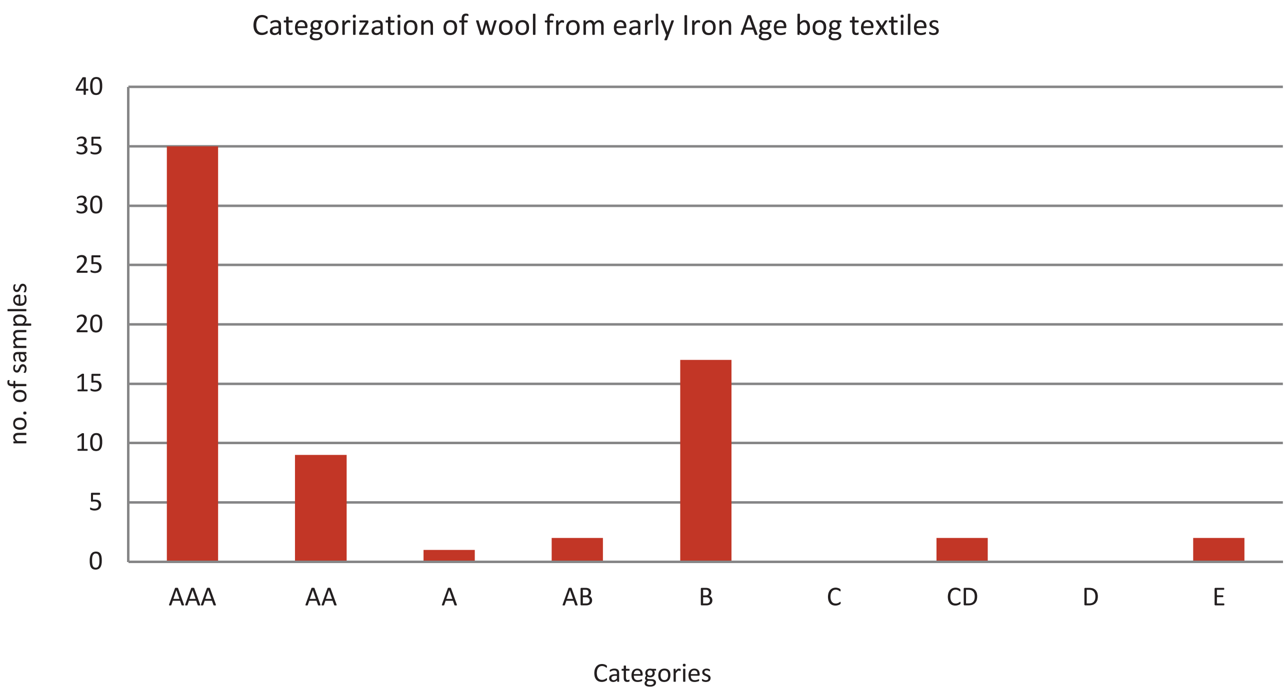

Fig. 4. The homogeneity of the diameter measurements from the early Iron Age burial textiles is illustrated by the very high number of samples in category AAA. Category B represents samples with a very narrow uninterrupted range and 1-2% fibres coarser than 60 microns.

Table 1. Many samples have no coarse fibres and in 15 samples only 1% of the diameter measurements are above 30 microns. Between three and ten % coarse outliers are recorded in a few samples.

Range and % of outliers in fibre diameter measurements. Wool from Early Iron Age bog textiles.										
range	**% of outliers in samples**									
measurements	0	1	2	3	4	6	8	9	10	no. of samples
only ≤ 30 µ	32	0	0	0	0	0	0	0	0	32
≤ 30 µ + ≥ 30,5 and ≤ 60 µ	0	7	4	1	1	1	0	0	1	15
≤ 30 µ + ≥ 60,5 µ	0	8	3	0	0	0	0	0	0	11
≤ 30 µ + ≥ 30,5 and ≥ 60,5 µ	0	0	3	2	2	0	2	1	0	10
no. of samples	32	15	10	3	3	1	2	1	1	68

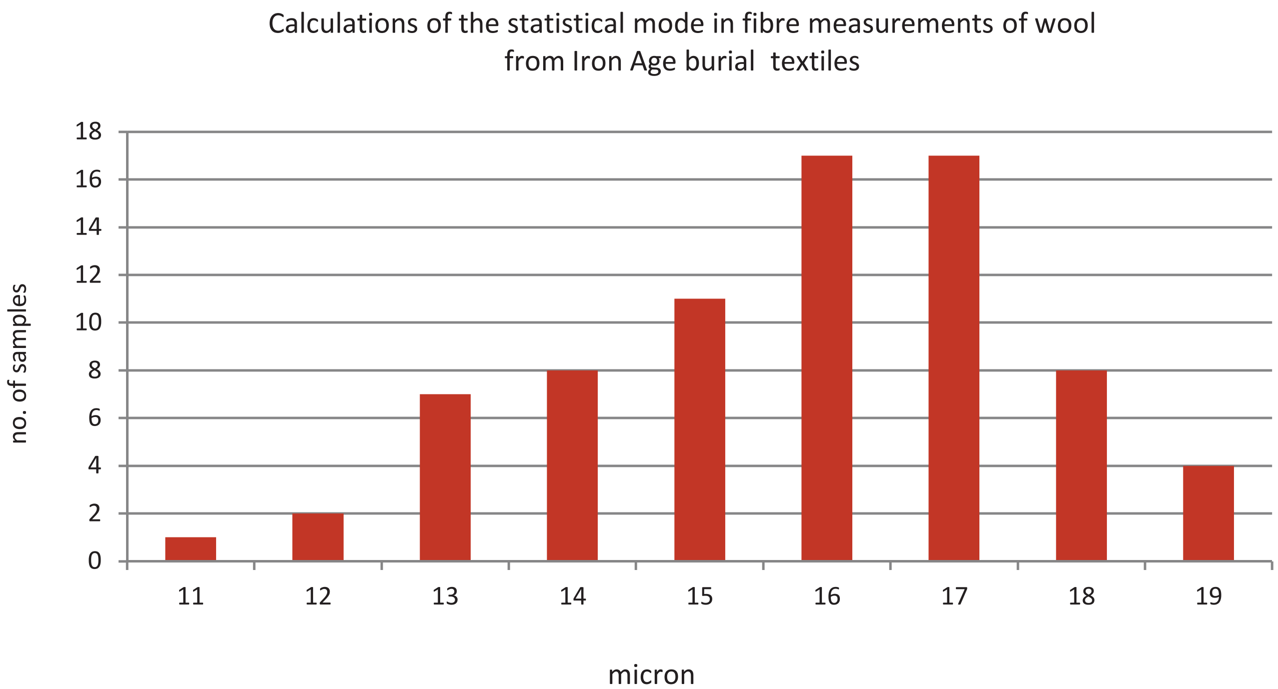

Fig. 5. This diagram sums up the statistical mode calculated from the diameter measurements from the early Iron Age burial textiles which appears different from the bog textiles (cf. Fig. 3). The measurements were made using 100x magnification and the mode is nonetheless in all cases less than 20 microns.

complexity of the textile materials and accentuates the need for evaluation and constant testing of our methods and interpretations, and we recommend that scholars take as many samples and measurements from each yarn as possible to give the statistically most reliable results.

Fibres in Danish early Iron Age burial textiles

Textile samples from 12 early Iron Age graves dated c. 100 BC-AD 300 from three different locations were also selected. All together analyses of 75 different yarns from 35 textiles were made. Compared to the bog textiles, these textiles are considerably more degraded and in most cases constitute only small and extremely fragile pieces. Nevertheless, the results are very similar to the bog textiles and the calculations of the mode are also in these cases below 20 microns and in most cases at 16 and 17 microns (Fig. 5). The reason for the mode being three to four microns higher is believed to be due to the use of higher magnification for capturing the images (see Fig. 1) (Skals *et al.* forthcoming).

The amount and distribution of the outliers in these textiles are similar to the bog textiles. Almost half of the yarns have no outliers and an almost equal number have only one or two outliers. In 13 samples, five to ten outliers were found (Table 2). Category AAA was given to 37 samples and a much smaller number are placed in the following two categories, whereas category B has the second highest number of samples due to 1-2% of outliers measuring more than 60 microns (Fig. 6).

Fibres in Danish Bronze Age burial textiles

So far, 73 yarn samples from 31 textiles have been analysed from the large Danish collection of textiles dated to the early Bronze Age (c. 14th–12th centuries BC). A narrow majority of the samples have a mode at 13 microns and in most cases it is below 20 microns, but compared to the early Iron Age bog textiles a greater variety is seen in the calculations which possibly indicates slight differences in the fibre combination of the raw material (Fig. 7).

The results of the diameter measurements also differ from the early Iron Age textiles by the amount of outliers, which is considerably higher. In only four cases all fibres measure less than 30 microns. In more

Table 2. The amount of coarse outliers is limited in the wool samples from the early Iron Age burial textiles. From three to ten % coarse outliers are recorded in one to five samples.

Range and % of outliers in fibre diameter measurements. Wool from Iron Age burial textiles.										
range	**% of outliers in samples**									
measurements	0	1	2	3	4	5	6	8	10	no. of samples
only ≤ 30 μ	32	0	0	0	0	0	0	0	0	32
≤ 30 μ + ≥ 30,5 and ≤ 60 μ	0	10	6	5	2	1	0	0	1	25
≤ 30 μ + ≥ 60,5 μ	0	10	0	0	0	0	0	0	0	10
≤ 30 μ + ≥ 30,5 and ≥ 60,5 μ	0	0	4	0	2	0	1	1	0	8
no. of samples	32	20	10	5	4	1	1	1	1	75

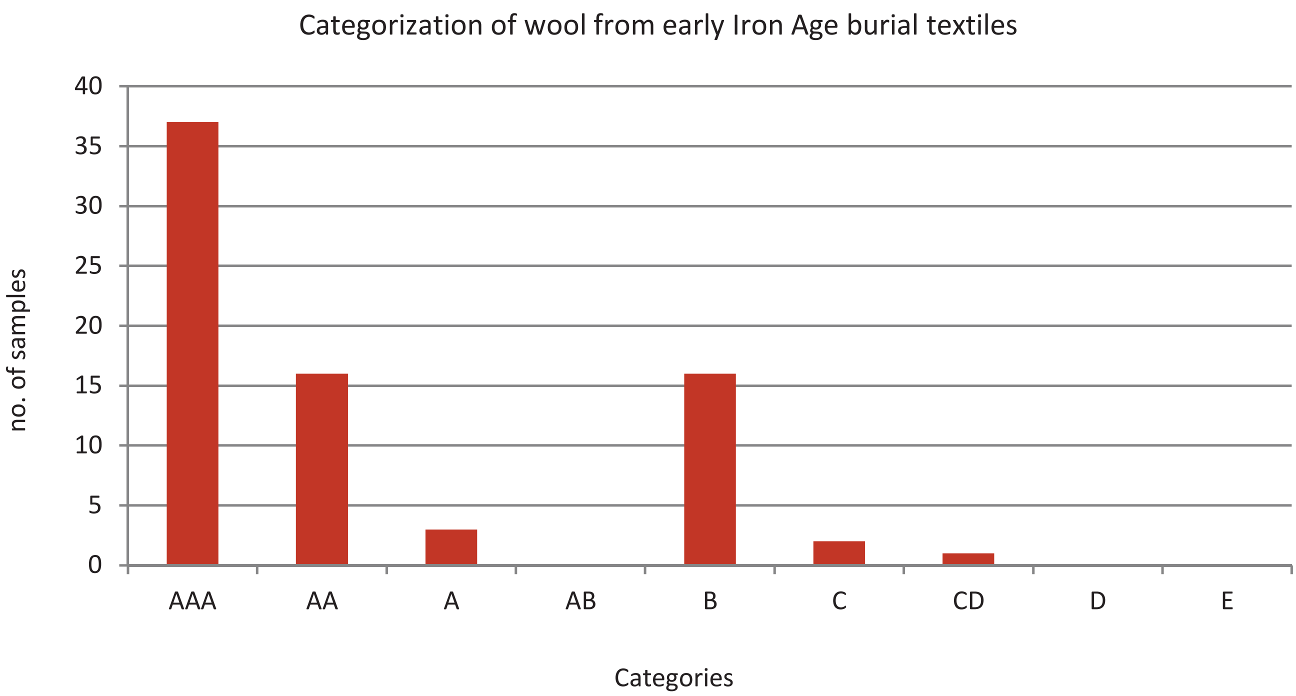

Fig. 6. The diagram of the categorisation of the wool from the early Iron Age burial textiles resembles the one for the contemporary bog textiles with high peaks for categories AAA and B.

Table 3. In the early Bronze Age, coarse fibres are common and samples without any coarse outliers are rare.

Range and % of outliers in fibre diameter measurements. Wool from Bronze Age textiles.											
Range	**% of outliers in samples**										
measurements	0	1	2	3	4	5	6	7	10	12	no. of samples
only ≤ 30 μ	5	0	0	0	0	0	0	0	0	0	5
≤ 30 μ + ≥ 30,5 and ≤ 60 μ	0	3	6	0	1	0	2	0	0	0	12
≤ 30 μ + ≥ 60,5 μ	0	4	3	6	1	1	0	0	0	0	15
≤ 30 μ + ≥ 30,5 and ≥ 60,5 μ	0	0	4	14	6	11	3	1	1	1	41
no. of samples	5	7	13	20	8	12	5	1	1	1	73

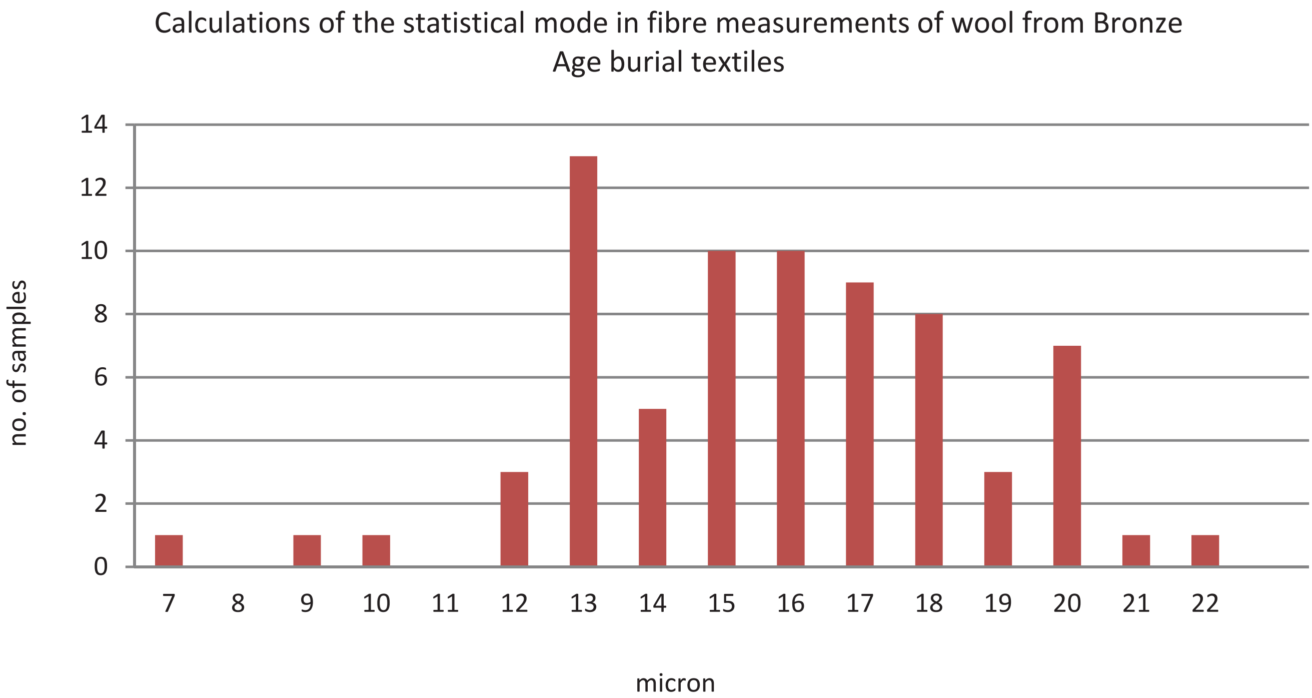

Fig. 7. Many wool samples from early Bronze Age textiles have modes that are below 20 microns, but in two samples it is just above 20 microns.

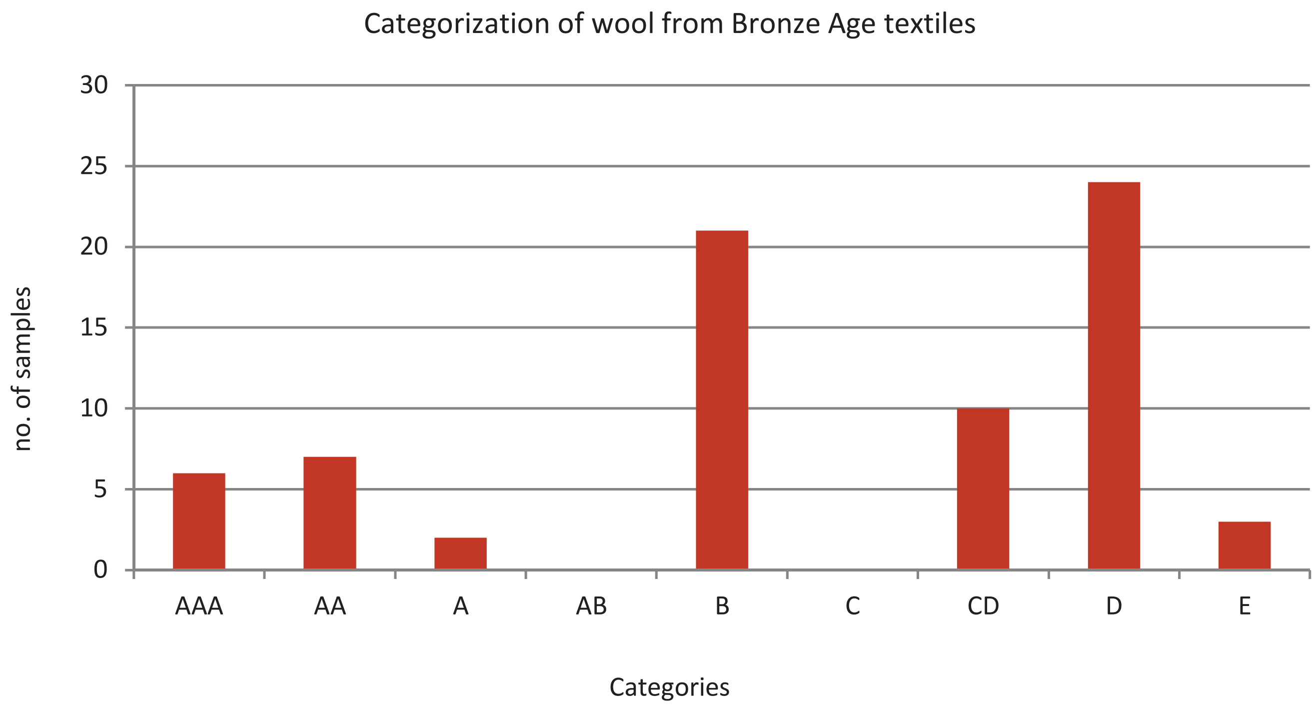

Fig. 8. The large amount of coarse fibres in the early Bronze Age wool is illustrated by the high peaks belonging to categories B and D.

than half of the samples, up to 14 outliers were recorded of which several measure more than 60 microns (Table 3). This is also reflected in the categorisation where the majority of the samples are placed in categories B and D (Fig. 8). Category B is given to samples with one to five outliers measuring more than 60 microns. Unfortunately, no sheep skins have been identified in a Danish Bronze Age context that can be compared to the textiles.

Evaluation and interpretation

During this process of measuring wool fibres from the prehistoric textiles and furs, including the necessary investigation of the methodology, it has turned out that analysis of wool fibre diameter measurements is more complex than anticipated. We discovered that different methodologies like scanning electron microscopy and transmitted light microscopy, and the use of different magnification for capturing the fibre images especially in the light microscope, can give different results. We discovered that the exact same results could not be reproduced from a different sample from the same yarn because of an uneven distribution of the fine and coarse fibres in the yarns. We found that these differences result in slight variations in the calculations of the mode and can result in a different categorisation of two samples from the same yarn. Moreover, we found that the categorisation of samples with narrow uninterrupted ranges below 25 microns and only one percent of outliers above 60 microns needs to be further discussed and evaluated. These discrepancies are extensive and the results from fibre quality analyses need to be carefully discussed and developed before further interpretations can be attempted.

Nevertheless, our results show that wool for textiles in the Bronze and early Iron Ages consisted to a large degree of very fine fibres measuring less than 20 microns, which is extraordinarily fine. Fibre measurements from textiles and furs from Bronze Age finds from Norway, Sweden, Bosnia and Hercegovina have resulted in ranges similar to ours from the lowest measurements of 5-10 microns to between 20 and 30 microns, whereas the results from the Hallstatt wool and furs in most cases show ranges from 9-19 microns to 27-57 microns, although two results have ranges from 7-27/29 microns respectively which could possibly be compared to our results (Rast-Eicher and Bender Jørgensen 2013).

We think that the key parameter for the interpretation of the wool preparation lies in the difference in the amount of coarse fibres before and after spinning, and as no unprepared material exists we must use the amount of coarse fibres in the preserved fleeces and the differences in the amount in the yarns to evaluate this. Our results show that a change in the fibre content of the yarns takes place from the Bronze Age to the Early Iron Age. This is observed in the decrease in the amount of outliers and as the fibre distribution pattern of fine fibres in both periods are similar it indicates that Bronze Age wool was spun without a thorough removal of coarse fibres while in the early Iron Age coarse fibres to a large extent were removed deliberately.

This does not mean that Bronze Age wool in Denmark was not sorted at all before spinning. Dye analyses of the yarns from the Bronze Age textiles have all been negative, but it is still possible to distinguish conscious use of colours in the wool yarns caused by differences in the natural pigmentation in the fibres. This implies that some sorting according to colour took place, while it was not considered important to remove all the coarse fibres. Patterning using pigmented fibres is seen in the early Iron Age bog textiles. Here it co-exists with plant dyeing technology and a more widespread use of white wool (Vanden Berghe *et al*. 2009).

Other analyses of the wool fibres such as strontium isotope analysis have added a further interpretational dimension to fibre studies. Using a systematic analysis of the wool from one of the early Iron Age garments – the so called Huldremose II costume – it was discovered that the wool came from three different locations, of which two were outside the present Danish area. This fact was not visually distinguishable in the yarn for this garment. Neither the measurements of the twist angle nor of the results from the fibre measurements indicated any difference in the wool fibre composition (Frei *et al.* 2009). The non-local wool used in this garment must therefore have been traded but processed locally. As this was the first textile to be tested in this way, we now have to be open to the possibility that wool was traded over long distances and that textiles which to the naked eye look homogeneous may contain wool from mixed fleeces and possibly even different sheep breeds. This is definitely a surprising discovery that emphasises the need for diverse and cautious interpretations.

Although the interpretation and understanding of the results from fibre analyses have proven to be more complicated than expected and new questions have turned up, new information has also been obtained. It can be concluded that the sheep wool used in the Danish Bronze Age textiles mainly consisted of very fine fibres mixed with a varied amount of coarser fibres and kemp and sorted according to colour. No difference can be observed in the wool used in the early Iron Age textiles from bogs and burials but this differs from Bronze Age wool in having a more uniform fibre combination with only occasional coarse fibres and kemp. The results from c. 1500 years of textile production do not indicate any outstanding differences in the raw material and the absence of coarse fibres in the early Iron Age bog and burial textiles is believed to be a result of processing, determined by factors such as the time of year for harvesting or a meticulous sorting of the wool. The discovery of the mixture of local and non-local wool in one textile adds a different dimension to the question of fleece type. It appears that the raw wool did not necessarily come from only one flock of sheep and may have been transported over long distances before it was mixed with local wool and made into yarn in this part of the world.

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Orit Shamir and Uzi ‘Ad

Loom Weights of the Persian Period from Khirbat Burin, Israel

Introduction

A salvage excavation in the western part of Khirbat Burin, directed by Uzi ‘Ad (‘Ad 2013) on behalf of the Israel Antiquities Authority, was undertaken from December 2009 to January 2010 in the wake of construction works for a mobile phone antenna (Fig. 1).

Khirbat Burin is located in the northern Sharon – the internal plain of central Israel, on a hill in the midst of the agricultural areas. It is next to an ancient crossroad: the longitudinal road that branches off of the Via Maris and the lateral roads that linked Nablus (*Neopolis*) with the ancient settlement on which the city Netanya is situated today, and with Caesarea (Fig. 2).

Burin is indicated as a small village on the Jacotin map (1799) and as a ruin by *The Survey of Western Palestine* from 1880. A survey that was performed at the site in the 1980s documented potsherds that dated to the Iron Age II, Persian, Hellenistic, Roman, Byzantine and medieval periods (‘Ad 2013). Six excavations had been conducted along the slope and northern and eastern fringes of Khirbat Burin in the years between 1998 and 2001, prior to the widening of a nearby road. Buildings and installations that ranged in date from the Hellenistic to the Ottoman periods and pottery from the Persian period were exposed.

The current excavation yielded architectural remains and installations dating from the Persian (5th–4th centuries BC, stratum VII) to the Mamluk periods (13th–5th centuries CE). Also exposed was part of a large Persian-period building, a building with several rooms probably from the early Roman period (1st century CE) including a refuse pit and a large tabun from the late Roman period (2nd–3rd centuries CE). A large, impressive building with a water cistern from the early Islamic period (7th–9th centuries CE) was also found. Another large building and the remains of three structures, one above the other, from the Mamluk period (13th–14th centuries CE) complete the stratigraphy.

The eight occupation layers attest to the importance of the site’s location and to its being a tell. An analysis of the finds shows that throughout all of the periods the settlement was rural and its economy was based mainly on agriculture.

At the bottom of the lower area of the Persian period were walls and a floor founded on fill (thickness in excess of 1.5 m), the purpose of which was to raise the level of the area prior to the construction of the building.

Numerous fragments of pottery vessels, basalt grinding bowls, shards of tabuns (ovens) and 73 clay loom weights were discovered above the floor of a courtyard in a burnt layer (Fig. 3). The loom weights were near a wall. The source of the fire was probably the tabuns or destruction of some other kind. Apparently, one of the building’s walls (exposed length in excess of 7 m) continued east and west beyond the limits of the excavation. The dimensions of the walls and the effort invested in levelling the area indicate that the building occupied a large area (‘Ad 2013).

The pottery from the destruction layers provide a date in the 4th century BCE. All this may provide evidence of a relatively short life for the Stratum VII buildings, which appear to cease to function in the mid-late 4th century, probably close to the time of Alexander the Great’s conquest of the Persian Empire (Gendelman forthcoming).

Fig. 1. Khirbat Burin (Photo: Sky View).

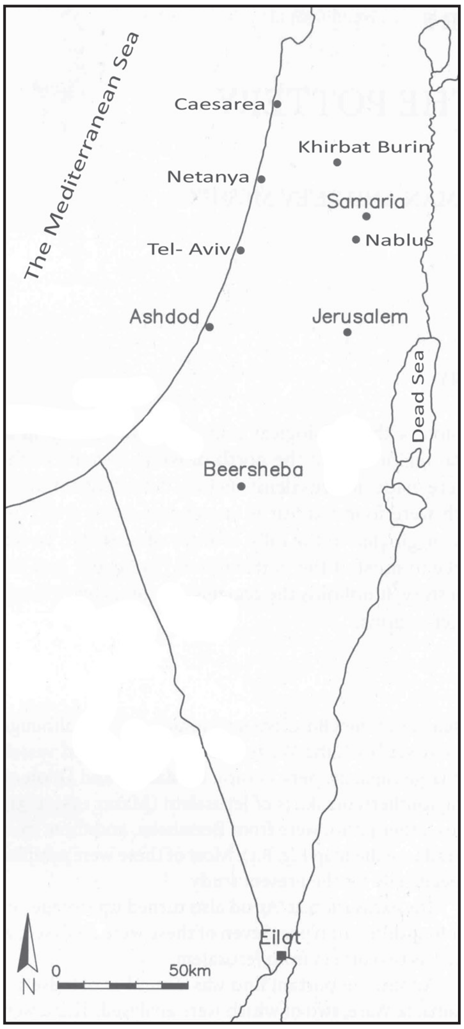

Fig. 2. Khirbat Burin location (Drawing: Shaked Shamir).

The loom weights

Thirty six of the 73 loom weights were preserved and registered. The others were very fragile and were disintegrated. All the loom weights are made of brown, unfired clay (Fig. 3). They were burnt in the fire with the wooden beams of the loom. All are biconical and (Fig. 4) vertically perforated. The weight ranges from 23.9-41.7 g (Table 1), with an average of 31±4.3 g. The diameters range from 3.3-4.7 cm with an average of 3.8±0.4 cm and the heights range from 2.6-3.8 with an average of 3.1±0.4 cm (Table 1).

The courtyard was probably used for household activities as indicated by the hearth and grinding bowls. It is large enough to hold a loom. The loom weights were found near a wall and were scattered in two rows of approximately 78 cm, indicating the width of the loom.

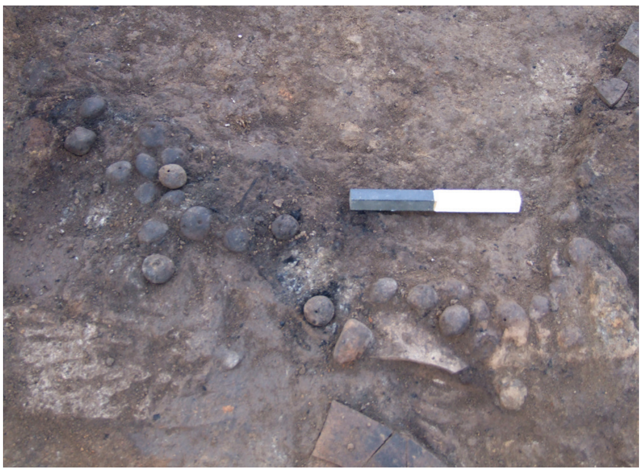

Fig. 3. The loom weights (No. DSCF 2767) in situ (Photo: U. 'Ad, Courtesy of the Israel Antiquities Authority).

Discussion
Material:
Most of the clay loom weights of the Persian period were not fired, similarly to those of the Iron Age. In the Hellenistic-Roman periods they were usually fired.

Type and Weight:
The light weight biconical loom weight is the dominant shape of Persian period. Similar objects have been found in Jerusalem (Shamir 1996,139, 144), Maresha (Shamir 1997), Horbat Rogem, Horbat Mesura and Horbat Ha-Ro'a (Shamir 2004), Tell Shiqmona (Elgavish 1968, Pl. LXIII:166) and Tel Michal (Singer-Avitz 1989, 359). Some were also found in the Occupied Territories at Qadum (Stern and Magen 1982, 193-194) (see location map of Persian-period loom weights in Shamir 1997, 6), Khirbet Abu et-Twein (Mazar 1981, 23) and Khirbet Nimra (Shamir 1997).
The weight of a loom weight is an important functional parameter for the operation of the warp-

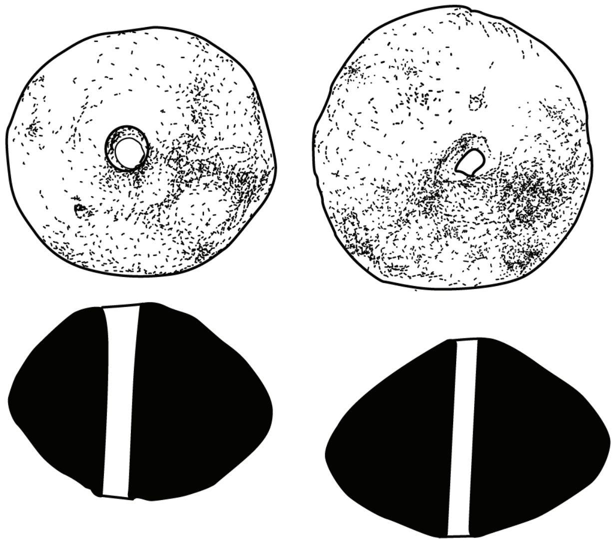

Fig. 4. The loom weights (No. AS797-10) (Drawing: Marina Shuiska, Courtesy of the Israel Antiquities Authority).

Table 1. Weight, height and diameter measurement of the thirty six loom weights from Khirbat Burin.
*** Where there are two diameters it is because they are not always exactly round.**

No.	Weight (gr)	Height (mm)	Diameter* (mm)
1	23.9	28.5	32.7
2	24.1		
3	24.7		
4	24.8		
5	25.4	34.0	37.22-39.92
6	26.3	36.6	34.42-37.82
7	26.6	31.5	39.1
8	27.8		
9	27.9		
10	28.1		
11	28.3		
12	28.3		
13	28.4	25.5	38.2
14	28.9		
15	29.1		
16	30.6	26.0	37.7
17	31.1		
18	31.4	28.6	34.74-35.61

No.	Weight (gr)	Height (mm)	Diameter* (mm)
19	31.7	30.6	35.11-38.47
20	32.1		
21	32.4		
22	32.5		
23	32.5		
24	32.8		
25	32.9	29.1	37.5
26	33.1	29.0	33.1
27	33.4		
28	33.6		
29	33.8		
30	34.1		
31	34.7		
32	36.1	31.6	38.71-39.54
33	36.3	33.6	44.3
34	37.2	38.1	36.34-37.84
35	38.7		
36	41.7	34.1	47.3

weighted loom (Mårtensson *et al*. 2009, 382). It is in fact the most critical element affecting performance and consequently indicating respective needs and preference in textiles. The tension applied to the warp threads is particularly decisive for the qualities of the woven textile, inasmuch as it is directly related to the properties of the thread, the weave pattern and the desired result regarding textile form, density or strength (Papadopoulou 2012, 60).

Loom weights of the Persian period are very light, usually 20-50 g (Shamir 2004), in contrast to the heavy loom weights of the Middle Bronze Age II up until the Iron Age and Hellenistic-Roman periods (Shamir 1994) which weigh *c.* 100-800 g. In general, light loom weights were used for fine textiles with very thin threads, while the heavier ones were used to produce thicker/heavier or coarser textiles (Shamir 1997; Andersson Strand 2012, 211). Across the region many of the Persian-period loom weights came from public buildings, although some were found in private houses (Shamir 1995). There is no indication of which material was used for weaving but the materials that were available are wool, goat hair and linen.

Several years ago the author reconstructed a warp-weighted loom and wool threads were reproduced that were similar to those found at Masada. Using light loom weights (20-40 g) similar to those from Maresha (Shamir 1997; Shamir forthcoming a), it was found that the weaving could be accomplished with a maximum of three warp threads tied to each loom weight. Mårtensson *et al*. (2009, 396) and Andersson Strand (2012, 211) estimated a tension of 20-30 g per warp thread. This calculation is not suitable for Khirbat Burin. Gleba and Cutler (2012, 118) estimated 5 g for very fine thread. This may indicate the desire to produce very fine and relatively dense textiles or pattern-weaving (Gleba and Cutler 2012, 118). The following calculation was done to elucidate the use of the loom:

Each loom weight from Khirbat Burin: 27 g.
5g tension for each thread = 5.4 threads
5.4 x 73 loom weights = 394 threads
394 threads over 78 cm (width of the loom) = *c.* 5 threads per cm

We cannot compare this calculation to textiles from the Persian Period because they have not survived in Israel, but woollen textiles from the Iron Age II (9th century BC) are usually 3-20 warp threads per cm in woollen textiles and 8-40 warp threads per cm in linen textiles; but the loom weights that weigh approximately 250g (*e.g.* Kuntillet ʻAjrud, Sheffer and Tidhar 2012, 292-297) and linen threads are usually 10-30 warp threads per cm (*e.g.* Kadesh Barnea, Shamir 2007, 258).

The rows of loom weights found in certain sites, such as those mentioned below and by Barber (1991, 93-103), enable us to reconstruct the width of the loom, and hence the maximum width of the cloth that could be woven on it (Barber 1991, 103). By examining the table presented by Barber (1991, 387-389), which gives the various widths of warp-weighted looms and the number of loom weights from those looms, it can be demonstrated that there is no correlation between these two parameters. The distribution pattern of rows of loom weights found at sites such as Tell Amal, Tell Beth-Shean, Tell Es-Sa'idiyeh and Tell Deir Alla undoubtedly points to their belonging to looms. At Tell Amal, two-metre long parallel rows of loom weights were found *in situ* (Levy and Edelstein 1972, 331-335; 342; Shamir 2013). At Beth Shean most of the loom weights were found in two concentrations along the eastern wall of the central hall of Building 28636. In the southernmost concentration, the weights extended along 1.5 m, probably indicating the width of the loom. The loom weights were probably arranged in two rows. The charred beam (made of olive wood) found nearby may have belonged to the loom (Shamir 2006).

A metre-long parallel row of 62 loom weights was found *in situ* at Tell Es-Sa'idiyeh, in House 6 of Stratum 5 (Pritchard 1985, 17-19; Figs 2-3). Phase IX at Tell Deir Alla yielded three parallel rows of loom weights dating to the 9th century BC (Vogelsang-Eastwood 1990, 60). At Troy (Blegen *et al.* 1950, 350), a row of loom weights 1.1 m long was found *in situ*. At Gordion in Anatolia, 21 loom weights, some still bearing threads, were found lying in three rows (Brown 1980, 62; 86). All this data enables us to reconstruct the width of the cloth which is almost identical to the width of the loom.

Schierer conducted an experiment (1987; 2005, 103), after a discovery of 36 loom weights in rows at Gars-Thunau in Austria, in which she tried to destroy the loom and the textile by burning the threads. She concluded that a loom was very likely to have stood on the spot in which it was being worked on. This was probably also the situation at Khirbat Burin where the area suffered from a fire that caused loom weights to fall from the loom in two rows.

No three rows of loom weights, indicating twill weaving, have been found in Israel and the few twill textiles from the Roman period which have been discovered were imported. The weave was found in small quantities among woollen textiles (32 out of 1635 textiles from Roman period sites) (Shamir forthcoming b, 105). Despite the fact that looms capable of weaving twill existed in this period and even before, twill has not been found in Israel that dates prior to the Roman period.

Summary and conclusion

The discovery at Khirbat Burin is one of several finds of loom weights arranged in rows and contributes further information on the loom weights in the Persian period which are characterised by conical shape and light weight. Their distribution at the site can indicate the width of the loom, as in this case. The weaving could have been carried out using a maximum of three warp threads tied to each loom weight producing fine textiles with thin threads.

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Ulrike Rothenhäusler and Antoinette Rast-Eicher

Early Bronze Age Textile Imprints from Tall Bderi and Tall Mozan, Northern Mesopotamia/Syria

Introduction

Cuneiform tablets from the Ebla deriving from the third millennium BC document that the production of textiles was a highly developed craft in Mesopotamian civilisation in this period (Barber 1991, 166). As true textiles are rarely preserved in Mesopotamian excavations, it is more often the imprints that are left to us that convey information about techniques, yarns and quality of objects from the ancient world. The most fortunate finds are those precise imprints which enhance greatly the possibility of determining original fibres in the manufacture of the textile. The following article is an overview of the examination of textile imprints found at two excavation sites in northern Mesopotamia/Syria (Fig. 1). At Tall Bderi, imprints were found on vessel fragments that were made of gypsum. The imprinted textiles were used to build up and stabilise the gypsum during their production. At Tall Mozan most of the textile imprints were visible on the backs of clay imprints but also found as bitumen imprints and on the bases of a pottery vessels. For the textile imprints found in clay, textiles were used to cover trade goods, which were sealed with clay and secured with cylinder seals. The bitumen imprint was from a floor mat and was found near a fireplace. The floor mat was coated with bitumen for fire protection. Textile imprints on the bases of pottery vessels are often from the mats on which the vessels were stored during the production process during air drying and before burning (Crowfoot 1938, 3-11; Shamir and Baginski 1993, 9-10; Tufnell 1958, 72). In all cases a wide range of textile techniques and quality levels were exhibited. Investigation and documentation of these imprints were carried out as part of Ulrike Rothenhäusler's studies at the State Academy of Art and Design, Stuttgart, Germany in the Faculty of Object Conservation. Antoinette Rast-Eicher, of Archeotex, Enneda, Switzerland, conducted analysis of fibres imprints under the scanning electron microscope (SEM).

All textile imprints and their casts were examined under microscopic magnification (5-10x) and the criteria considered included dimension and spinning direction of the yarns, thread diameter, thread count per square centimetre, textile structure, chronology, stratigraphy and state of preservation. All imprints were photographed. In cases of unclear or badly distorted images, drawings and textile reconstructions were attempted. For a more refined identification of those imprints on clay from Tall Mozan, Plasticine™ was incorporated to create a positive image of the textile.

As compared to the study of actual textiles, examination of textile imprints is limited to surface inspection. The imprint material has been known to shrink or expand during drying, however with clay or pottery significant shrinkage cannot be expected below 1000°C. Furthermore, the warp and weft of a textile could only be determined when selvedges or sometimes flaws in weaving were imprinted. Of the 164 analysed imprints from both excavations, only 5 cases seemed to have evidence which allowed recognition of the warp and weft.

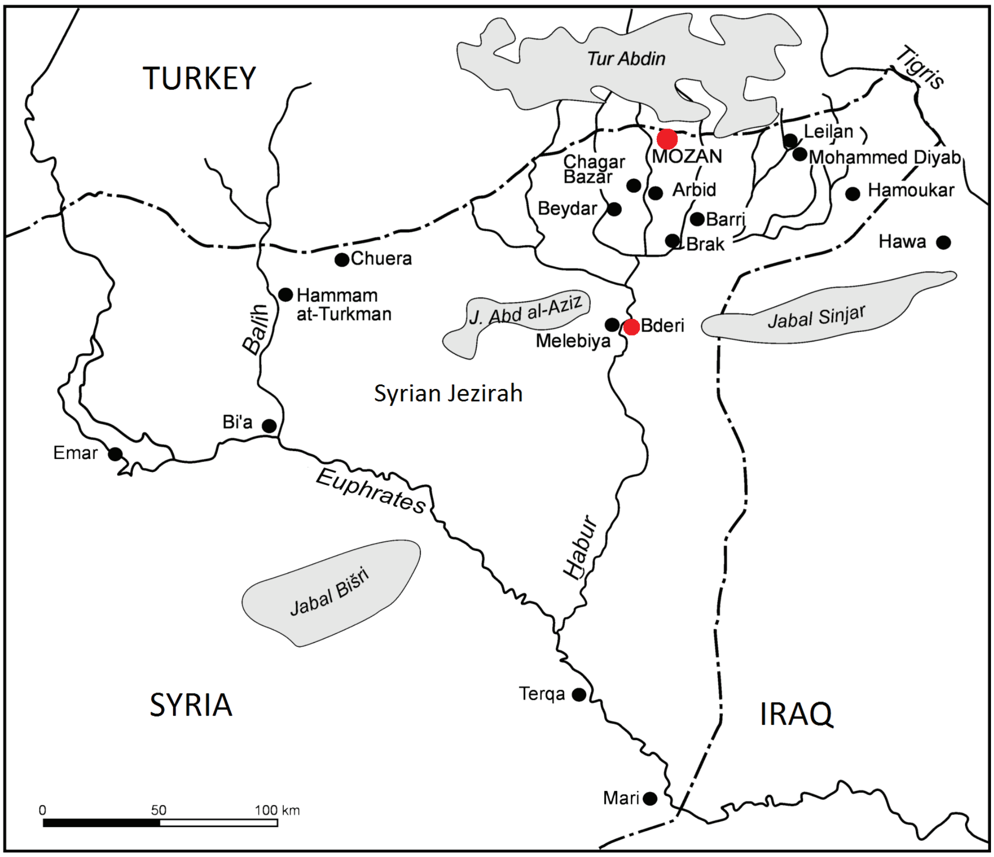

Fig. 1. Location of the two excavation sites in North Mesopotamia/Syria (After Bianchi *et al.* 2014, S. 2 Abb. 1).

The gypsum imprints from Tall Bderi

During the 1985-1990 excavations at Tall Bderi under the local direction of Peter Pfälzner, numerous gypsum fragments with textile imprints were found (Pfälzner 1990, 212-221; Pfälzner, 1993, 49-62; Pfälzner 1994, 244-247, 250-255, 273-274, 282-284). In the summer of 1998, to retrieve optimum information from the textiles, 72 of the gypsum fragments were cast with gypsum after isolation using talc. These casts were brought to the University of Tübingen, Germany, and examined in 2001 by Ulrike Rothenhäusler. The cast pieces have an average size of 7.5 x 6.0 centimetres (maximum size 10.3 cm, minimum size 3.5 cm). While the original fragments exposed the negative imprint of the textiles, the casts now gave the positive image.

The textiles seemed to have been used in the production of gypsum vessels and helped to build up and strengthen the vessels. Gypsum was also used for the insulation of basketry (Kingery *et al.* 1988, 219-244). At Tall Bderi, three kinds of gypsum vessels were found: storage vessels, bowls and discs, which were used as vessel covers. The large storage vessels have on average a height of 80cm and a width of 50 cm; the sherds found belonging to it were 3-4 cm thick. The bowls, with round, oval or nearly rectangular diameters, showed an average height of 10-30 cm, a width from 30-50 cm and sherd thicknesses of 2-4 cm.

Textile techniques used in Tall Bderi

Basketry techniques were recognised on 24 imprints, with the following identifications: coiled ware (n=1), stake-frame basketry (n=8), plain weave 2/1 (n=12), twill weave 6/6 (n=2), and twining (n=1). Most basketry techniques were found only on the gypsum discs (vessel covers). The stake-frame basketry constitutes an exception, the gypsum being used to tighten the basketry.

Two different types of weave could be determined from the textile imprints: one group was a plain weave (= 17); the second group (n=19) a more complicated identification as one system was not visible. In total, three different techniques were given as possibilities: rep-like plain weave, plain weave 2/1, and twining. The woven textiles were used in the manufacture of gypsum vessels (n=29), bowls (n=5) as well as a disc.

The following selection shows the variety of the textile imprints from Tall Bderi:

Fig. 2. Imprint BD 89/2745/204-1FS 890 from Tall Bderi (© Ulrike Rothenhäusler).

Fig. 3. Imprint BD 89/2745/170-2 FS 725 from Tall Bderi (© Ulrike Rothenhäusler).

1. BD 89/2745/204-1 FS 890 (Fig. 2)
Size: 7.3 x 7.3 cm
Textile structure: twill weave 6/6
Thread: zS/zS, diameter: 5/5 mm
Thread count: 10/10 threads in 4 cm
Used as a gypsum disc
Date: EJ IIIb (2400-2200 BC)

2. BD 89/2745/170-2 FS 725 (Fig. 3)
Size: 7.6 x 5.4 cm
Textile structure: plain weave 2/1
Thread: zS/zS, diameter: 12/20 mm
Thread count: 8/3 threads in 4 cm
Imprint on a gypsum disc
Date: EJ IIIb (2400-2200 BC)

3. BD 86/2945/546-1, FS 178 (Fig.4)
Size: 8.3 x 7.0 cm
Textile structure: plain weave
Thread: s/s, diameter: 0.5-1/1-2 mm
Thread count: 7/4 threads in 1 cm
Imprint on a fragment of a storage vessel
Date: EJ IV (2300-2100 BC)

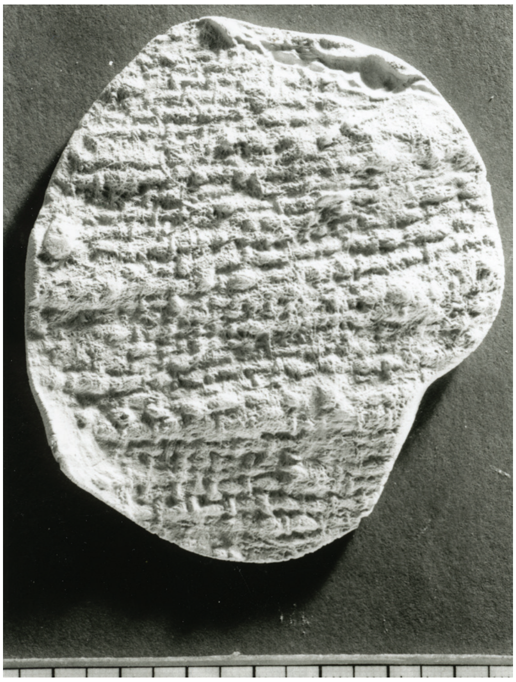

Fig. 4. Imprint BD 86/2945/546-1, FS 178 from Tall Bderi (© Ulrike Rothenhäusler).

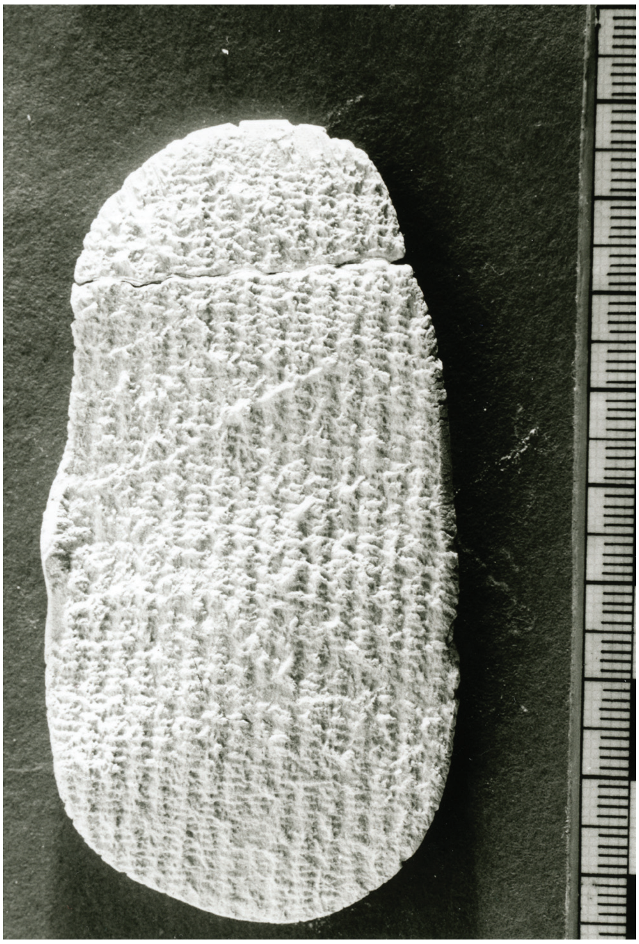

Fig. 5. Imprint BD 86/2941/066-1 from Tall Bderi (© Ulrike Rothenhäusler).

Fig. 6. Imprint BD 88/2745/077-6, FS:480 from Tall Bderi (© Ulrike Rothenhäusler).

4. BD 86/2941/066-1 (Fig. 5)
Size: 8.4 x 4.4 cm
Textile structure: rep-like plain weave
Thread: s/?, diameter: 0.5-0,7/1.5 mm
Thread count: 23/5 threads in 1 cm
Imprint on a fragment of a storage vessel
Date: EJ II-IIIa, (2850-2400 BC)

5. BD 88/2745/077-6, FS 480 (Fig. 6)
Size: 6.5 x5.9 cm
Textile structure: rep-like plain weave
Thread: s/s, diameter: 0.3-0.5/0.7-1.2 mm
Thread count: 6/17 threads in 1 cm
Imprint on a fragment of a storage vessel
Date: EJ IIIb (2400-2200 BC)

Dating

The textile imprints in gypsum were excavated from nearly all stratigraphic layers and dated from between 2850 and 2100 BC (Early Jezirah (EJ) II – Early Jezirah IV). The number of the imprints and the range of techniques have a tendency to increase from the early to the more recent stratigraphic layers. The stake-frame form of basketry appears to be the earliest technique and dates from between 2850 and 2400 BC. Also from this time period there is a textile imprint of a plain weave with one hidden system. The earlier stratigraphic layers hold more of the basketry imprints while fabrics of a finer quality register more often in the recent layers. The largest quantities of imprints as well as the greatest variety of techniques were found in the period from 2500 to 2250 BC (EJ IIIb).

Fig. 7. Illustration of the front side of a sealing (© Universität Tübingen, Projekt Tall Mozan, Photo: K. Wita).

Clay, ceramic and bitumen imprints from Tall Mozan

The examined imprints were excavated in the upper city of Tall Mozan/Urksh, Syria, in the years 1998-2001 during excavations undertaken by the Deutsche Orient Gesellschaft under the direction of Peter Pfälzner and Heike Dohmann-Pfälzner, University of Tübingen (Bianchi *et al*. 2014; Dohmann-Pfälzner and Pfälzner 2001, 2002). Textile imprints were found on 92 clay seals, on one fragment of a pottery vessel base and in bitumen.

Research on the seals and seal impressions of northern Mesopotamia has a long tradition. The fronts of the clay imprints show an impressive wealth of seal illustrations (Fig. 7). Not only are the fronts of the seals with their excellent illustrations, but the backs are also very interesting as they show a variety of features according to their use. Seals were used to seal doors and to protect the contents of pottery vessels and other containers. The vessels were often covered with textiles and closed with threads. To secure the contents, clumps of pliant loam were applied to the textile and threads and afterwards sealed with cylinder seals. Because pottery vessels, other trade goods and doors could be sealed, we also find wood, leather, felt or straw on clay imprints, all of them materials that are usually not preserved in archaeological contexts (Otto 2004).

From the textile imprints found at Tall Mozan the following basketry techniques could be identified: coiled basketry, stake-frame basketry, twill weave 2/2, twill weave 4/4, twill weave 6/6 and simple linking. Of the woven textiles the techniques are plain weave, plain weave 2/1, plain weave 2/2 and rep-like plain weave. As was the case with the imprints from Tall Bderi, the latter technique cannot be precisely determined, although it could possibly be a plain weave 2/1 or twining.

An idea of the variety and quality of textiles in use can be given from the following examples:

1. MZ01C2-i2973 (Fig. 8)
Size: 3.1 x 2.9 cm
Textile structure: coiled basketry
Thread: ?/?, diameter: 2/8 mm
Thread count: 9/3 threads in 1 cm
Date: EJ IIIb (2400-2200 BC)

2. MZ01C2-i2677 (Fig. 9)
Size: 3.0 x 3.1 cm
Textile structure: simple linking
Thread: zS, diameter: 2.5-3.0 mm
Date: EJ IIIa (2600-2400 BC)

3. MZ01C2-i3056 (Fig. 10)
Size: 2.4 x 1.9 cm
Textile structure: plain weave
Thread: s/s, diameter: 0.6-0.8/0.6-0.8 mm
Thread count: 4/4 threads in 1 cm
Date: EJ IIIa-V (2600-2000 BC)

4. MZ01C2-i3055 (Fig. 11)
Size: 1.8 x 1.9 cm
Textile structure: rep-like plain weave,
Thread: s/?, diameter: 0.05-0.1/≤ 0.6 mm
Thread count: 96/9 threads in 1 cm
Date: EJ IIIa-V (2600-2000 BC)

5. MZ01C2-i2073 (Fig. 12)
Size: 4.1 x 1.9 cm
Textile structure: plain weave 2/2
Thread: s/s, diameter: 0.1-0.2/0.2 mm
Thread count: 66/15 threads in 1 cm
Date: EJ IIIa-V (2600-2000 BC)

6. MZ01C2-i3019 (Fig. 13)
Size: 1.4 x 1.6 cm
Textile structure: plain weave 2/1
Thread: s/s, diameter: 0.3-0.6/1.2-1.5 mm
Thread count: 16/6 threads in 1 cm
Date: EJ IIIa-V (2600-2400 BC)

7. MZ01C2-i1348 (Fig. 14)
Size: 2.0 x 1.6 cm
Textile structure: plain weave
Thread: s/s, diameter: 0.5-0.6/2.0-2.5 mm
Thread count: 18/3 threads in 1 cm
Date: OJ I (1900-1800 BC)
Random: Twining
Tread: z, diameter: 1.2 mm

Fig. 8. Imprint MZ01C2-i2973 from Tall Mozan (© Universität Tübingen, Projekt Tall Mozan, Photo: K. Wita).

Fig. 9. Imprint MZ01C2-i2677 from Tall Mozan (© Universität Tübingen, Projekt Tall Mozan, Photo: K. Wita.

Fig. 10. Imprint MZ01C2-i3056 from Tall Mozan (© Universität Tübingen, Projekt Tall Mozan, Photo: K. Wita).

Fig. 11. Imprint MZ01C2-i3055 from Tall Mozan (© Universität Tübingen, Projekt Tall Mozan, Photo: K. Wita).

Fig. 14. Imprint MZ01C2-i1348 from Tall Mozan (© Universität Tübingen, Projekt Tall Mozan, Photo: K. Wita).

Fig. 12. Imprint MZ01C2-i2073 from Tall Mozan (© Universität Tübingen, Projekt Tall Mozan, Photo: K. Wita).

Fig. 13. Imprint MZ01C2-i3019 from Tall Mozan (© Universität Tübingen, Projekt Tall Mozan, Photo: K. Wita).

Dating

The 92 textile imprints date from 2600 BC until the late medieval or even modern period. The majority of imprints (n=28) were dated to between 2600 and 2400 BC with another 12 being classified as from 2400-2300 BC. Most of the techniques identified are in evidence until 2600-2400 BC, the exception being the coiled basketry, which could be dated to 2400-2300 BC and the twill weave 2/2 dating from 2300 to 2100 BC.

Fibre analyses

Six samples of fibre imprints were examined using a scanning electron microscope (SEM). Unfortunately, clay as an imprint material is not precise enough to show the characteristic surface of a wool fibre (Fig. 15). With a measurable diameter and evidence of rounded fibres, however, the samples of imprint MZ 01C2-i3080 and imprint MZ00C2-i1644 appeared to be similar to wool fibres. Imprint MZ 01C2-i3080 dates between 2400 and 2100 BC (EJ IIIb-IV) and imprint MZ00C2-i1644 between 2000 and 1800 BC (Old Jezira I). Fibres from the string on imprint MZ01C2-i1751 show evidence of bast fibres. There is a diameter of 40-100 micron, much thicker than it would be for the fibres of linen or hemp (these normally being 10-15 micron thick) (Fig. 16). The fibres of the three other imprints could not be identified.

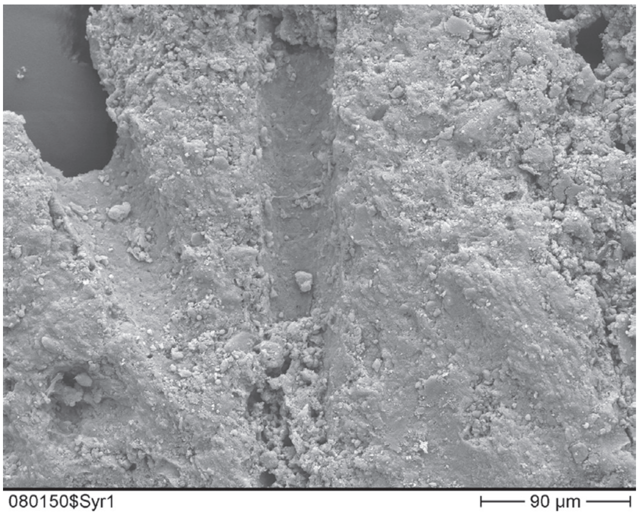

Fig. 15. Imprint MZ00C2-i1644 from Tall Mozan. Because of the rounded fibre imprint and a diameter of 60-70 micron this is most likely a wool fibre (analysis and picture ©Archeotex, Enneda, Photo: A. Rast-Eicher).

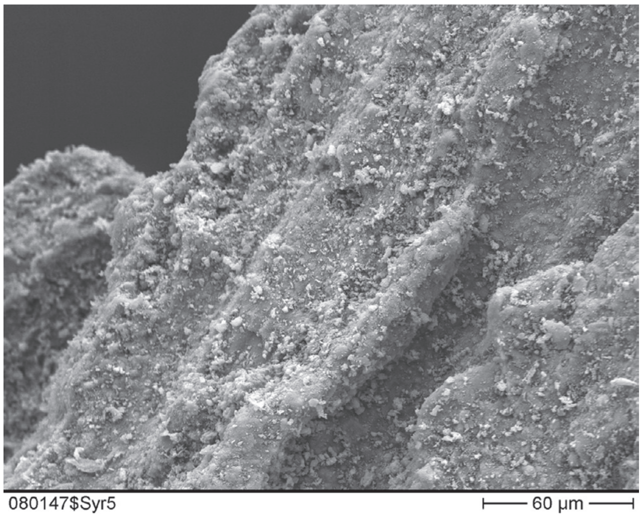

Fig. 16. Fibres from the string on imprint MZ01C2-i1751 from Tall Mozan show in the SEM nodes which is evidence of bast fibres. The fibres have a diameter of 40-100 micron (analysis and picture ©Archeotex, Enneda, Photo: A. Rast-Eicher).

Conclusion

The textile impressions discussed here are a selection from the 164 impressions identified at two excavation sites. The analysis of the complete material, which was done during the studies of Ulrike Rothenhäusler, shows more variations in textile technique and more details like flaws in weaving and textile borders. The work described here demonstrates how productive collaboration between an archaeologist and a textile specialist can be. As clay seals are common finds at excavation sites in Mesopotamia, the identification of textiles and other organic impressions on the backs of them is a topic with huge potential for further illuminating research.

Acknowledgements

The authors are very grateful to Heike Dohmann-Pfälzner and Peter Pfälzner for giving them the possibility of examining the imprints from Tall Bderi and Tall Mozan and publishing the first results in this article. Our thanks also go to Christoph Kümmel, University of Tübingen, for selecting the fragments and the cast, and to Anne Wissing, University of Tübingen, Ulla Mannering, National Museum of Denmark, Kim Travis, Tiziana Lombardo and Stephanie Wümmers, Swiss National Museum for their support.

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Tereza Štolcová, Dorte Schaarschmidt and Sylvia Mitschke

Textile Finds from a Chieftain's Grave

Preliminary Report from Poprad-Matejovce, Slovakia

Introduction

A double-chambered chieftain's grave from Poprad-Matejovce discovered in 2005 is dated to the early Migration period (late 4th/early 5th century AD). Over four months in 2006, an interdisciplinary group of specialists covering archaeology, archaeobotany, geology, geophysics, palynology, dendrochronology and conservation carried out the rescue excavation (Pieta and Roth 2007; Belanová and Pieta 2007; Pieta 2009; Štolcová *et al.* 2009, Štolcová and Zink 2013; Lau and Pieta 2014). It was done in collaboration of three institutions: the Archeologický ústav Slovenskej akadémie vied in Nitra, the Podtatranské múzeum in Poprad and the Archäologisches Landesmuseum, Stiftung Schleswig-Holsteinische Landesmuseen, Schloss Gottorf in Schleswig. Although the grave was penetrated by ancient robbers, it yielded abundant evidence of organic finds: wooden furniture parts, leather objects, bast fragments and layers of textiles. Fragile waterlogged organic finds as well as in situ blocks were transported to Schleswig, where they were stored at a temperature of -20°C and since then have been processed step by step under laboratory conditions.

The grave consisted of outer and inner chambers made of European larch (*Larix decidua* Mill.) with a north-south orientation (Fig. 1). At a depth of five metres below the present surface, the base of the structure was constructed as a platform of twelve over four meter long timbers set on two round beams. On top of it was the outer log-built chamber of L: 3.95 m, W: 2.70 m and H: 2.00 m. It was covered using 12 solid beams. The sarcophagus-like inner chamber (2.90 x 1.70 m) was built in a muntin-and-plank construction, covered with a gabled roof and pediments on each side. The grave was insulated by a layer of charcoal from the surrounding area. The ancient robbery event not only caused surrounding silt sediment and underground water to fill it up, but also helped to preserve the organic objects. Additionally, very few goods were left in the grave after the robbery and most of those that remained had been displaced. The dispersed human body remains belong to a 20-25 year-old male individual with a height of 171 cm. Apart from that, there was a pendant made of a golden *solidus* of the emperor Valens (375 AD), some pottery, a glazed *mortarium* and a bronze Hemmoor bucket. Also found were a gaming board with glass gaming pieces, a bronze arrowhead, a silver clasp, a silver awl with

Fig. 1. View of the grave at the end of the excavation in 2006 (Photo: Karol Pieta).

wooden handle, an amber bead and many hazelnuts spread around the floor of the inner chamber. Above all, there were many parts of wooden furniture turned on lathe (*e.g.* a death bed and a round table), layers of textiles, various leather objects and a basket. The wooden parts of the grave construction are still being conserved in Schloss Gottorf in Schleswig. After a time-consuming conservation process, the wooden

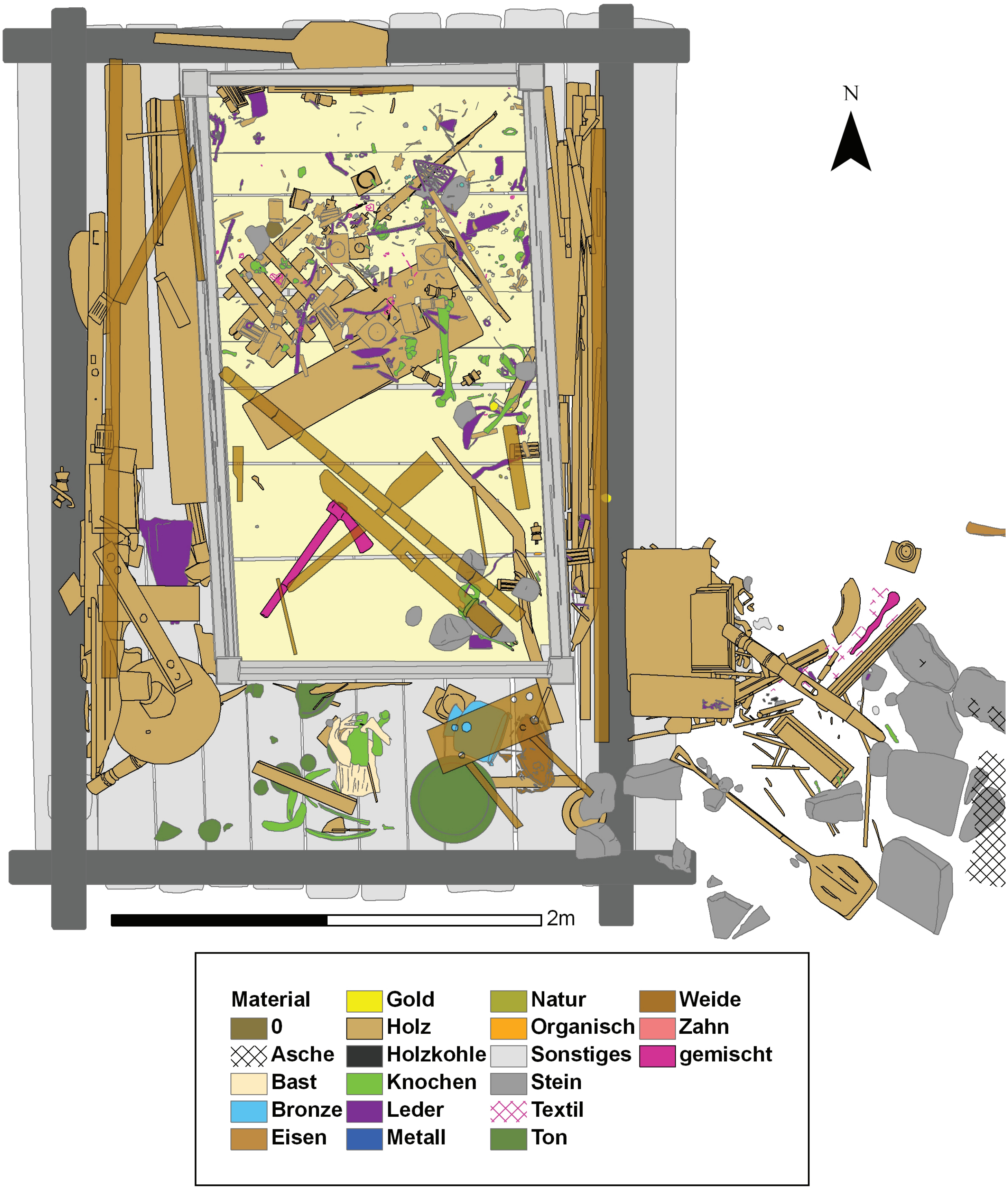

Fig. 2a. Detailed GIS-based visualisation of the grave (© Karin Göbel).

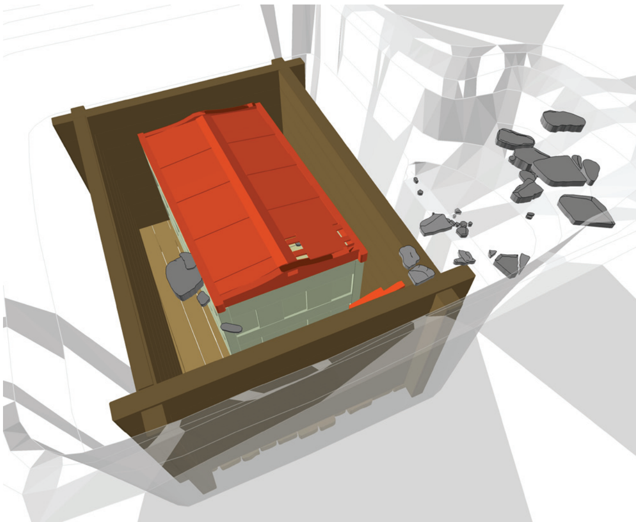

Fig. 2b. 3D-reconstruction of the inner and outer chamber (© Karin Göbel).

Fig. 3. Documentation of fragile organic finds in the laboratory (Photo: Claudia Janke).

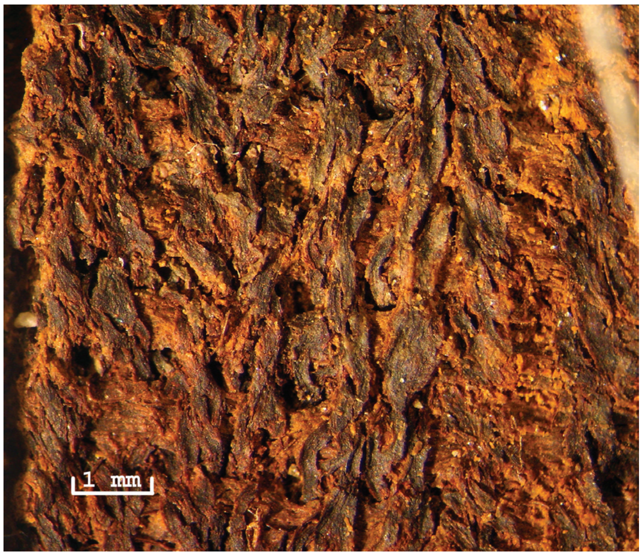

Fig. 4. Tablet-woven textile fragment with severely degraded threads in both systems (Photo: Tereza Štolcová).

furniture was transported to Slovakia in 2013. First analyses of the grave inventory in the Geographical Information System (Fig. 2a) as well as outputs of 3D-digitalised finds (Fig. 2b) have shown very exciting results. However, the final evaluation and laboratory examination of *in situ* blocks is still an ongoing process, and it has great potential to give us a much deeper insight into the culture of the early Migration period in northern Slovakia.

Processing of the in situ blocks
The laboratory examination of the *in situ* blocks was executed in several stages (Fig. 3). It started in Schleswig in 2008 within the European project *Clothing and Identities – New Perspectives on Textiles in the Roman Empire* (*DressID*) when parts of the floor of the inner chamber were examined (Štolcová *et al.* 2009; Štolcová and Lau 2013; Štolcová and Zink 2013). Stable and cold laboratory conditions with a suction unit were established to process the large waterlogged *in situ* blocks. The cleaning of the fragile organic objects was done with a fine air-brush and demineralised water, small brushes, delicate dental tools and tweezers. All the stages of the excavation were accompanied by close examination through an operation microscope. Thus, even the finest structures of textile remains in the soil of an *in situ* block could be traced. Among other things the documentation was made with the help of a drawing tube attached to the microscope. This guaranteed an exact documentation of delicate but mostly decayed textile remains and their surrounding context. All sketches and photographs were later edited and integrated into the Geographic Information System database (Štolcová and Zink 2013, Fig. 9). The organic finds retrieved from the blocks were processed in the wood conservation department in Schleswig or stored in a freezing room for further treatment. These excavation and documentation methods have also been applied to the latest stage of the laboratory research, which started in 2013 under the German Research Foundation's project *Das frühvölkerwanderungszeitliche Kammergrab von Poprad, Slowakei – Ein interdisziplinäres Forschungsprojekt*

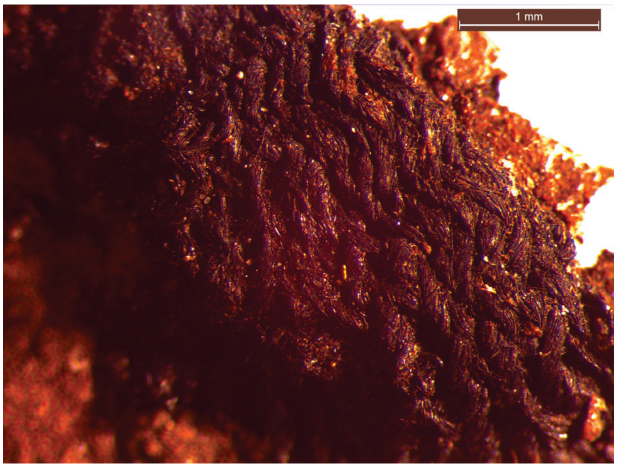

Fig. 5a. Detailed photo of the carbonized fabric made in sprang technique (Photo: Tereza Štolcová).

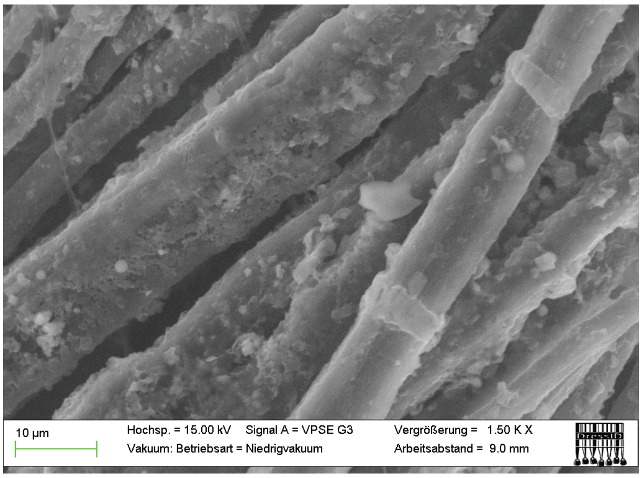

Fig. 5b. Plant fibre from sprang textile fragment identified in SEM (Photo: Sylvia Mitschke).

zur Auswertung eines außergewöhnlichen Fundes (The Migration-period chamber grave at Poprad, Slovakia – an interdisciplinary research project for the evaluation of an extraordinary find). In collaboration between the Centre for Baltic and Scandinavian Archaeology in Schleswig, the Niedersächsisches Landesamt für Denkmalpflege in Hannover, the Koninklijk Instituut voor het Kunstpatrimonium in Brussels and the Curt-Engelhorn-Zentrum für Archäometrie in Mannheim, the remaining *in situ* blocks are currently being processed in Hannover and are revealing new and interesting finds.

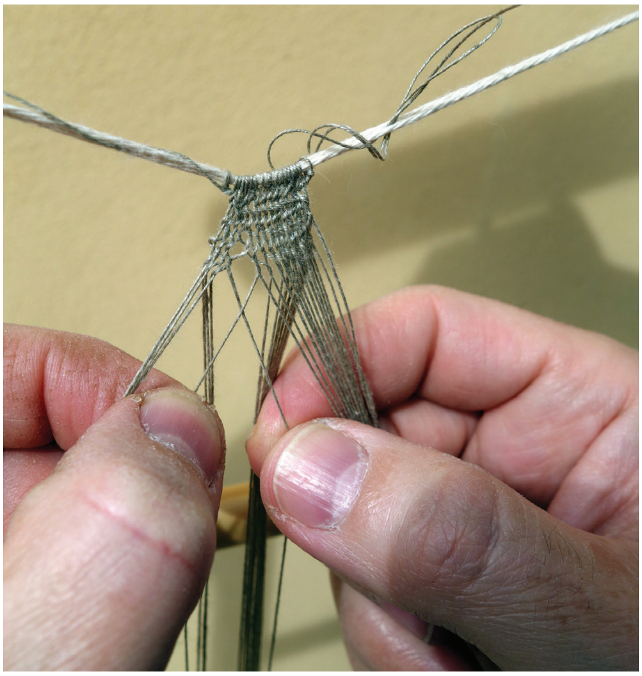

Fig. 5c. Reconstruction of sprang technique based on the find from the grave (Photo: Tereza Štolcová, reconstruction by Juraj Zajonc).

Results

Although textiles were the least preserved organic material from the grave, it was still possible to detect many layers of various types. Most of the textiles could be determined as being made of sheep's wool (OVIS) the preservation of which may have been caused by the acidic environment in the grave. Apart from remains of decayed tabbies, twills and microscopic fragments of golden threads, it was possible to identify several tablet-woven textiles, a single piece of sprang and parts of a slit tapestry fabric. The large collection of recovered leather objects is assumed to have been connected to the textiles as well.

Tablet-woven textiles

On a small wooden plank from inside of the inner chamber, the remains of woollen tablet-woven textiles were still attached (Štolcová *et al.* 2009, 273, Fig. 10). One of the fragments was made with approximately nine four-holed tablets, which corresponds to c. 36 threads per cm. The pattern 3S-3Z-3S consists of three tablets twisted in the same way (S) alternating with three tablets twisted in the opposite way (Z). Due to their poor state of preservation it was possible to determine neither the spin direction nor the original dimensions (Fig. 4).

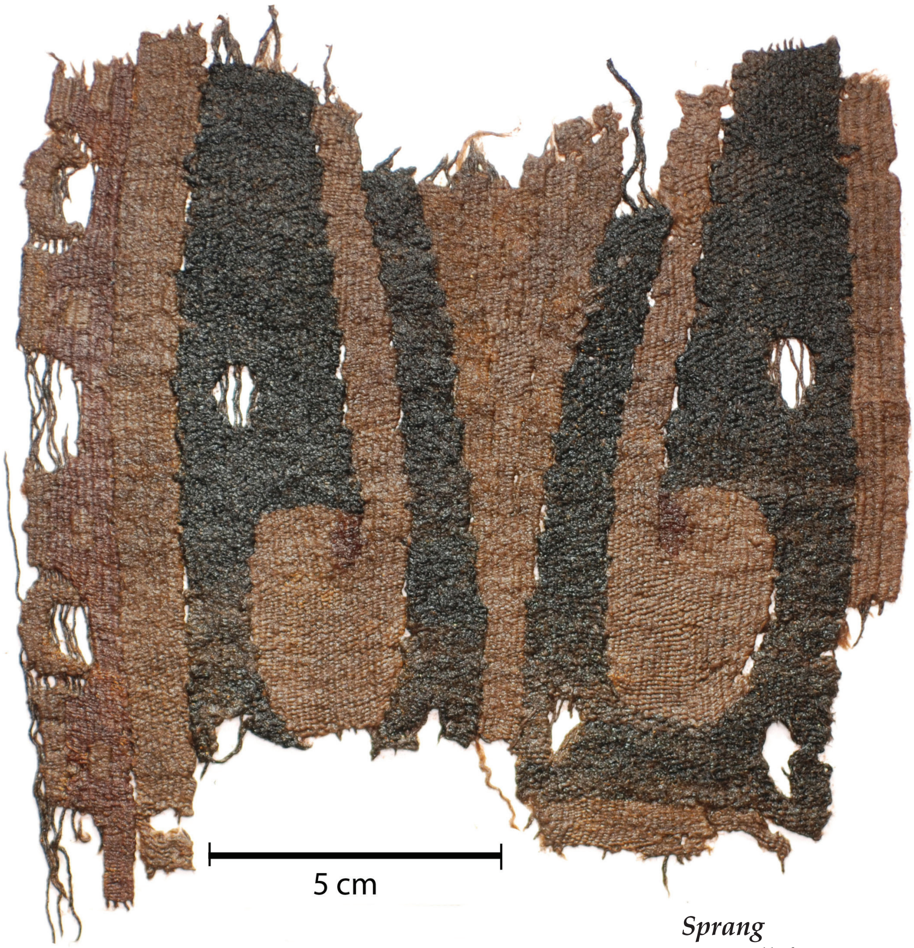

Fig. 6a. Largest preserved piece of a slit tapestry textile (Photo: Dorte Schaarschmidt).

Fig. 6b. Detail of the reinforced selvedge of the tapestry textile (Photo: Dorte Schaarschmidt).

Sprang

A small fragment of sprang fabric (6 mm x 2.5 mm) preserved through carbonisation was found on the bottom of the inner chamber (Fig. 5a). Its analysis with the scanning electron microscope has proved that it was created from very fine, about 0.2 mm thick z-spun threads, made from a plant material, most possibly linen (*Linum usitatissimum* L.) (Fig. 5b). The fragment consists of a simple interlinked sprang 11/11 structure with alternating z and s twists in each row (Seiler-Baldinger 1994, 52, Fig. 95b). Its reconstruction showed that the rows with S twists were made from the right to the left side whereas the rows with Z twists were executed from the left to the right (Fig. 5c).

Tapestry

Recent examination of a wooden plank from the eastern side of the outer chamber revealed one of the best preserved textile fragments in the grave. After recovery, unfolding and initial cleaning, it was revealed that the textile was produced in a slit tapestry technique (Fig. 6a). It consists of many fragments within which the largest piece has a size of 14.5 cm x 16.7 cm. Its reinforced selvedge was created by a brown weft running over three warp threads (Fig. 6b). The ground plain weft-faced weave creates a palmette-

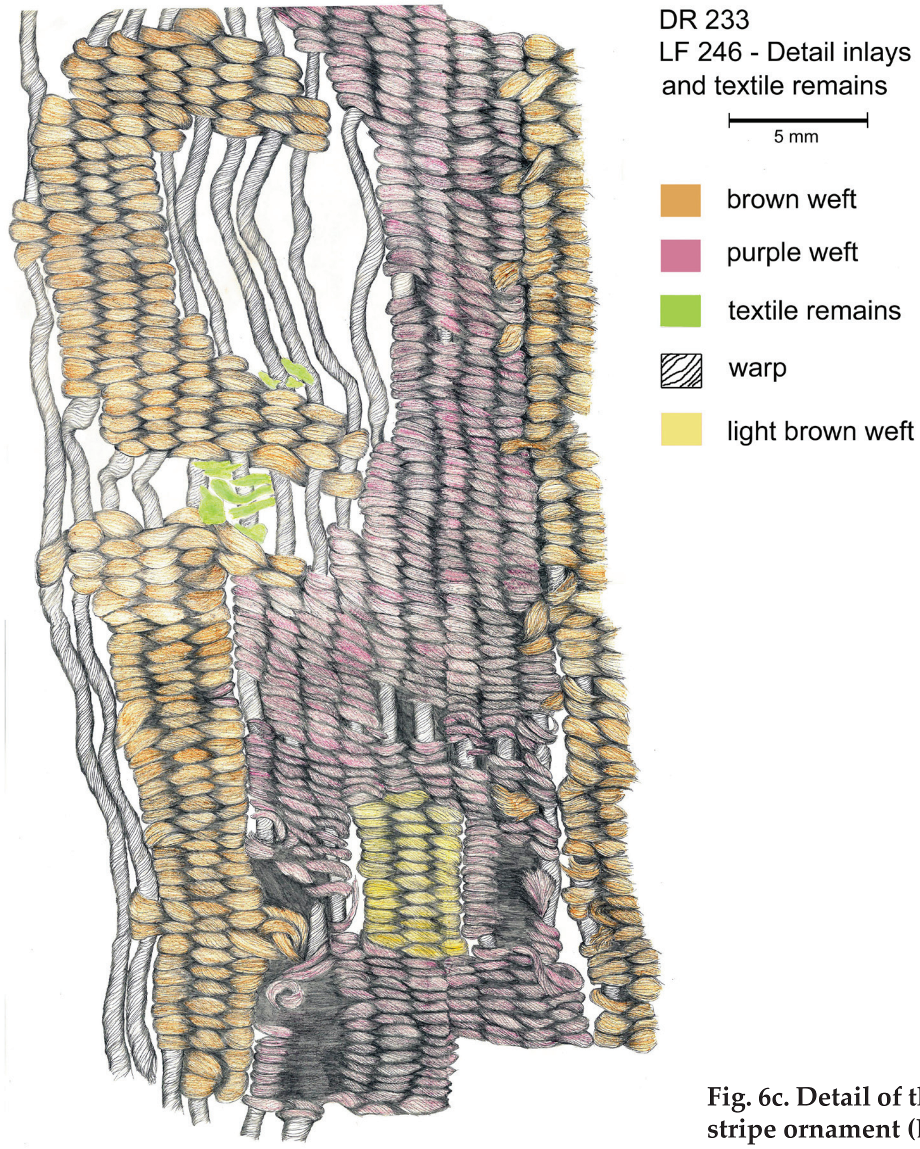

Fig. 6c. Detail of the half-moon shapes and reddish stripe ornament (Drawing: Dorte Schaarschmidt).

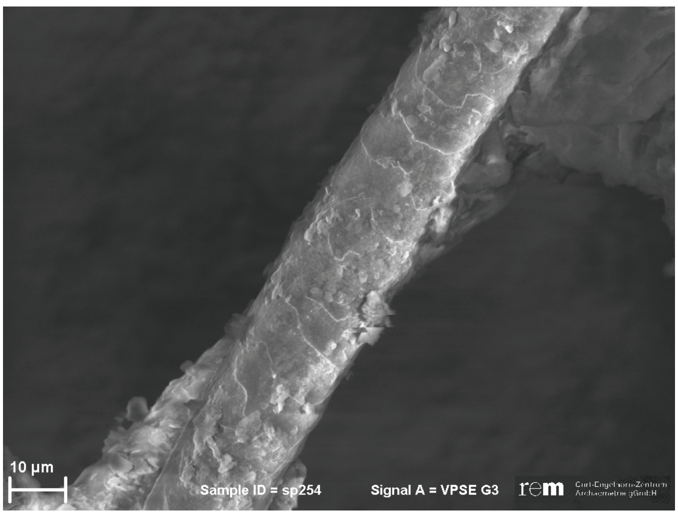

Fig. 6d. Sample of aligned woollen remains in the openings in SEM (Photo: Sylvia Mitschke).

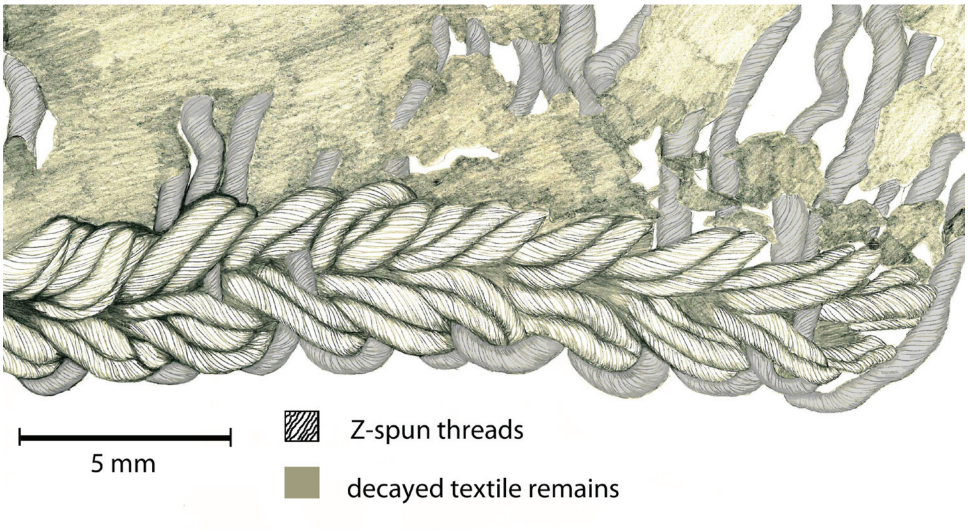

Fig. 6e. Detail of a braided border from the tapestry textile (Drawing: Dorte Schaarschmidt).

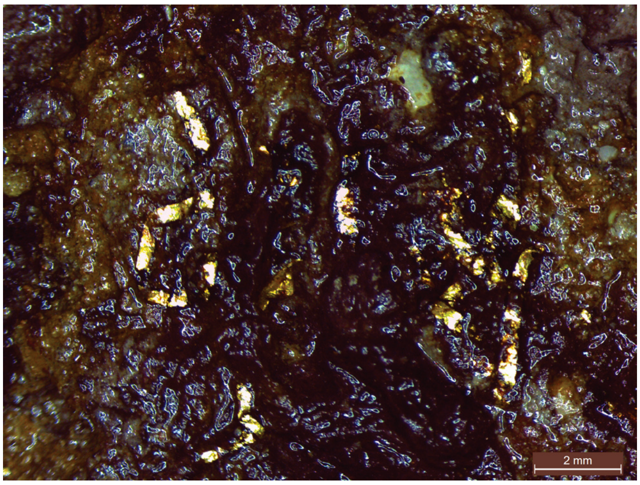

Fig. 7a. Remains of gold strips found in decayed layers of textiles (Photo: Tereza Štolcová).

Fig. 7b. Looped thread with fragments of golden strips wound around the black core (Photo: Tereza Štolcová).

like pattern through the use of at least three different coloured wefts. The palmette is formed by brown and black wefts with an inlay of red threads in the rounded areas followed by an intricate ornament of a reddish stripe with light brown squares and half-moon shapes set in wide openings (Fig. 6c). Microscopic traces of textile remains in these openings indicate that they were originally filled with another, presumably finer, yarn (Fig. 6d). The different coloured parts of the fabric[1] are connected through the continuing use of the same warp with another weft and thus show the typical slits, creating a slanting edge in the ornament. Coloured parts are also connected using a variation of dovetailed joints with two weft threads turning back around a common warp thread of the adjacent area and creating a straight line in the pattern. Both warps and wefts were identified as woollen. The warp threads are 0.65 mm thick and their thread count is about nine to ten threads per cm. The different coloured wefts vary slightly in their thickness from 0.4 mm to about 1.0 mm. Depending on which colour was used for the weft, the thread count differs from seven to eight weft threads per cm in the black areas, about 15 weft threads per cm in the brown areas and up to 20 threads in the reddish stripe of the ornament. The most distinctive threads of black, brown and red colour were determined as z-spun whereas the least preserved remains, which originally filled the symmetrically arranged openings, were only microscopically identified as woollen remnants of aligned structure. An ongoing examination of the last *in situ* block found in the same area as the above described piece yields further details of this textile. It is a horizontal edge of the same tapestry textile with remains of warp threads finished in a braided style (Fig. 6e).

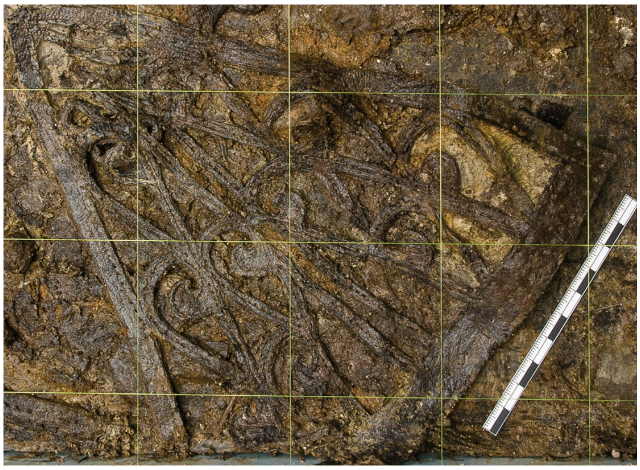

Fig. 8a. An ornamented open-work leather piece of triangular shape, size c. 20 x 23 cm (Photo: Tereza Štolcová).

Fig. 8b. Leather trefoil attached to a strip, remains of stitching clearly visible (Photo: Tereza Štolcová).

Gold threads and gold embroidery

Scattered all over the floor of the inner chamber, remains of gold threads and thin gold strips were found in decayed layers of textiles. These include either fragments of gold strips wound around a decayed black core or remains of narrow and straight stripes cut from a gold leaf, which are c. 1 mm wide and 20 µm thick (Fig. 7a). Lastly, a gold thread with a black core creating seven loops in a spiral-like ornament has been preserved (Fig. 7b). It can be presumed that it was originally part of a larger piece of embroidery.

Fig. 8c. Leather loop (Photo: Tereza Štolcová).

Textiles and leather

So far, more than 80 single leather pieces were found in the grave. Most of the leather finds were well preserved due to the slightly acidic pH-value of the soil, as well as the waterlogged conditions. All of them bear traces of stitching and therefore may have been connected to an already decayed underlying material, most probably textiles (Fig. 8a). They consist of various ornamental pieces like numerous trefoils (Fig. 8b) or leather loops (Fig. 8c) and strips of many sizes and types. Presumably they were parts of clothing.

Future perspectives

As research on the Poprad-Matejovce grave is still ongoing, it is not possible to state the exact cultural context of the grave. Chronologically it belongs to the so-called North Carpathian Group, whose settlements can be found in hilly areas of northern Slovakia, but graves from this region are very rare (Pieta 1991, 376; Lau and Pieta 2014, 361). The costly construction of both chambers, as well as the inventory containing coloured tapestry pieces, remains of golden threads and intricate leather objects points to the highest social class in Europe, known from comparable Late Roman graves like Pilgramsdorf (Lau 2012; 2014), Neudorf-Bornstein (Abegg-Wigg 2014) or Gommern (Becker 2010). The influence of the Roman Empire is visible in many aspects on the finds from Poprad, above all in the form of the inner grave chamber and the furniture as well as some grave goods like the golden *solidus* or the glazed *mortarium*. However, the date and place of the burial also indicate that there may be many different elements intermingled together. Strontium isotope analyses planned for the near future will hopefully answer questions about the origins of these finds. Further conservation, detailed documentation, technical analysis and evaluation of textile and leather remains as well as colour and dye analyses will bring essential insights into the production and use of textiles in the Late Roman period and the beginning of the Migration period from the territory of Slovakia.

Notes

1. Samples for dye analyses of this textile were submitted to Ina Vanden Berghe from the Koninklijk Instituut voor het Kunstpatrimonium in Brussels.

Acknowledgements

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Julia Barbara Krug-Ochmann

Achaemenid and Sassanian Trousers from Douzlakh Salt Mine at Chehr Abad, Iran

Introduction

Up until now trousers from the Achaemenid and Sassanian periods have only been known from ancient depictions. The most famous examples from Achaemenid times are the reliefs of the eastern stairway of the Apadana in Persepolis, showing the variety of ancient Persian costume. But of course these reliefs don't tell us anything about the material details of the trousers themselves, like the pattern, the weave or the colour. As such, the discovery of the salt mummies at Chehr Abad with all their well-preserved clothing is a matter of special importance. For the first time it has now been possible to examine and understand the weaving and sewing technology of original, pre-Islamic trousers. The first results are presented in this short article.

The trousers from Chehr Abad

The items which are introduced in this article consist of one pair of woollen trousers and three fragments identified as trousers, discovered in the ancient salt mine of Chehr Abad in the northwestern region of Iran. The findspot of Chehr Abad was a multiperiodical salt mine and used during the Achaemenid and Sassanian periods. From time to time, galleries inside the mine collapsed and buried the miners alive, together with their clothing, tools and everyday objects (Abolfazl *et al*. 2012, 61-81).

Since 1994 many finds have been unearthed during several excavations of the "Saltmine Exploration Project", a collaboration between Iranian archaeologists and the Ruhr University of Bochum. Most of the finds are associated with the radiocarbon-dated human remains of the so-called "Saltmen" from the Achaemenid and Sassanian periods (Pollard *et al.* 2008, 137). Due to the salty environment, the mummies, their clothes and all other organic material are partly in an excellent state of preservation. The archaeological analysis is important, since Achaemenid and Sassanian trousers were only known from ancient depictions. In February 2014 the technical studies on the weaving structures, e.g. the spin direction of the threads and the pattern, were undertaken in the Museum of Zanjan.

Contrary to first assumptions and rather surprisingly, there are some similarities in the pattern and the weaving between the trousers of Chehr Abad and their Mediterranean and northern European counterparts. In particular the so-called Thorsberg trousers, the Damendorf trousers and one pair of linen trousers from Egypt can be cited here (Schlabow 1967, 76-77; Farke 1993, 69-81; Hodak 1996, 293). Finds No. 131 and 132 from Saltman 2 (430-570 AD), a radiocarbon-dated Sassanian mummy (Pollard *et al*. 2008, 138-140), indicate that the trousers' reverse and crotch were also sewn together by rectangular and presumably

Fig. 1.
Find No. 131 and No. 132 from Saltman 2. Reverse side of a pair of trousers:
Find No. 131: width 30 cm, length 40 cm.
Find No. 132: width (at belt loop) 37 cm, width (mid) 16 cm, length 40 cm (Photo: Krug-Ochmann).

triangular yoke sections (Fig. 1). Yoke sections are very characteristic of trousers; their purpose is to join the reverse and crotch with the garment's front side and legs. The Zanjan trousers are as such more closely related to Northern European than Mediterranean trousers. The latter have a triangular yoke section located at the leg's reverse side – not at the crotch, as verified in northern European trousers. Inversely, the weaving structure of all the Zanjan trousers are tabbies, correlating more to Mediterranean trousers, such as one pair of linen trousers from Egypt in the Museum Kunstpalast Düsseldorf or one pair of linen trousers in Damascus (Hodak 1996, 293; Pfister 1951, 26; Kwaspen 2013, 252-263). Northern European trousers are mainly woven in a twill weave. In some respects the trousers of Zanjan represent a technical combination of northern European and Mediterranean trousers.

The weave structure of this two above mentioned fragments is a weft-faced tabby. Warps and wefts are made of unpigmented wool and S-spun, the thread count is nearly 17 weft and 14 warp per cm. The sewing thread of the trouser legs' flat-fell seam and of the belt-loop is z-spun and s-twisted. The belt loop was created by reverting and fixing the upper waist part of the garment (Fig. 2).

Further technical examinations of a fragment also associated with Saltman 2 prove that it represents a very unique type of trousers – hitherto unknown. The analysis indicates that the three pieces sewn together are part of the front side of a pair of very tight shorts. In fact there are no trouser legs; the lower parts of the pants are reverted and fixed in the lumbar region. So these tight shorts reached only over the pelvic area, just covering the buttocks and the iliac region. The upper thighs were not covered. The cut seems to be identical to a comparable Sassanian pair of trousers

Fig. 2. Belt-loop of find No. 131 (Photo: Krug-Ochmann).

Fig. 3. Find without inventory number (tight shorts). Half-basket weave with single s-spun warp and paired s-spun wefts. Width 36 cm (at belt loop), length 25 cm (Photo: Krug-Ochmann).

Fig. 4. Find without inventory number (tight shorts). Butt-seam (Photo: Krug-Ochmann).

of Saltman 1, which is now lost. The single pieces of the trousers indicate two different weave structures of undyed wool, a very fine tabby (as a patch) and a half-basket weave with a single hard s-spun warp and two paired loosely s-spun weft threads (Fig. 3). The weave has a thread count of nearly twelve warps and seven paired (making 14 threads/cm in total) wefts per cm. The different parts are sewn together using a butt seam (Fig. 4). Unique is also the fact that the belt is still inside its loop (Fig. 5).

The woollen pair of trousers of Saltman 4 (405-380 BC) is complete and forms part of the mummy. Saltman 4 is the best-preserved mummy of the Douzlakh Salt Mine at Chehr Abad. It was radiocarbon-dated to the Achaemenid period (Pollard *et al.* 2008, 140-141) and has been identified as a young man who died in a mining accident. The cause of his death was a broken neck, and he was killed while crawling on all fours. But his discovery represents a golden opportunity to learn more about the way the trousers were worn, the combination with other garments and finally about the sociological context of the individual himself.

Due to the salty atmosphere, the mummy textiles are inelastic and difficult to examine. The baggy pair of woollen trousers is partly covered by a long tunic; hence the upper parts of the trousers are not visible. The weave structure is a tabby with a z-spun weft and an s-spun warp. The thread count is nearly eight weft and eleven warp per cm. However, two further characteristics could be detected: the side seam runs alongside the trouser leg. But in the amount of the lateral thigh there is an opening. It is not a damage of the seam, but has been left open on purpose. It calls to mind a pocket, although it is not backed with fabric and was therefore useless as pocket (the skin of the mummy`s leg is visible) (Fig. 6). The side seam itself alongside the trouser leg is not visible, since it is covered by a red woollen fancy-effect thread, which is stitched as decorative element on the actual side seam (Fig. 7).

Achaemenid imagery confirms the presence of baggy pairs of trousers. The most famous example is the eastern stairway of the Apadana in Persepolis, the great audience hall of the Achaemenid kings. The stairway is decorated with reliefs, showing the variety of the empire's nations. Median, Armenian, Bactrian, Cappadocian and Skythian people are depicted wearing baggy trousers (Walser 1980, Fig. 15-28). The Skythian and Cappadocian people even bring trousers as a present or tribute for the king. All trousers which are depicted have in common that they seem to be as loose as the woollen pair of trousers of Saltman 4. Regrettably there is no ancient imagery of the short Sassanian type of trousers.

Conclusion

The trousers of Zanjan are noteworthy in every sense: based on the pattern and weaves they apparently represent a technical combination of northern European and Mediterranean trousers. While their weave (all are tabbies) correlates with trousers from Egypt or the Levant, it seems that the pattern, especially the position of the yoke sections, corresponds more with Northern European trousers. Hitherto unknown is a very special type of a short pair of trousers from the Sassanian era most comparable to modern shorts. Two pairs of trousers of this type have been identified: one by a fragment from Saltman 2 and another from Saltman 1 – the latter of which is only recorded by a photo and is sadly now lost. Future research will discuss the function of this short pair of trousers. Since one pair of long trousers is already assigned to Saltman 2, the question arises of whether the short pair of trousers are a kind of undergarment. Finally, future thoughts will help to reconstruct the most likely patterns of Achaemenid and Sassanian trousers.

Fig. 5. Find without inventory number. Upper waist-part of a very short pair of trousers with belt still inside its loop (Photo: Krug-Ochmann).

Fig. 6. Saltman 4. Amounting to his right leg`s thigh the trousers` side seam is partially left open. The mummy`s skin is visible (Photo: Krug-Ochmann).

Fig.7. Saltman 4. Seams covered by a red woolen fancy-effect thread (Photo: Krug-Ochmann).

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Julie Unruh

Evidence for Textiles in Loma Negra, Peru, as Recorded in Copper Corrosion

Introduction

Between 1979 and 1987, the Metropolitan Museum of Art acquired nearly 400 metal artefacts said to come from shaft tombs at Loma Negra, a Moche site in the Piura Valley on the North Coast of Peru (Lechtman *et al* 1982; Shaffer 1985; Schorsch *et al.* 1996; Shaffer and Uricheck 1997; Perkins 1997; Schorsch 1998; Centeno and Schorsch 2000). Notable for the excellent quality of their manufacture (Disselhoff 1972; Jones 1975; Jones 2001), the objects were made of hammered unalloyed copper sheet metal, cut to shape and joined mechanically using slotted and crimped tabs. Many were plated with extremely thin layers of silver and gold, using an ingenious electrochemical deposition process found thus far only on artefacts from the Piura Valley (Lechtman 1979; Lechtman *et al.* 1982; Schorsch 1998; Centeno and Schorsch 2000). The corpus includes headdress ornaments, staff heads, ear spools and nose ornaments, as well as hundreds of artefacts of unknown purpose. These objects include three-dimensional representations of insects, spiders, scorpions and crayfish; owl-head rattles; canine heads; representations of human figures in high and low relief; large plaques depicting the "decapitator" figure Ai Apec; human hands and feet; and crescent-shaped objects decorated with depictions of animals and humans. Single objects of an iconographic type are rare: nearly the entire collection can be divided into groups of objects that seem to form pairs or sets.

The shaft tombs at Loma Negra are assigned to the Moche culture (approximately AD 100–800), although the site is geographically isolated from the main Moche centres to the south by the Sechura Desert. During the Early Intermediate period (approximately AD 200–600), when the tombs were constructed, the Moche population shared the Piura Valley with a second indigenous culture, the Vicús. Despite the coexistence of the two groups, the metal artefacts produced by each remained stylistically distinctive.

All of the Moche objects in the Metropolitan Museum associated with Loma Negra are thought to be from the Moche II-III period - roughly contemporaneous with Tombs 1 and 2 (AD 200–300) at the Moche site of Sipán (Alva and Donnan 1993).

Pseudomorphic evidence for lost organic material

Evidence of organic objects deposited with metal objects in burials can be preserved within corrosion in a process similar to fossilisation commonly called pseudomorphism[1]. As the corrosion layers develop on metal artefacts, organic materials in direct contact with the metal are surrounded by or impregnated with corrosion products, sometimes resulting in negative "moulds" and three-dimensional replicas of the organic materials. The organics may subsequently degrade and disappear, but a record of the organic material remains.

Due to the fragile plating, corrosion layers on most of the Metropolitan Museum's Loma Negra artefacts have never been removed. As a result, numerous associated textile fragments remain extant on the surfaces of the metal objects, attached to corrosion layers. However, a large amount of mineralised organic material and pseudomorphic structures also remain intact within those layers. The corrosion primarily documents textiles, but information about feathers, cordage, plant fibres and other material survives as well.

In addition to pseudomorphs that preserve the same three-dimensional forms as the original organic material, the collection contains abundant examples of two-dimensional corrosion patterns also produced as a result of prolonged contact with textiles. On first glance, it may not be obvious that some of these corrosion patterns are textile evidence. In many cases, they do not resemble textiles. Nonetheless, textile-produced corrosion patterns can contribute useful textile data. That data includes evidence of weave pattern (Fig. 1); dots of corrosion in rows or grids indicating the position of threads (Fig. 2); stripes, striations, or dashes corresponding to threads or cords (Fig. 3); and additional elements preserving information about thread diameters and twist directions. The majority of the Loma Negra objects exhibit outstanding examples of these sorts of textile-related corrosion structures, as well as three-dimensional pseudomorphic structures and remains of actual textiles.

The textile corrosion structures on the Loma Negra metalwork have been previously examined by Anne-Louise Shaffer (1985). However, Shaffer's focus was on reconstructing burial relationships between artefacts rather than on the textiles as artefacts themselves. In particular, the possibility of using the less obvious two-dimensional corrosion patterns to obtain information about ancient textiles has not yet been fully explored. Worldwide, textile-produced patterns in corrosion remain an untapped archaeological resource.

One reason for the under-utilization of corrosion data is that many questions remain about how to correctly interpret corrosion patterns. Little information is available about the analysis of less well-defined corrosion structures in general. Textile-produced corrosion patterns can preserve many of the diagnostic features of textiles, and that data can contribute, as actual textiles do, to the compilation of a set of culturally-defined textile characteristics. However, unlike textiles, corrosion structures cannot be turned over, weaves cannot be manipulated and individual yarns cannot be separated. Even more basic issues include questions such as: does the pseudomorphic replacement process desiccate the yarns or cause them to swell, and do "tracks" in corrosion produced by yarns provide an accurate estimation of yarn diameter? If one is trying to obtain thread counts from rows of dots, exactly what part of the textile is a dot? Does a grid pattern really indicate the weave structure? As yet, protocols for the study of textile corrosion structures have not been established, and therefore, the retrieval of corrosion pattern data is not standard archaeological procedure.

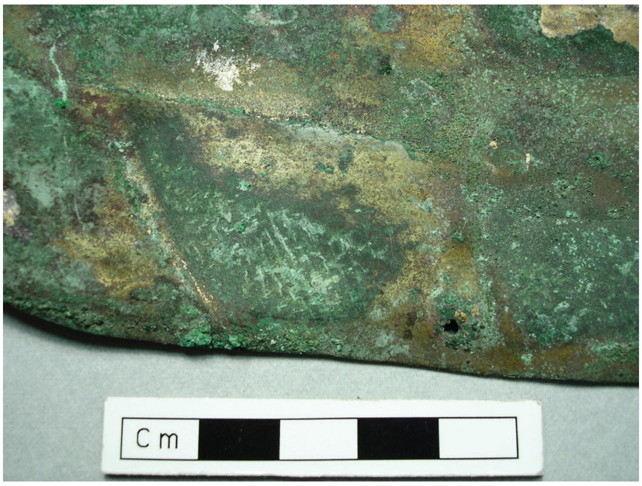

Fig. 1. Grid pattern produced by the undersides of textile yarns in contact with the metal surface. Detail of object 1987.394.133 (© Julie Unruh).

Fig. 2. Rows of dots and dots in a grid pattern indicating the position of yarns in a textile. Detail of object 1979.206.1270 (© Julie Unruh).

Project goals

A study of the Loma Negra textile corrosion patterns was initiated to serve two research goals. First, it was anticipated that the study would provide information about how to correctly read corrosion patterns, and that guidelines for the interpretation of textile-produced corrosion patterns could be proposed. The second goal was to recover a large body of information concerning objects made from organic materials deposited in Loma Negra tombs, in particular the diagnostic features of the textile structures. It was anticipated that a database of the Loma Negra textile corrosion information could form the basis of a Loma Negra textile typology, and by extension, contribute to a Moche textile typology.

Fig. 3. Parallel striations created by thicker yarns in the warp of a faced textile. Detail of object 1980.563.3 (© Julie Unruh).

A further benefit of the project was that the textile data clearly describes depositional relationships between objects made of organic materials and copper objects, a situation originally observed by Shaffer (1985). That facet of the study will not be described in this article.

Methodology

Each Loma Negra copper object was surveyed to assess the presence and location of corrosion structures that indicate lost organic material and the presence of surviving organic material. The survey confirmed that a textile had been in contact with virtually every buried object, and 21 percent of objects exhibited evidence for an association with two or more textiles. In total, 601 textile corrosion "events" were identified on 347 objects. Most of the objects lacking textile corrosion structures also lacked archaeological corrosion, indicative of past cleaning.

From the objects initially surveyed, 129 were chosen for in-depth analysis. This group was selected based on the legibility of the textile corrosion structures, the information to be gained by comparing particular structures, or to include multiples in a typological series. The textile analysis was a straightforward data-collection process and an inquiry into how to accurately read indistinct corrosion patterns that contain recoverable textile information. The methodology for the latter was simple: where preserved textiles or unambiguous textile corrosion structures existed side-by-side with less legible corrosion patterns, the two were compared and differences were tracked.

Insofar as possible, textile corrosion structures were analysed as if they were actual textiles. Weave structures were classified according to Emery (1966). Additional characteristics surveyed were thread count, single and plied yarn diameter, twist direction, number of single yarns in the plied yarn and ply direction. A decision not to record the angle of twist was made for two reasons: 1. it was anticipated that twist angles of corrosion structures could not be accurately measured; 2. hand-spun yarns often have great variability in twist angle, so a measurement of an angle on one yarn at one location is somewhat arbitrary. In retrospect, this decision was unfortunate. As it turned out, about 35 percent of the objects had extant organic yarns from which it would have been possible to record twist angle, and this piece of data might have been useful in indicating warp and weft directions.

Measurements were made using electronic calipers accurate to .01 mm, under appropriate magnification, which included a x3 head loupe, a x10 "thread counter" and a binocular microscope with a range of x10 – x80. Where textile fibres were extant, preliminary fibre identification was possible without sampling. Thirty-two of these identifications were confirmed using polarised light microscopy (PLM). Fourier transform infrared microscopy (FTIR) was performed on four additional samples.[2]

Interpreting textile corrosion structures

The investigation into accurately reading corrosion structures produced some answers about appropriate methodology, and revealed cases in which the textile corrosion structures should be considered untrustworthy. The following tentative guidelines are proposed.

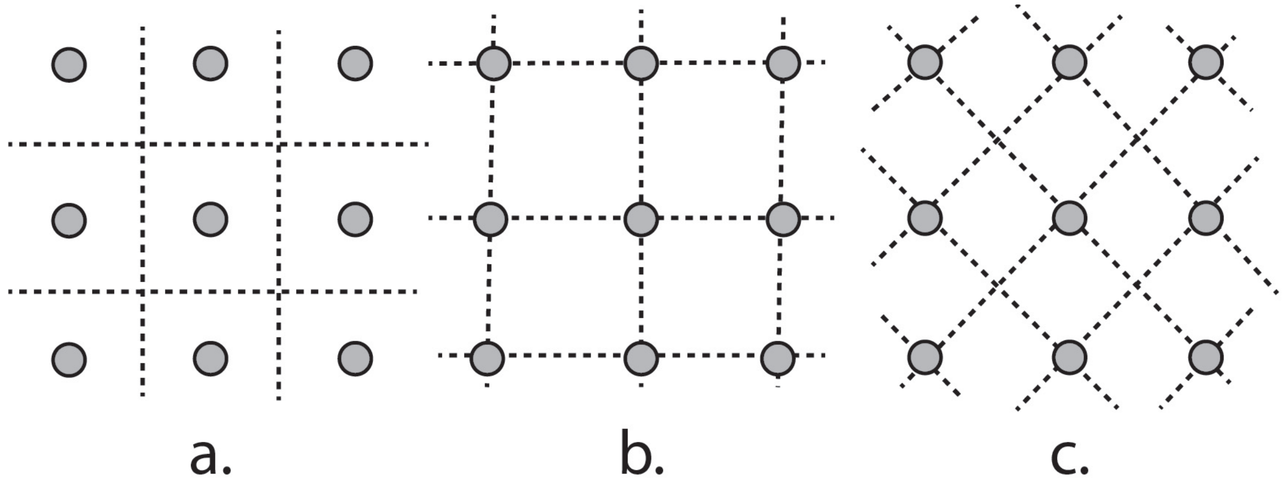

Fig. 4. Three possible interpretations of dots of corrosion: a) spaces between yarns; b) the points of contact of crossing yarns; or c) points of contact of yarns in one system only (Drawing: Julie Unruh).

Identification

Good textile pseudomorphs are visually obvious, but it may be necessary to train the eye to recognise the less apparent patterns that also indicate the former presence of a textile. Such patterns include grids, dots or dashes in regular formations, striations, concave impressions of yarns and unusually straight edges. The patterns may be delineated by differences in colour or texture. Unless the structure is a pseudomorphic textile that retains excellent detail, examining corrosion under high magnification is not helpful: at high magnification, patterns cannot be recognised. However, low magnification can assist in recording accurate measurements taken by hand. Raking light is essential for identifying low relief patterns, and a light source that is moveable to different viewpoints and angles is ideal. Positive identification of textile corrosion structure remains frustratingly difficult at times. Caution is necessary. Notably, the regular cellular structure of some wood can mimic a textile grid.

Structure orientation

An initial question was whether dots of corrosion in regular grid patterns represented spaces between yarns (Fig. 4a), or the points at which crossing yarns contacted the metal (Fig. 4b). Moreover, on a backstrap loom, warps are under higher tension than wefts. The result is physically straighter warps and wefts with more pronounced over-and-under contours. If the dots represented yarns in contact with the metal, and the textile was woven on a backstrap loom as expected, it might be possible that only the wefts would contact the metal. In that case, the correct orientation of the textile grid would be diagonal to the grid of dots (Fig. 4c)

In fact, all three situations were observed. However, in most cases, dot patterns were more likely to mark spaces between yarns rather than yarns. If that is the case, the most accurate measurements line up with the grid (Fig. 5). However, there were many instances in which the dots are clearly vestiges of the yarns themselves, as evidenced by somewhat elongated bumps or marks, or as concave impressions of the yarns (occasionally with visible twist directions). Where there was reasonable evidence that the dots designated yarns rather than spaces, the most accurate measurements were usually found to be oriented diagonally to the apparent grid, and thread counts were most accurately measured in a “w” or inverted “w” pattern (Fig. 6). Exceptions did exist.

Thread counts

It may be possible to measure only a few threads in a pattern. In these cases the thread counts per centimeter can be extrapolated (threads/cm = n/d, where n = number of yarns measured, and d = total distance measured in centimetres). Where possible, a useful strategy is to extrapolate thread counts in several locations, and to calculate an average thread count.

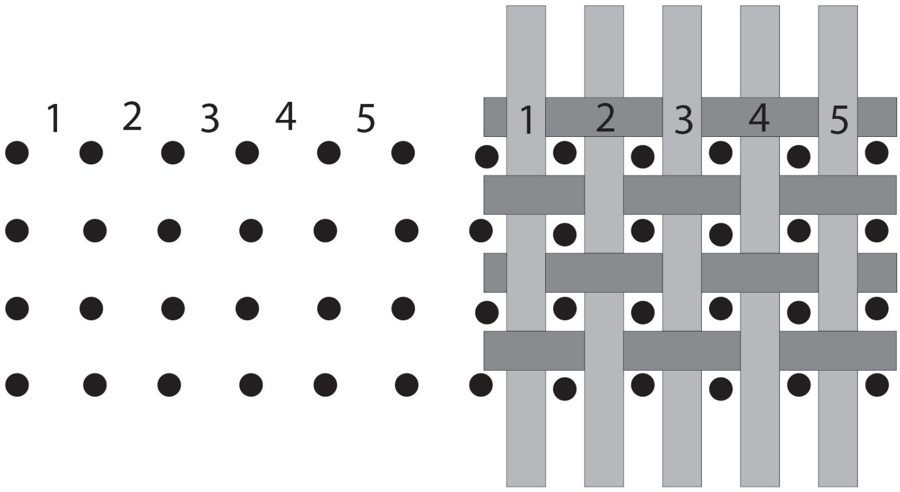

Fig. 5. Measuring a thread count with corrosion dots representing spaces between yarns (Drawing: Julie Unruh).

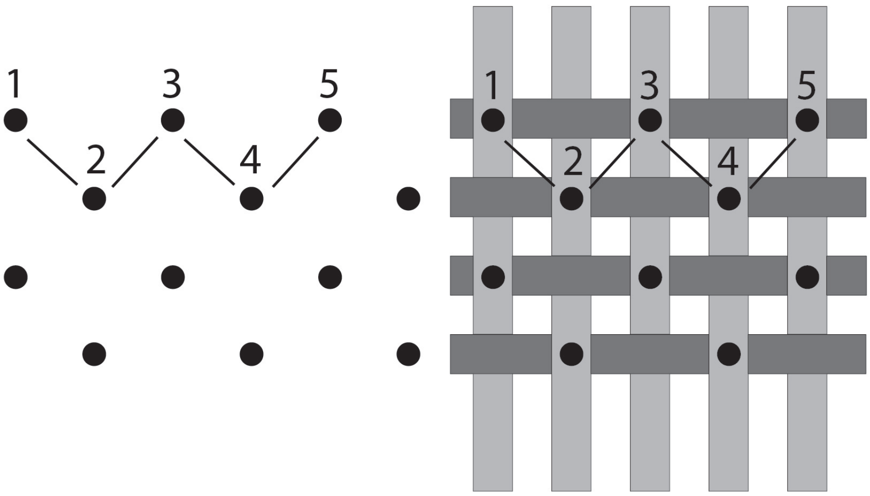

Fig. 6. Measuring a thread count with corrosion dots representing threads in one system only, in a "w" pattern (Drawing: Julie Unruh).

A test was performed to gauge the level of accuracy of thread count extrapolation using two modern basket weave textiles with known thread counts of 23 and 20 threads/cm. Nine measurements of each textile were taken using 4-20 elements. For both textiles, the extrapolated thread counts had between 81 percent and 100 percent accuracy, with accuracies averaging 94 percent. This degree of accuracy was considered satisfactory.

Yarn diameters

The effects of yarn degradation and mineralisation on yarn diameter are not known. In the Loma Negra collection, it was possible to directly compare organic textile remains with corrosion structures produced by the same textile. In this collection, from the particular burial environment of Loma Negra tombs, some trends could be identified, though they were not as consistent as would be wished. Three-dimensional mineralised yarn structures were usually slightly larger in diameter than the corresponding organic yarns. "Tracks" left by yarns in grid patterns generally measured slightly smaller in diameter than the corresponding organic yarns. Differences were in tenths of millimeters; however, since yarn diameters frequently are only tenths of millimeters, that magnitude of error was significant. More work is needed to determine whether these observations indicate consistent relationships, and if so, whether it is possible to identify a likely degree of error for measured diameters of mineralised yarns and two-dimensional marks produced by yarns.

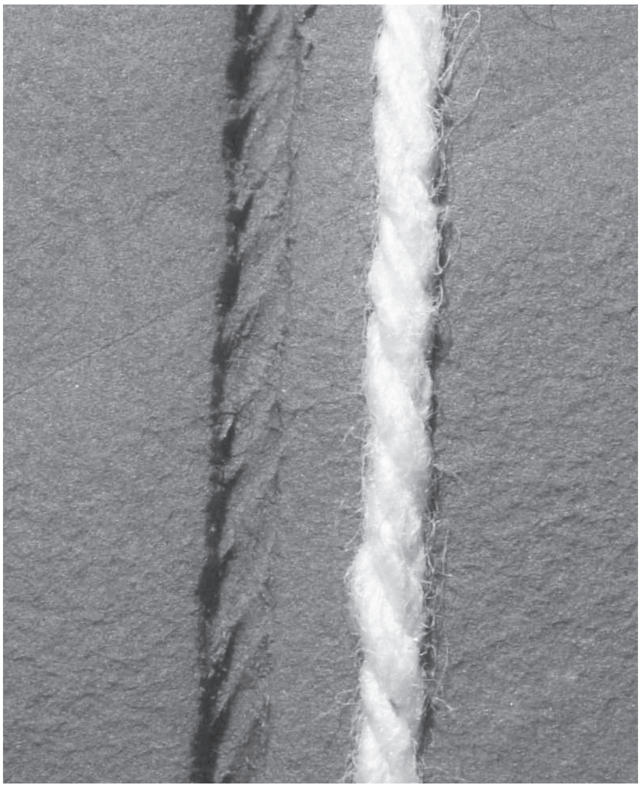

Fig. 7. Reversal of perceived twist direction in an impression (Drawing: Julie Unruh).

Twist direction
If yarn structures are negative impressions, the twist direction will appear as reversed (Fig. 7). If only the lower section of a yarn is extant, either as mineralised or organic material, the twist will also appear reversed. In order to establish the correct twist direction, it is therefore important to first determine whether the corrosion structure is an impression or only the lower section of a yarn. Sometimes this determination is possible; sometimes it is not.

Weave structure
All woven textiles are based on warp and weft systems at right angles to each other. Even complex weaves utilise this basic grid structure, and if only vestiges of complex weaves are preserved, it is the regularity of the grid that is most apparent in the corrosion. The visual dominance of a grid pattern has been observed even in textile corrosion structures produced by twill weaves that might be expected to have a diagonal appearance. It seems that even when other characteristics of a textile can be determined with some accuracy, unless the weave structure can be clearly seen, it may remain in question. The Loma Negra analyses were greatly assisted by the fact that many weave structures of surviving textiles remained intact.

Corrosion products
An in-depth investigation into the process of pseudomorphism was beyond the scope of this study. However, it was possible to do a baseline study of corrosion on Loma Negra artefacts to ascertain whether corrosion products associated with textile structures were random or systematic.

During the initial survey phase, corrosion products associated with textile patterns were classified by colour and type of textile corrosion structure with which they were related. The identification of copper corrosion products via colour is notoriously erroneous, but with no possibility of a large-scale analytical programme, a visual assessment based on colour proved expedient. Subsequently, certain specific corrosion products were identified using open architecture x-ray diffraction (XRD), microdiffraction XRD, open architecture x-ray fluorescence (XRF)[3] and energy dispersive x-ray spectroscopy (EDS)[4]. A programme of XRD and EDS analysis performed in 1997 also contributed additional useful data (Shaffer and Uricheck 1997).

Based on the visual assessment, correspondences were indeed found. A turquoise colour was seen only in association with textile corrosion structures and never in the absence of textile. A corrosion product thought to be paratacamite (a bright, pale green colour) was in association with 68 percent of textile corrosion structures, with probable malachite (dark green) second most common and probable cuprite (bright red) third. The majority of partially mineralised yarns were categorised as turquoise, blue or the pale green “paratacamite”. However, the majority of completely mineralised yarns were tagged “malachite” or “cuprite”. The majority of the corrosion which had formed two-dimensional patterns under or between yarns also appeared to be malachite or cuprite.

The turquoise product remains unidentified. The best matches to some of the lines in the XRD spectra may be ramsbeckite, a copper sulphate, and langite, a copper sulphide. However, the sample contains additional species or phases that could not be identified. Gillard and Hardman report that in experiments reproducing negative casting with a sodium chloride solution a “blue-green mineral layer is rapidly deposited on the surface of the metal and textile”; the mineral layer, called botallackite, recrystallises to atacamite, and then to paratacamite (1996, 178). The majority of all partially mineralised yarns in the collection are either turquoise or blue, which is consistent with a theory that some of them may be yarns at the initial botallackite stage. Another possibility is that the turquoise colour simply indicates copper-stained organic remains. “Turquoise” may therefore indicate not one product, but a group of possibilities. Nonetheless, the observation that turquoise occurs only in association with textiles structures is worth further investigation.

A product visually identified as paratacamite was in association with the majority of textile corrosion structures. In instances in which the product was analysed via XRD and by the silver nitrate chemical spot test (Odegaard *et al.* 2000, 108), nearly 50 percent of what was categorised as "paratacamite" was not (an observation of particular interest to conservators, who are frequently required to make visual identifications of paratacamite). Nonetheless, even if only half of the suspected cases are paratacamite, there remains a high correlation of this compound in association with textile corrosion structures, again an observation worth further investigation.

XRD analysis of corrosion products was only possible for 12 textile corrosion and feather samples. A predominance of malachite and cuprite was confirmed in this small sample. The preliminary evidence suggests that despite the availability of a variety of anions, a limited number of corrosion products become pseudomorphic structures. It seems germane that the few textile pseudomorph copper corrosion products reported in the literature are all carbonates, oxides or chlorides (Gillard and Hardman 1996; Gillard *et al*. 1994; Gillard, Hardman and Watkinson 1993; Chen, Jakes and Foreman 1996; Jakes and Sibley 1984; Sibley and Jakes 1982; Carroll 1973). Chen has proposed a fibre mineralisation model in detail (1995). However, her model proceeds from the assumption that malachite and atacamite will be the end products. No published models explain why malachite and atacamite would be thermodynamically preferred products across dissimilar environments. Reasons for the mineralisation of yarns by certain products to the exclusion of others have not been suggested.

Given the small range of corrosion products, it becomes interesting to look at what defines a textile pattern. In some cases, the arrangement of malachite versus cuprite creates the pattern. For example, the textile structure can be delineated by malachite dots on cuprite backgrounds, the dots corresponding to spaces between yarns. This arrangement also appears in reverse: cuprite dots on malachite backgrounds. Cuprite converts to malachite, so in the first scenario, a cuprite layer first developed under the textile, after which malachite developed between the yarns. In the second scenario, a cuprite layer developed under the textile, after which malachite developed under the yarns. There is no obvious determining factor for the position of malachite formation. Nor is it obvious why, if the two products are transposable in the same type of pattern, they remain distinct.

Jakes and Sibley describe the colour differences in a pseudomorphic silk textile composed of green and black corrosion products as caused by differential mineral replacement and attribute the difference to dyed versus undyed fibres (1984, 421–422). A comparable situation exists in the Loma Negra material. In the majority of faced textiles, although both warp and weft appear to have been cotton, the faced yarns are more mineralised, and the unfaced yarns remain more organic. It seems that a difference in the chemistry of the fibres has promoted preferential mineralisation of the faced set. Moche cotton was rarely dyed, but it was deliberately grown in a range of colours (Vreeland 1999). Whether structural differences of naturally pigmented cotton could promote preferential mineralisation has not been investigated.

In some cases, the perceptible pattern is produced by different crystal morphology or "habits".[5] Finer crystals appear lighter; larger crystals appear darker. It seems that specific habits of malachite, in particular, correspond to specific sites with respect to the textile. Malachite under yarns forms as finely divided, pale green, white or grayish crystals, creating pale two-dimensional "tracks" of yarns and grid patterns. Malachite which forms between yarns is dark green, generating a pattern of dark green dots. Mineralised yarns and three-dimensional grid patterns are also dark green, glossy malachite. Malachite within partially mineralised yarns appears pale green.

In short, preliminary observations suggest that mineralisation of textile yarns may involve only a small number of specific corrosion products, and the crystal morphology of those products varies with location in predictable ways. Again, these observations merit further study.

One additional question was whether camelid could be distinguished from cotton via corrosion product. Camelid is a keratin which contains the amino acid cysteine, which contains a disulphide bond. In theory, the sulphur present in cysteine might remain in the corrosion layer as a cuprous sulphide. Feathers, which are also cysteine-containing keratin, might also leave the same marker.

Because camelid was scarce in this collection, feather pseudomorphs were analysed to determine whether the presence of sulphur can be used as a marker for protein. In three trials, feather pseudomorphs were found to be composed of malachite, cuprite and/or atacamite, with no sulphur component in any of the samples. Gillard and Hardman propose a reason: "At pH < 9, the bonding of copper to the wool matrix is predominantly due to green carboxyl/copper (II) complexes. Copper (II) complex formation at disulphide sites is minimal. Copper (II) ions catalyse the oxidation of the disulphide bond but bind elsewhere, presumably through greater electrostatic attraction" (1996, 179). In fact, only two sulphur-containing corrosion products were identified via XRD: brochantite, from a location in which there were not believed to be any textile corrosion structures at all, and the unidentified turquoise, which is seen in yarns positively identified as cotton. Silver scavenges sulphur, gypsum contains sulphur, and in a tomb, the decomposing body is a source of protein. Accordingly, even if sulphides were found in association with feathers, the presence of so much sulphur not in association with a feather source seems a good indication that in this collection, sulphur-containing corrosion would have to be considered an unreliable marker for keratin.

Textile analysis results and discussion

Two hundred and four instances of textiles, 69 instances of cordage, 39 instances of feathers (12 in clear association with textiles) and seven instances of plant fibres or wood were identified on the 129 artefacts subjected to in-depth analysis. Additionally, 17 of those objects had corrosion patterns indicating lost materials that remain unidentified.

Basket weave: a possible diagnostic for Loma Negra

Textiles have stylistic differences that vary with time and geographical origin. It is therefore possible to construct a cultural and chronological sequence of textiles similar to the ceramic sequences used by archaeologists. As with ceramic chronologies, a textile sequence can demonstrate cross-cultural influences, identify periods of social change, indicate technological developments and provide other information of use in interpreting the archaeological record. At least one textile sequence has been demonstrated to expand the ceramic sequence for coastal Peru (Wallace 1979).

Excavated data is always incomplete data. Moreover, some Moche sites have not yet published their textiles' diagnostic statistics. In general, textiles attributed to the Moche culture have not yet been extensively studied or published. Accordingly, a typology for Moche textiles is in its initial development.

The majority of published Moche textiles, both with and without provenance, are decorated textiles. Weave structures include brocade, tapestry, and double and triple cloth, as well as extraordinarily complex weaves with discontinuous warps, wefts and complementary yarns (Donnan and Donnan 1997; Prümers 1995; Kajitani 1982; Conklin 1979; O'Neale 1947). Excavated Moche textiles do include large numbers of undecorated plain weaves, as well as undecorated twills, plaiting and interlacing; however, only France-Éliane Dumais has studied undecorated textiles in depth (2008). The focus on decorated textiles to the exclusion of the others means that a broad concept of Moche weaving has yet to be formulated. However, several scholars have proposed diagnostic characteristics for both yarn make-up and woven structure for the Peruvian North Coast and Moche. Moche yarns are predominately cotton, s-spun singles. Camelid fibre is typically z-spun, plied and used sparingly in conjunction with cotton yarns. The principal Moche weave structure is a plain weave utilising single (rather than paired) yarns in both warp and weft.

The Loma Negra objects are thought to have been deposited in tombs. Accordingly, the associated textiles do not necessarily typify Moche textiles in general use: they can only be said to represent a group of textiles deposited in a burial context and specifically those in contact with metal objects. Moreover, the corrosion can only record the portion of the textile in direct contact with the metal object's surface: one layer of yarns and one side of the textile. Since Moche weavers created structures which incorporate more than one set of yarns in warp, weft or both, and in which obverse and reverse are dissimilar, it must be assumed that some of the data recorded in the corrosion is incomplete. Accordingly, it must be assumed that the Loma Negra textile corrosion structures present a simplified picture of the textiles in the Loma Negra tombs. Fortunately, the simplification does not negate the usefulness of the data. Even if a complete weave structure is not present or cannot be fully deciphered, as long as basic characteristics can be determined, a typology of diagnostic weaving characteristics for Loma Negra tomb textiles can be generated.

The textile corrosion data indicates that the Metropolitan Museum's Loma Negra textile type is largely consistent with the proposed Moche type described above. It utilises s-spun, single yarns, predominantly cotton, with camelid fibres used to a much lesser extent. 29 % of the Loma Negra textile corrosion weave structures analysed in detail remained unidentified, and 15 % were only tentatively identified; but among those positively identified, plain weave predominated as expected, at 93 %.

However, excluding faced plain weave (which normally requires single elements in the faced system to achieve the desired effect, and which accounted for 13 % of plain weave), only 25 % of the plain weave uses one yarn in each system. Instead, a majority of the plain weave textiles, at 65 %, utilise paired yarns in both warp and weft – *i.e.* basket weave (or 2/2 plain weave, Fig. 8). The remaining 10 % of plain weaves

Fig. 8. The primary textile type in association with the Loma Negra material: s-spun cotton (unplied) singles in a basket weave. Detail of object 1979.206.1275 (© Julie Unruh).

utilise combinations of singles and pairs (*i.e.* half basket weave).

If tentative identifications are included, increasing the sample size but decreasing the statistical validity, the numbers remain similar. 29 % of the textile corrosion weave structures remained in question, but among those positively identified or tentatively identified, 92 % are in plain weave; 13 % of the plain weave textiles are faced; of the remaining plain weave textiles, 30 % use one thread in each system and 61 % are basket weave.

Even allowing for a degree of error in the corrosion/textile analysis, this is a higher percentage of basket weave than has been reported elsewhere. Paired warps and wefts account for 11.5 % of El Castillo (Moche III) plain weave textiles; 20 % of Guadalupito (Moche IV) plain weave textiles (Dumais 2008); approximately 33 % of the Pacatnamu plain weave textiles (Donnan and Donnan 1997); 26 % of Gallinazo – Moche I fragments from the Virú Valley and Santa Valley (Wallace 1979); 11% of Conklin's Moche III-V sample (1979); and 15 % of the Vicús textiles (AD 250–650) in the collection of the American Museum of Natural History, New York (personal observation, 2007).

As noted earlier, this study only counted occurrences of textile structures, not individual textiles. In several cases what appears to be the same textile can be tracked across several objects. It is therefore possible that there were only a handful of textiles with paired warps and wefts, each in contact with dozens of objects. In fact, this interpretation is reasonable based on excavated precedent and on the textile data. In the Moche tombs excavated at Sipán, large textiles were wrapped around entire burial groups, enclosing multiple assemblages of artefacts (Alva and Donnan 1993; Prümers 1995). In the Loma Negra textile data, the thread counts and yarn diameters of basket weave textiles form a continuum: in both warp and weft, thread counts range from eight to 32 yarns/cm (four to 16 pairs/cm) with yarn diameters ranging from 0.16 mm to 0.9 mm in both sets of yarns. Based on visual characteristics, it seems unlikely that the Loma Negra basket weave textile corrosion structures all represent the same piece of fabric (Christiansen 2005, elaborates on the inability of standard data points to fully describe visually distinctive types). Statistically, the variation in thread counts almost certainly describes more than one textile. But in light of expected variations in hand-woven textiles, the majority of basket weave textile corrosion structures could, in fact, all derive from only a few textiles in contact with multiple objects. As a point of comparison, within one Chimu plain-weave backing on a mantle fragment in the collection of the Metropolitan Museum (33.149.99), the thread counts vary from 12 to 24 threads/cm in the warp, and 5 to 11 threads/cm in the weft, with a variation of yarn diameters from 0.22 mm-1.2 mm.

Nonetheless, paired warps and wefts seem to occur as a feature of Moche tomb textiles more often than previously acknowledged. Five out of the six Moche weave structures from Moche I and Moche III burials at Huaca del Sol have pairs in both warp and weft (Donnan and Mackay 1978). The Moche IV textiles from Site F in the cemetery at the foot of Huaca de Luna include an unusual number of basket weave textiles (O'Neale 1947). Wallace observes that in general, paired warps and wefts are common in Peruvian North Coast textiles (Wallace 1979, 41; 1975, 110). An informal survey of textiles on view in the Museo Tumbas Reál de Sipán in Lambayeque, Peru identified a basket weave structure in the majority of cases (personal observation, 2007). Additionally, although the weave structures of the textiles from El Brujo have not been published, two textiles from the tomb of "Señora de Cao" which are illustrated in detail appear to be basket weave (Barreda 2007, 230 –231).

It seems that the Loma Negra basket weave textiles are not as anomalous as they first appear. The possibility that a basket weave should be viewed as a diagnostic feature of Moche tomb textiles or perhaps even a widespread Moche type deserves further investigation. In fact, it has been proposed that the basket weave structure was developed as a basic weave on the North Coast (Wallace 1979, 47 and 49). Further, it was proposed that paired wefts, rather than warps, are the *diagnostic* component of this weave structure, a suggestion that is supported by the continuation of paired warps but not paired wefts into the later Chimu period (Rowe 1984).

Donnan and Donnan theorise that "weavers used single warps and wefts when they wanted an open, light-weight fabric, and paired warps and wefts when they wanted a more tightly woven, heavier fabric" (1997, 217). However, the Loma Negra material does include basket weaves that could be characterised as open, indicating that the fabric density was not the sole factor in the choice of weave structure. Many researchers have proposed a deeply embedded principle of dualism that pervades pre-Columbian Peruvian cultures from the Initial through to the Inka periods, manifested in political, religious, aesthetic and mythical arenas (Schorsch 1998; Quilter 1997; Burger and Salazar-Burger 1993; Lechtman 1984; Lechtman 1977; Moore 1995). It is tempting to ascribe the use of not just pairs, but of pairs of pairs, to cultural values relating to dualism and symmetry, particularly in light of the symbolic meaning proposed for paired yarns in textile weave structures from elsewhere in pre-Columbian Peru.

Camelid

Moche weavers used camelid sparingly, but published assemblages of Moche textiles do contain camelid (Conklin 1979; Donnan and Donnan 1997; Dumais 2008; Kajitani 1982; O'Neale 1947; Prümers 1995; Wallace 1979; O'Neale and Kroeber 1930; Kroeber 1944). The Loma Negra collection exhibits an overwhelming preponderance of cotton and a puzzling scarcity of camelid. Thirty fibre samples from 19 textiles were identified using polarised light microscopy: 28 are cotton, and only two are camelid. Fourier transform infrared spectroscopy (FTIR) was performed on four additional samples which seemed likely to be camelid in light of the weave structure, fibre colour or spin direction: three of the four were cellulosic (cotton), and the fourth was indeterminate. A near absence of camelid at Loma Negra is inconsistent and unlikely. One explanation is that the camelid has degraded to the point that it is difficult to identify via microscopy, implying an alkaline environment (Sibley and Jakes 1984). In a number of cases, organic textile remains are associated with a brown or rust-coloured substance which is not obviously burial soil and that sometimes seems to occur in geometric patterns. Although two FTIR trials did not identify protein within this material, it may be the trace of degraded camelid yarns and seems worth more in-depth investigation.

Additional structures

The Metropolitan Museum corrosion/textile structures include double cloth in 2 % of the positively identified weave structures, plaiting or interlacing (1 %) and twill (4 %). Additionally, 8 % of the weaves were suspected to incorporate supplementary yarns, though none of those cases were confirmed. All of these values are likely to be low estimates. Because only one side of a textile is recorded against the surface of the metal, and because only fragments of textiles are preserved, it is very unlikely that all double cloths and textiles with supplementary yarns were identified on the Metropolitan Museum objects. Likewise, the technique of plaiting cannot necessarily be distinguished from weaving in corrosion patterns, and interlacing could only be confirmed if an extant interlaced edge survives, so it is likely that the percentage of plaited or interlaced textiles is actually higher than identified. The 4 % occurrence of twill weave is also lower than expected. Twill is reported in four out of six cases of the textiles from the Moche III Burial M-III at Huaca del Sol (Conklin and Versteylen 1978), accounts for 25 % of textiles at Pacatnamu (Donnan and Donnan 1997) and is proposed by Wallace (1979, 49) and O'Neale (1946) to be characteristic of Moche. However, 29 % of the Loma Negra textile corrosion structures analysed in detail had weaves that remained unidentified, and 15 % were only tentatively identified. Some of these are fragments of complex weaves for which a repeating pattern could not be discerned, but a portion of the "uncertain" group included structures that were too indefinite to identify, and these may include additional twill.

"Cordage" was defined to include sewing thread, feather attachment threads, cords used to secure the metal objects to unknown substrates, and wrapping cords. Ninety-nine instances of cordage had been identified in the initial survey, and 69 of these were examined in detail. Of those cordages for which twists and number of ply could definitely be discerned, 52% are ss/Z cotton threads. However, z-spun cotton does exist (3 %). The number of ply generally ranges from one to six, though one s-spun cord consists of at least 27 threads plied Z.

Feathers were found on 17 % of the 367 artefacts initially examined. In the 39 occurrences of feathers on the objects examined in detail, the feathers showed evidence of an associated textile in 12 cases. In other words, of the 204 textile events examined in detail, 6 % are believed to have been feathered textiles.

Grassy plant material or wood was identified on only 2 % of the objects. This percentage seems low, based on our understanding of North Coast burial practices, and it seems likely that more thorough inspection of those objects not examined in detail would reveal more instances of plant material.

Conclusion

The information contained in corrosion patterns can be well worth the effort of recovery. The rediscovery of a group of textiles physically absent from the archaeological record is the obvious benefit to documenting information recorded in corrosion. The corrosion textile structures observed on the Museum's Loma Negra collection also provide enough data to expand the textile sequence of North Coast Peru, and raise the possibility that basket weave may be a diagnostic feature of Loma Negra tomb textiles. It is emphasised that the majority of the corrosion structures analysed were not three-dimensional pseudomorphic replicas of textiles. The bulk of useful data was recovered from two-dimensional textile corrosion patterns, which are not usually analysed as part of standard archaeological procedure.

Notes

1. In this article, "pseudomorph" refers to mineral-replaced or partially mineral-replaced textile structures. The term "textile corrosion structures" refers to both mineral-replaced textiles and to the largely two-dimensional corrosion patterns produced on the Loma Negra artefacts by contact with textiles during burial.
2. Fourier transform infrared spectroscopy was performed by Marco Leona, David H. Koch Scientist in Charge, Department of Scientific Research, The Metropolitan Museum of Art.
3. X-ray diffraction and x-ray fluorescence were performed with the assistance of Tony Frantz, Research Scientist, Department of Scientific Research, Metropolitan Museum of Art.
4. Energy dispersive x-ray spectroscopy was performed by Mark T. Wypyski, Research Scientist, Metropolitan Museum of Art.
5. Observation initially made by Ellen Howe, Conservator, Sherman Fairchild Center for Objects Conservation, The Metropolitan Museum of Art (personal communication, 2007).

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Textile Archaeology in Roman Venetia

Background

As confirmed by literary and epigraphic sources from the 1st century BC to the late Roman period, the production and trade of wool and woollen fabrics played a primary role in the economic system of Roman Venetia, area large part of the Augustan *Regio X* (which corresponds now to north-eastern Italy). The topography and natural resources must have contributed positively to the emphasis on sheep breeding, since it contains plains, alpine pastures and coastal salt works.

The PhD research presented here is one of a long line of studies developed by scholars of Padua University over the last two decades. Comprehensive studies began with an investigation of iconographic, literary and epigraphic evidence of textile processing in the ancient Venetian region, followed by a topographic approach aimed at identifying the routes of transhumance and the relationship between breeding and farming. Later, the main interest turned to archaeological data, especially concerning the analysis of settlements specialised in sheep breeding, which culminated in the years 2004-2010 with the only excavation of Roman sheep farm in Italy thus far (found in the Ca'Tron estate, in the Altinum area, near Venice's North Lagoon) (Busana, Cottica and Basso 2012; Busana *et al.* 2012).

More recently, new attention has been paid to archaeological textile tools, which are essentially the only archaeological traces left by textile processing in our region. (Because of the terrain features, fibres, yarn and textile fabrics are rarely preserved in Italy: a piece of wool from Adria, studied by Margarita Gleba, is the only Roman fabric known from Venetia until now: Gleba 2012).

In 2009 the *TRAMA Project – Textiles in Roman Archaeology: Methods and Analysis* began, which consisted, at that time, of a survey of Roman textile tools, limited to the western area of ancient Venetia (the provinces of Brescia, Verona, Vicenza and Padova), in order to collect data for further investigations on the technology and economic, social and ideological aspects of textile craft.

PhD research

Within the same *TRAMA* Project, my doctoral project (University of Padua, Italy, 2011-2013) has been a natural development, the main goals of which can be summarised in two steps: to define the number of textile archaeological records and, in so doing, complete the systematic survey of textile implements, published and unpublished, found in the eastern Venetia region (the provinces of Rovigo, Venezia, Treviso and Belluno) and to build a plausible framework for textile making based on specific analyses of finds and their contexts of provenance (Fig. 1).

In the eastern district 1630 finds were recorded that include shears, spindle whorls, spindle shafts, distaffs, spindle hooks, loom weights and spools from the 2nd century BC to the 5th century AD, a sample believed to be significant and able to reveal trends with a good degree of reliability.

In order to consider such a large number of artefacts, a comprehensive database using open source software (SQLite interfaced with Openoffice.org Base) was

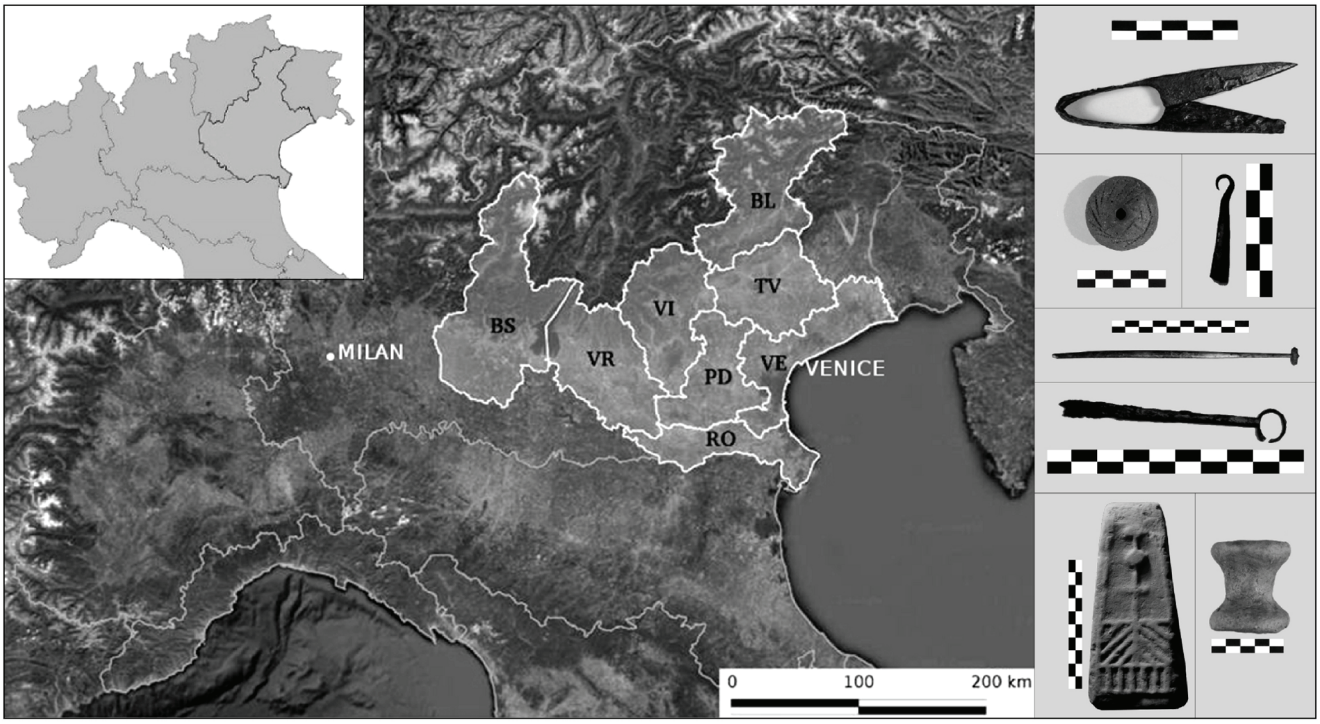

Fig. 1. Area of research and classes of tools recorded (Illustration by author, Photos: courtesy Ministero dei Beni e delle Attività Culturali e del Turismo – Soprintendenza per i Beni Archeologici del Veneto).

created (Busana, Francisci and Tricomi in press). The database includes two different tables linked to one another: a 'Site Table' (where data was collected about the discovery and the context) and a 'Finds Table' (containing administrative data, class of object, raw material, morphometry, weight, decoration, condition, wear, chronology, bibliography and archive data of each tool, using fixed vocabularies). Each item was then documented using photos and sometimes drawings. The database was also linked to a GIS that allowed us to manage data more efficiently and to perform statistical and spatial analyses.

After a general overview of the *chaîne opératoire* of textile processing and a focus on the 'textile industry' of the investigated area from ancient sources and environmental data, the study focused on artefacts, particularly on their functional and morphometric parameters.

Textile tools

The shears class in the database includes only two items. Finds of shears are rare in the Roman period in the whole of central and eastern Venetia, and this may be because of the state of research and/or the effects of ancient recycling. This contrasts with the data available for western Venetia, where the frequency of finds in funerary contexts seems to be connected to Celtic cultural influences.

Spindle shafts and distaffs are also very rarely found, apart from rare examples in durable material, as they were made mostly of wood and bone and are therefore subject to problems of conservation and recognition if they only survive in a fragmentary condition.

Of the spinning tools, the most numerous are the spindle whorls, corresponding to 182 items, although the larger class of recorded objects is that of loom weights (1630 implements). Spools are rare too, perhaps for technological reasons.

Quantitative analysis carried out on measurable parameters allowed us to identify particular morphological categories and a specific range of measures.

As regards the spindle whorls, they were divided into six morphological categories. The discoid-shaped are the most attested, followed by the truncated cone-shaped and the spheroid ones. Other morphologies such as the biconical, the bitruncated cone-shaped and the hemispheroid spindle whorls appear in lesser numbers. The majority of items weigh between 15 g and 30 g, with a peak between 20 g and 25 g.

Amongst the loom weights it is possible to distinguish two morphological macro-groups: the discoid-shaped and the truncated pyramid-shaped. The latter includes three variants related to shape and size of the lower base:

1. truncated pyramidal with a rectangular base, presenting a regular profile from the side
2. truncated pyramidal with a thin rectangular base, where the side profile gets thinner below
3. truncated pyramidal with a square base, where the side profile gets thicker below

As proved by experimental archaeology, great attention has to be paid to the loom weight's profile, because thickness variations affect the position of the loom weights when they are hung side by side on the loom and, therefore, the general result of the fabric woven (Mårtensson *et al.* 2007; Mårtensson *et. al.* 2009; Andersson Strand 2012, 210-212).

The truncated pyramidal loom weights with rectangular base are the most numerous, a shape which is confirmed as the most common. As concerns the weight, the majority of loom weights is concentrated in a specific weight range, since most of them weigh between 500 g and 800 g, with a peak between 600 and 700 g.

Chronologically, it should be emphasised that no loom weight dates past the 2nd century AD, which suggests a decline in this period of the use of the warp-weighted loom, which was probably gradually replaced by the two-beam loom or another kind of loom, as testified in literary and archaeological evidence (Wilson 1938, 21; Hoffmann 1964, 327; Wild 1992, 12-17).

Considering the physical and functional parameters of objects is a fundamental step that highlights the high degree of standardisation of a lot of implements and reveals the presence of tools specialised for the production of particular types of fabric.

Conclusion

In light of the recent results of experimental textile archaeology, available data in our region seems to indicate a production of yarns and fabrics in the Roman period of intermediate quality, neither too fine nor too coarse, with a few rare exceptions. Such a framework does not contradict what is known from the ancient literary sources that tell us about a sort of Cisalpine primacy in the production of coats and blankets (in Latin *gausapa*, *lodices* and *trilices*): not characterised by fineness and elegance, but famous for their hardiness and heaviness.

A further stage of research has considered the parameters of the weight of spindle whorls and loom weights according to the archaeological context, rural or urban. Both classes of tools are heavier and more standardised in the countryside than in the cities. We think that this variation is very relevant, since it represents an index that can reveal a varied yarn and textile production, finest in the city and heavier in the country, thus destined for different consumers or markets. Furthermore, the urban yarns and fabrics appear to have been more differentiated as regards the quality, suggesting a demand for a wider range of products, perhaps aimed at customers of different social and economic classes. The rural areas seem instead to have been engaged in intense textile production at a slightly lower qualitative level.

Very interesting has been also the comparison between finds from funerary contexts and those from settlements, a topic which concerns the symbolic meaning attributed to textile tools. Spindle whorls and other spinning tools are well attested in Roman tombs as grave goods of female burials, while loom weights or spools rarely appear in cemeteries and, if present, the burial is not marked by gender indicators. Thus this reveals a specific selection, where only some objects – *i.e.* the spinning tools – are invested with a particular symbolic significance. Spindle whorls, spindle shafts, distaffs and hooks in the Roman world were considered not only as activity markers, but also as symbols of feminine virtue and moral qualities, relating to the role that Roman society attributed to women. Otherwise, this meaning is not extended to weaving tools, showing a discontinuity with previous pre-Roman habits, when local Venetian Iron Age people used to put loom weights, spools and even miniature looms as grave goods in the burials of the most influential women. The change can be seen as the result of a different organisation of textile manufacture in Roman times when the weaving activities were removed from the purely domestic sphere of women and in all likelihood implemented at a larger scale and carried out in appropriate workshops by male individuals, workers or slaves as well.

In conclusion, the research presented here offers an innovative and systematic analytical approach to archaeological textile evidence, trying to go beyond simple typology. It is focused on preserved textile tools, in order to identify the fabrics that unfortunately have not survived. The inspiration was provided by studies carried out by the Centre for Textile Research (CTR) in Copenhagen. In a more general perspective, this work stands as a possible model for the study of these kinds of archaeological records, which may potentially be useful in other spatial and chronological contexts.

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Julia Galliker

Middle Byzantine Silk in Context

Integrating the Textual and Material Evidence

Introduction

During the first millennium AD, silk became the most desirable fibre in the Mediterranean region. The material's westward spread through long-distance trade was a major factor in cultural and economic exchange among distant civilisations (Loewe 1971; Young 2001, 14-15; Hansen 2012, 235). While historians generally agree on the broad outlines of this process, the conventional understanding of silk as an exclusive material confined to the imperial court in the middle Byzantine period (AD 843–1204) is poorly integrated with the body of evidence and lacks explanatory value. The goal of my recently completed PhD project at the Centre for Byzantine, Ottoman and Modern Greek Studies at the University of Birmingham, UK was to redefine the current historical understanding of Byzantine silk by demonstrating its social importance, contribution to technology development and integration into the regional economy. The following provides a brief overview of the historical context associated with silk, research problems, methodologies and findings presented in my dissertation "Middle Byzantine Silk in Context: Integrating the Textual and Material Evidence".

Historical context

Byzantine writing conveys the importance of silk to the empire during the full extent of its history. Following the Arab conquest and territorial losses in the 7th and 8th centuries, silk was among the resources rationalised for imperial purposes. 10th-century sources such as the *Book of the Eparch* (Koder 1991, 20-41) and the *Book of Ceremonies* (Reiske 1829) demonstrate the ways that silk was employed by the Byzantine state in various ceremonial, diplomatic and economic roles.

In Byzantine sources, representational pattern weaves were prominent as a vehicle to project meaning, rank and status. Designs portrayed impressive symbols such as lions, griffins, mounted riders, peacocks and eagles (Reiske 1829, II.15.581-588). In addition to written sources, representational images in various media displayed luxury textiles as a means to project imperial status and power. Among the textiles depicted in illustrations, several portrayed figured patterns similar to those described in written works. For example, the portrait of Nikephoros III Botaneiates (1078-1081) and his courtiers displayed garments with a variety of woven repeating patterns as shown in Fig. 1.

Complementary to literary and representational evidence for figured silks, hundreds of textile fragments attributed to Sasanian, Byzantine and Islamic workshops are now held in museum collections and religious institutions. Fine silks were highly valued in medieval Europe and were used for liturgical and reliquary purposes (Muthesius 1982; 1997, 119-139). In the late 19th and early 20th centuries, non-scientific excavations in Egypt led to the large-scale transfer of remains to the antiquarian market (Fluck *et al*. 2000; Fluck 2005; 2008). Examples of catalogues showing silks recovered from church treasuries, shrines, tombs and cemeteries include works compiled by Schmedding 1978, Martiniani-Reber 1986, Stauffer 1991 and Desrosiers 2004.

In addition to their striking visual appearance, surviving figured silks are important to textile history because of the scale and complexity of their patterns. Known as weft-faced compound weave, the structure separates the warp into independent binding and

Fig. 1. Nikephoros Botaneiates and his courtiers, c. 1071-1081. Paris, Bibliothèque nationale de France, Ms Coilin 79, fol. 2r. (© Julia Galliker).

pattern units (CIETA 2006, 43). A fabric bound with twill is generally described as samite; a tabby binding is called taqueté (CIETA 2006, 43, 47). To reduce the labour required for selection of pattern sheds, workshops used drawlooms equipped with a figure harness for repetitive production of woven patterns. Although the origin and development of these looms is obscure, patterns tied up in a figure harness provided a means of recording and storing work for later reproduction.

Research problem

During the past century, a sizeable literature has developed to interpret surviving evidence in terms of art history, textual analysis and technical weave structure. The advantage of an art historical approach is that it can integrate evidence from a variety of media. While figural representations offer a rich body of material, fragments are too poorly situated temporally and geographically to support specific conclusions. Unlike some Islamic and Genizah compilations, a systematic survey of Byzantine texts for textiles has yet to be produced (Goitein 1967-1993; Serjeant 1972; Stillman 1972). The scattered and fragmentary nature of source evidence limits the applicability of conventional historical research methods. Difficult terminology and the cross-cultural character of textile interactions represent additional obstacles (Jacoby 2004).

During the past century, historical textiles have been gradually recognised as a source of technical production information. Researchers have devised various methods of analysis to study the relationship of cloth components to each other, and to consider the

Fig. 2a. Fantastic animals in roundels, Cooper Hewitt, 1902 1 222, macro scale (© Julia Galliker).

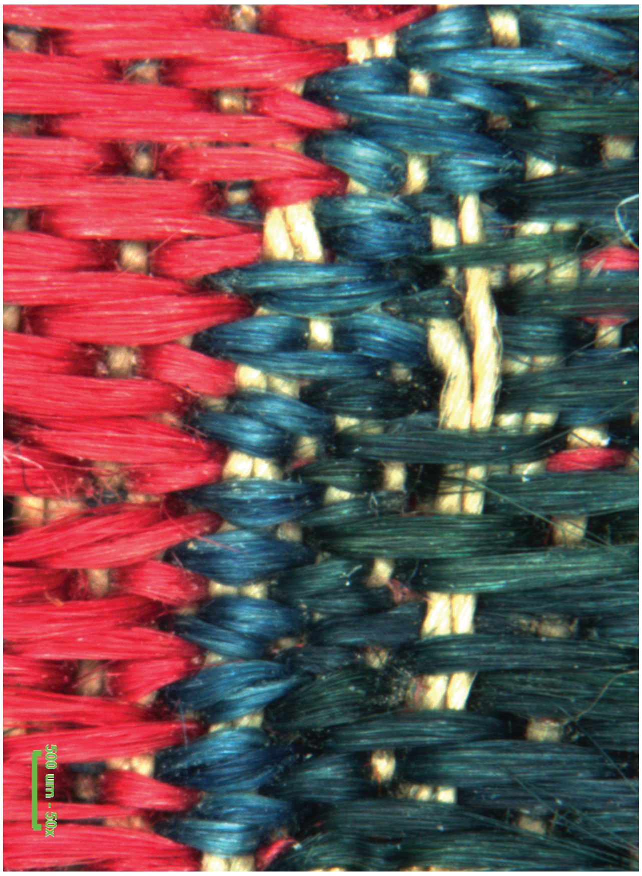

Fig. 2b. The same as Fig. 2a at 50 x magnification (© Julia Galliker).

techniques and equipment involved in the process of construction. While the CIETA method is now recognised as the standard analysis framework in the field, the literature is mainly confined to piece-specific analyses of the most intact and impressive surviving examples. The lack of comprehensive collection surveys has meant that available evidence has been considered selectively. While the fragility of surviving silks requires high conservation standards, the unintended consequence is that access is effectively limited to all but a few researchers. Crucially, the field lacks a resource that synthesises technical features and interprets evidence in a form accessible to non-specialist historians and textile researchers.

Despite the challenges, the quantity and variety of source material represents an opportunity for a fresh approach with the aid of information technologies. The research framework was defined in terms of three principles: comprehensive and balanced treatment of sources, use of methodologies appropriate to the nature of evidence and cross functional interpretation to integrate textual and material remains.

Methodology

Whilst ostensibly related, silk remains and textile mentions have very different characteristics requiring a common basis for analysis. A framework structured in terms of silk textile production stages provides a means to integrate the bodies of evidence. These include fibre and yarn preparation, textile construction, pattern reproduction and the end-use of finished cloth. Other relevant evidence includes quality characteristics and planning decisions. A specific strategy for data collection was defined to ensure comparable and reproducible data. A standardised approach established relative context for the purpose of comparative analysis.

Textile mention database

In written works, textile descriptions vary depending upon an author's interest, knowledge and purpose of recording. Most mentions contain only partial information, but include some specific details such as production place, materials, weave type, end use, design, quality and usage context. Amongst the available research methods, prosopography provides

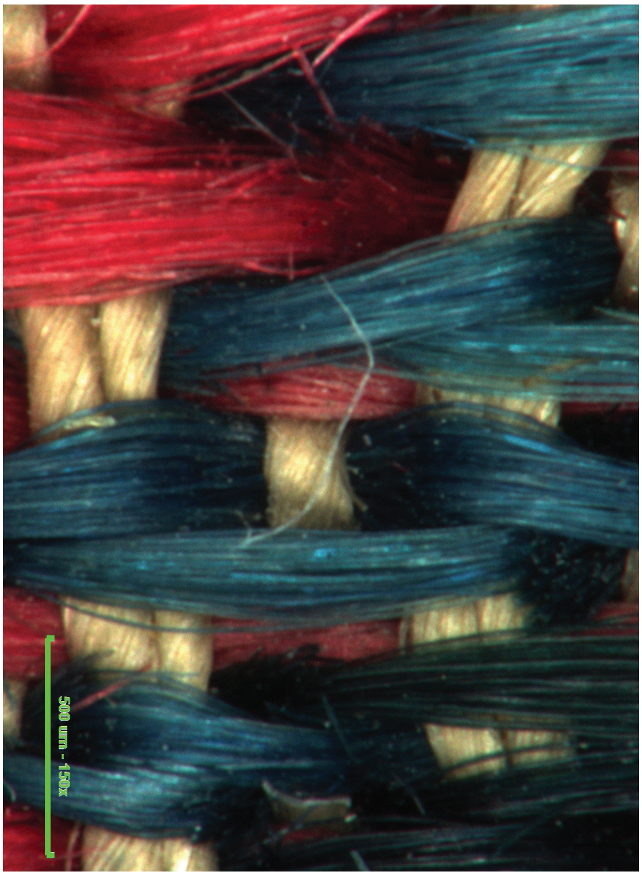

Fig. 2c. The same as Fig. 2a at 150 x magnification (© Julia Galliker).

a method of aggregating the fragmentary and scattered data associated with textiles into a consolidated resource (Short and Bradley 2005; Keats-Rohan 2007). The resulting textile mention database provided a structured approach to analysis with the advantage of relational design to organise and access information.

Computer vision analysis

Analysis of textile fragments requires a different set of tools to extract meaningful information in a way that can be analysed and compared with written evidence. The advantage of textiles is that they are composite structures created through a series of processes. Woven line by line, fabrics provide a sequential record of production. A consistent methodology is required to discern technical details from extant fragments and to define relationships among sets of distinguishing characteristics.

During the past decade, dramatic advances in imaging technologies have made digital photographs the medium of choice for recording technical textile attributes. However, the fine resolution of silk textiles requires specialised microscopy equipment to capture consistent, high-quality images at a scale appropriate for objective characterisation (Fig. 2a-c). My equipment setup for *in situ* recording of textile attributes is shown in Fig 3.

An additional technical problem is that much of the production data embedded in textiles exists at a level that is too diffuse to be captured reliably by conventional measurement methods. Information technologies can aid in developing low-level data into meaningful information according to scientific research standards. Within the field of computer engineering, computer vision refers to technologies associated with acquiring and using information from digital images (Nalwa 1993, 3-29). My research programme combined macro- and micro-scale digital imaging with the use of specialised computer vision software tools developed for this project.

Findings

The textile mention database methodology resulted in a corpus comprising over 800 descriptive mentions of textiles found in 27 Byzantine texts dating from the 6th to the 13th centuries, as shown below. Analysis of silk terminology indicates that references were mainly inferential with meaning conveyed through contextual clues such as colour, embellishment, superlative description and setting. Although *serika*, *blattia*, and *metaxa* were all names used for silk, each had a distinctive identity as is evident from usage patterns. In addition to reporting events associated with silk, Byzantine historians frequently used textile objects for symbolic representation or to give figurative meaning to their writing.

Analysis of textual information on a consolidated basis indicates that trade in silk fibre involved active cross-regional exchange and specialised roles for grading, buying and processing the material. References to various textile occupations and the names of particular fabrics provide details about production and consumption of luxury goods and cloth items in common use. Evidence associated with pattern details is particularly illuminating because elements of aesthetic perception and symbolic representation coincided closely with other forms of imperial media. The detailed examination of the sources provided a basis for the definition of the terms *diblattion* and *triblattion* and demonstrated coincidental imperial use of monochrome patterned 'damasks' according to ceremonial requirements. Interpretation of data for end-use draws on the concept of 'brand' to show how analysis of textile names, especially those with a geographic basis, can detect attitudes and preferences for particular types of fabrics.

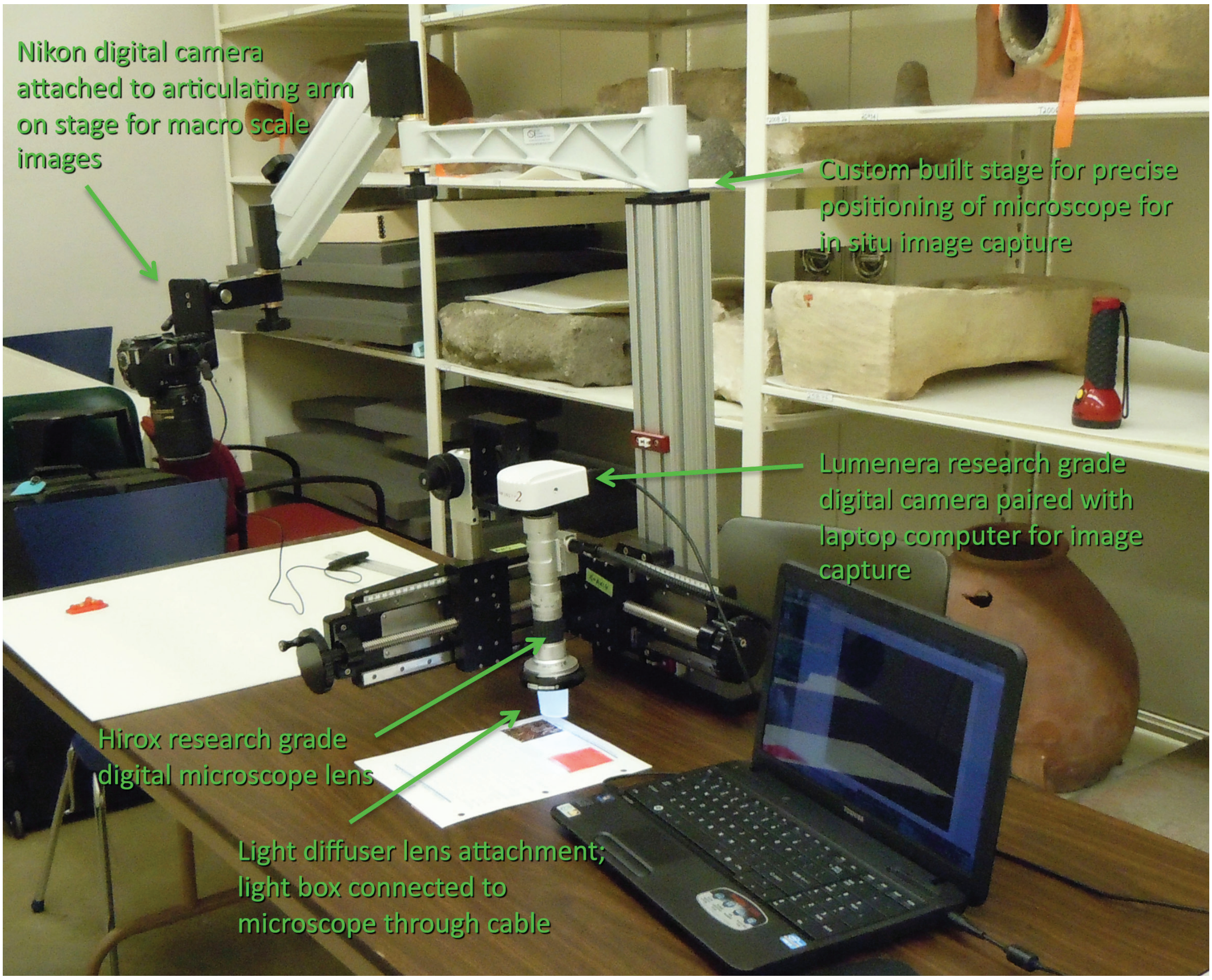

Fig 3. Annotated photograph of equipment set-up for in situ imaging of textile attributes (© Julia Galliker).

My imaging data is based on my analysis of 125 textile fragments from ten museum collections provisionally dated between AD 600 and 1300. As is typical for this class of artefacts, none of the fragments came from a known or dated context. According to my research protocol, I documented these textiles using a total of 10,635 images. Based on maximum width and height measurement, the total area of the textile fragments analysed is more than 780 m^2. Most pieces in the collection were woven exclusively in silk; gold is visible on just nine fragments, six of which were woven with the true lampas structure attributed to the 12th to 13th centuries (Schorta 1997). Technical analysis demonstrated that the weft-faced compound weave structure was the dominant method of patterning silks with 94 examples. Of these, 87 are attributed to Near Eastern and Mediterranean centres.

From a production point of view, surviving textiles contain information about the work environment and methods of production. Close analysis reveals characteristics associated with workplace organisation, processing steps, demonstrated skills, division of labour and work habits. Evidence indicates distinctive specialised roles for designer, weaver and assistant.

Amongst other attributes, errors provide a perspective on the working lives of weavers. The work was evidently exacting, especially the process of preparing the loom. The incidence of tie-up faults shows that minor and major errors were allowed to continue throughout a textile length. Some weavers faced equipment-related problems with uneven warp tension on their looms. The task of maintaining an even warp distance and weft density was ongoing. The difficulty of coordinating work between a weaver and an assistant is also obvious.

The textile evidence shows that a body of conventions existed that provided a means of standardising work. The high degree of consistency of certain practices over hundreds of years in widely separated workshops is a surprising finding from this analysis. The uniformity of twist direction and angle suggest that technologies associated with silk were transmitted with the material and adopted by specialised producers at various locations throughout the region. While patterns varied among textiles, particular design conventions were applied to the majority of silks in the collection.

In terms of structure, 1/2 samite was overwhelmingly the dominant method of patterning silks. Pairing a twisted warp with an untwisted weft meant that each component had a specific function that was adopted by producers with variation only in instances when a particular effect was desired. Differences occurred in incidental decisions such as the choice of either twill direction or in colour insertion order. The highly repetitive nature of weaving lends itself to the formation of craft habits that were presumably shared by weavers within a given workshop.

Economic motivations are evident in surviving fragments. The widespread adoption of the work-saving method of returning weft insertion demonstrates an efficiency innovation that reduced the labour involved in weaving complex silks (Verhecken-Lammens 2007). The use of lesser-quality dyes in warps was a means of economising on materials while disguising visible warps. Substitution of lower-quality or spun silk points to either economy or fraud. Discontinuous use of colour provided the appearance of a more expensive polychrome silk without the associated costs.

Contrary to the prevailing view of silk as an imperial prerogative confined to elite use, this research shows that silk had a larger role in the material culture of middle Byzantine society and was important in cross-cultural economic and social exchange. The evidence suggests that the historical process involving silk was shaped by a continuing cycle of elite differentiation and imitative reproduction, which in turn contributed to the transmission of the material and production in the region. From a broader perspective, this work demonstrates the relevance of textile studies to the interpretation of economic and social history.

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Maciej Szymaszek

A Forgotten Cultural Heritage

Late Antique Textiles in Swedish Museum Collections

Roughly 2000 late antique fabrics of Egyptian origin that were brought to the country in the 19th and the 20th century are now contained in Swedish museums. The ongoing project *A forgotten cultural heritage. Late antique textiles in Swedish museum collections* aims to investigate this largely unknown and unpublished material. The work was initiated in autumn 2013 with a preparatory study and is being continued as a post-doctoral project at the University of Gothenburg, Sweden. Thanks to funding received from the Swedish Institute and the Birgit och Gad Rausings Stiftelse, it was possible to carry out enquiries and study visits at a selection of museums in order to conduct a preliminary analysis of the material and to define the direction of future research. The work revealed a number of pieces that are of great interest for the history of late antique textiles collections in Sweden as well as written sources.

The largest collection of late antique textiles in Sweden was formed in the 1930s by Carl Johan Lamm, who purchased over 900 pieces in Egypt, although only a very small part of his collection is mentioned in his reports (Lamm 1933a, 1933b, 1934, 1936). By the mid-20th century, the textiles brought by Lamm had already been spread throughout the country and were incorporated into museums in Gothenburg, Lund and Stockholm. Publications discussing selected objects were mostly written in the 1920s and 1930s by Lamm and his colleagues such as Vivi Sylwan (1920, 1923, 1932) and Maurice Sven Dimand (1922, 1924). Over 50 years later, Marianne Erikson revived these studies by describing a selection of pieces kept in the Röhsska Museum in Gothenburg and presenting a brief overview of the collections of late antique textiles in Sweden (Erikson 1997). Even the valuable work of Erikson cannot be regarded as sufficient to give a full understanding and appreciation of this material that was brought to Sweden by collectors and textile enthusiasts. The concluding results of the preparatory stage of this project consist of an inventory of late antique textiles and a preliminary analysis of gathered material. During this work it was possible to state that barely 7 % of the textile objects have ever been published and only very few fabrics have been presented to the public. Furthermore, no attention has been paid to the correspondence and connections between textile merchants and museums that offer a promising source for investigating the development of textile studies in Sweden.

A collection of 55 fabrics, which are stored at the Museum of Vänersborg in Sweden, is an example of the significant findings which have been revealed during the preparatory research. The pieces formed the nucleus of the museum, which was established in the 1880s, making it one of the oldest collections of late antique textiles in the Nordic countries. Direct inspection of the objects has allowed the recognition of, among others, large fragments of woollen textiles decorated with the so-called *gammadia* (Szymaszek forthcoming).

The project is scheduled to last for a period of four years and aims to reintroduce late antique textiles stored in Swedish museums into the scholarly community through a comprehensive study, focusing not only on technical and iconographic aspects, but also on issues related to the process of musealisation of ancient fabrics in Sweden.

Fig. 1. Photo of the piece MMT 982 (Photo: Ola Myrin, © Malmö Museum).

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Nancy Spies

A Query

An article about two Ifriqiyan church treasuries by Isabelle Dolezalek (2013) lists one complete inventory of 12th-century liturgical textiles from the cathedral of Mahdiyya in modern Tunisia which were brought to Sicily while under Norman rule.

I have been able to translate and decipher most of the textile terms, but one continues to elude me. The term is “catafitti” and appears in the following listing:
17. Est alia cappa catafitti cum tribus tasellis auri frisii (Dolezalek 2013, 99).

Its meaning is unclear to Dolezalek. One person has speculated that "catafitti" is an orthographical drift from "catapicti", meaning "figured all over". Another person has cited the article by Antonio Garzya (2004) where "catafitti" means "stoffa" ("material").

Any suggestions would be gratefully received. Thank you.

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Ziff Jonker

5th Purpureae Vestes International Symposium

19-22 March 2014, Montserrat, Spain

In March 2014 the 5th Purpureae Vestes International Symposium was held at the Abbey of Montserrat. The symposium was organised by Carmen Alfaro (Universitat de València), Lluis Turell (Museu de Montserrat) and Jónathan Ortiz (Universitat de València). 56 scholars from 14 different countries were invited to speak.

Papers treated a variety of aspects including "The use of textiles in ancient Zoroastrian funerary practices" (Miguel Ángel Andrés-Toledo, Centre for Textile Research, Denmark), "Different starting borders found in Egyptian wool fabrics from the first millennium AD" (Chris Verhecken-Lammens, Katoen Natie, Belgium), "So simple yet universal. Experimental approach to clay spools from Bronze Age Greece" (Malgorzata Siennicka-Rahmstorf, Centre for Textile Research, Denmark and Agata Ulanowska, University of Warsaw, Poland), "Pliny's first century AD recipe for a purple dye-vat – decoded" (Chris Cooksey, England) and "Textiles from the "Tomb of the Kings" in East Jerusalem" (Christophe Moulherat, Musée de Quai Branly, France).

The symposium included a variety of excursions related to the general subject of "Textiles and Dyes in the Mediterranean World". On the Thursday (20th March) the participants of the symposium were invited to the exhibition *The Coptic Textiles of the Museum of Montserrat* of the Soler Vilabella Collection at the Museum of Montserrat. This exhibition gave the participants a unique insight into Coptic textiles from the cemeteries in Antinoë. The Coptic textiles show variety both in terms of type and chronology (3rd-18th centuries AD). The collection underwent restoration work in 2009-2012 by the Spanish Cultural Heritage Institute (IPCE). These textiles were discussed more thoroughly in the paper "Vilabella collection of Coptic textiles: complementary results from identification of dyeing materials" (Ilaria Degano, Università di Pisa, Italy; Paola Cesari; Annette T. Keller, Staatliche Fachschule für Optik und Fototechnik, Germany and Susanna Conti, Università della Tuscia, Italy).

A visit to the Textile Museum at Terrassa (Centre de Documentació – Museu Tèxtil) was organized for the Friday (21st March). The Textile Museum has more than 20,000 items representing 2,000 years of textile history. The participants were given a short lecture about the museum and its projects, followed by a guided tour of their exhibition. Afterwards, a guided tour to The Churches of Sant Pere de Terrassa was organised, due to its great historic and artistic heritage, including highly decorated frescos and altarpieces. Later the same day, an official dinner was held at Parador de Cardona. The organisers had planned an extravagant feast in the medieval castle.

The symposium ended on Saturday 22nd March, where organiser Carmen Alfaro announced that this would be her last Purpureae Vestes as she is retiring. She hopes Purpureae Vestes will continue to thrive even without her involvement.

The four day symposium served to bring together scholars working with Mediterranean textiles and dyes and has hopefully secured future collaborative research on these fascinating subjects.

I would like to thank Carmen Alfaro for a wonderful and very interesting symposium.

Susanna Harris

Textile Society of America, 14th Biennial Symposium

10–14 September 2014, Los Angeles, USA

The Textile Society of America (TSA) was established in 1987 and now has 700 members. Elena Phipps is the current president. Its mission is to provide an international forum for the dissemination and exchange of worldwide textile research and practice, including in its remit cultural, economic, historic, political, social, technical and artistic perspectives on textiles. This makes the biennial conference rather different from any of the archaeological textile conferences in Europe, especially the combination of archaeological research with industry and artistic textile practice.

This year the conference was on the theme "New Directions: Examining the Past, Creating the Future" and was held at UCLA, Los Angeles. The conference was organised over five days, which were packed with workshops, museum visits, 35 academic sessions, keynote lectures and several textile exhibitions which were buoyed up by receptions, an award dinner and a worldwide textile marketplace selling textiles, books, clothing and fibres. With so much going on, this review will try to convey some of the flavour of the conference and highlight some of its novel features.

The pre-conference workshops were hands-on sessions learning from experts in the field. I joined "Native American Basketry" at the Autry National Center. Here, Lalena Lewark showed us prized Chilkat and Navajo blankets and baskets as well as dazzling rodeo outfits from the collection, while Roseann Hamilton patiently taught us to prepare fibres and start a coiled basket in the Cahuilla tradition. Other workshops included identifying early Chinese silks (Feng Zhao), the science of colour (Dominique Cardon, Jim Druzik and Nancy Turner) and exploring European tapestries and textiles (Charissa Bremer David and Sharon Stone). These high-quality learning experiences were based in major venues in and around the city and provided the opportunity to meet delegates and visit the exhibitions.

The opening keynote speech by the opera, theatre and festival director Peter Sellars shone a ray of light, creativity and optimism into the topic of textiles and brought a fresh dynamic to the balmy evening reception on the terrace. The academic sessions were organised over two days, with five concurrent sessions of just under two hours each. The sessions covered broad topics such as ethnographic textiles from the Americas, Africa, South-East Asia and China, fibres and dyes both archaeological and current, contemporary art, media and new tech, global issues in intellectual property rights, product certification and development, pioneers of the textile disciplines, museums and education as well as sessions devoted to design and industry.

These sessions took the conference theme into all manner of rich avenues; whether this was new directions in markets for sustainable indigenous fibres (Ugandan bark cloth, Lesli Robertson; Japanese banana fibre, Yuko Fukatsu and Ryoko Murai), knit your own uterus for political campaigning (Marybeth Stalp and Theresa Winge), textiles as commentary on war in Latin America (Deborah Deacon) or, possibly more familiar to ATR readers, the fibre revolutions in ancient Old World archaeology – plant, wool and silk (organised by Margaria Gleba). I wish I'd made it to the session on textile design for science fiction and fantasy film (organised by Deborah Landis), where Hollywood designers explained how their textile designs are not only the basis of costumes but also become fully copyrighted material surfaces

reproduced in branded film merchandise. There were many ideas here to inspire and cross-fertilise.
The conference dinner included a number of prizes and awards for students and professionals. This was a heart-warming way to celebrate some of the great contributions textile researchers and practitioners have made to knowledge, publishing and contemporary art today. The final evening was drinks and Mexican tacos served street-style at the opening reception of the juried exhibition of textile art at the Craft and Folk Art Museum. By then, we were buzzing with intellectual over-stimulation, surrounded by new and old colleagues and piled up with new purchases. It was a fabulous conference.

Henrik Holmboe

Textile Terminologies from the Orient to the Mediterranean and Europe 1000 BC–AD 1000

18–22 June 2014, CTR, Denmark

The conference was organised by Salvatore Gaspa and Marie-Louise Nosch from the Danish National Research Foundation's Centre for Textile Research at the University of Copenhagen in collaboration with Cécile Michel from CNRS, Histoire et ARchéologie de l'Orient Cunéiforme (HAROC), Nanterre, France. The titles of the different sessions of the conference were: Raw Materials and Tools, Techniques and Manufacture, Garment Names, Symbolic and Religious Meanings, Metaphors on Textile Terms, Textile Terminology and Loanwords and Classification of Textile Terms. Within this framework, about 40 scholars presented their papers. Among them were philologists, linguists specialised in a number of Semitic and Indo-European languages and archaeologists. The opening keynote lecture by Felicitas Maeder "Irritating Byssus – A Term Through the Ages" was an impressive and learned overview of the terminological problem in question and also set a high scientific standard for the following four days. The subjects of the papers related to different research traditions, backgrounds, languages and periods, but the overall impression was that they all contributed to collective activity and succeeded in extending and adding to our common knowledge of textile terminology: an excellent example of what *Wörter und Sachen* is at its best, and what colleagues can achieve when they do not just stick to their own small areas. The contributions were of a high quality, and the conference was very well organised. The roughly 200 participants and I owe our thanks to the CTR and its staff. The conference proceedings will be published in the Oxbow Ancient Textiles Series.

Felicity Wild

NESAT XII

21–24 May, Hallstatt, Austria

A major highlight in the 2014 conference season was the 12th meeting of NESAT in an idyllic setting and in glorious summer weather. Hosted by the Natural History Museum, Vienna at their outpost in Hallstatt, under Anton Kern, Karina Grömer and their team of helpers, it attracted record numbers, with over 200 participants from countries world-wide and a packed programme of papers and posters.

On the first day the programme started, appropriately, with papers on current textile research in Austria, broadening after the coffee break to cover the Prehistoric period Europe-wide, from the earliest wools in the Neolithic period, through Bronze Age Scandinavia to finds from the Iron Age and Roman periods. In the evening, Hans Reschreiter (Natural History Museum, Vienna) gave us a fascinating introduction to work at the Hallstatt salt mines in preparation for our trip the following day. On the Thursday, we were divided into groups, with one block visiting the salt mines and Iron Age cemetery in the high valley in the morning while the other had a tour of the town down below and its museum, which opened in 2002. The blocks reversed for the afternoon session. Special credit must go to Hans Reschreiter and his team for guiding us through the mines, which contained a wonderfully preserved wooden staircase, and explaining the use of the surviving equipment and the difference in methods between the well-organised Bronze Age miners and their messier Iron Age successors. A wonderful day was rounded off in style with a buffet at the Conference Centre, where we were welcomed by the local team, all in Austrian national dress. Before the meal, a surprise presentation was made to Lise Bender Jørgensen of a Festschrift to mark her 65th birthday, accompanied by a suitable drink dispensed from a Hallstatt bucket. For the final two days we returned to the serious business of textiles. Papers on Friday covered tools and textile production in the morning, followed in the afternoon by early Medieval finds from bogs and burials in central and northern Europe. Saturday was devoted to papers on medieval and early modern textiles, ending with a series of papers on the application of new and advanced methods of analysis to specific groups of textiles. Posters were presented during lunch and coffee breaks.

In a brief review it is impossible to comment on the papers individually, though much new and important material was presented. The complete programme of papers, together with the abstracts submitted in advance by the speakers, can be found on the NESAT website (http://www.nesat.de/hallstatt_xii/NESAT_XII_Program.pdf). We look forward eagerly to the appearance of the full publication. Meanwhile, our thanks go out to Karina Grömer and her team for the smooth and efficient running of so large a conference and for making it such a memorable and enjoyable occasion. The next meeting will be held in the Czech Republic in 2017.

Helga Rösel-Mautendorfer, Karina Grömer, Anton Kern and Angelika Rudelics welcoming participants to the conference buffet (Photo: Felicity Wild).

Margareta Bergstrand

Dyes in History and Archaeology 33

29 October to 1 November 2014, Glasgow, Scotland

The 33rd meeting of Dyes in History and Archaeology was hosted by the University of Glasgow and took place in the University´s magnificent Bute Hall. The day before the conference a tour to the Centre for Textile Conservation and Technical Art History (CTCTAH) was organised. Anita Quye was the enthusiastic motor of the conference where the staff and students of the CTCTAH greatly contributed to a very successful meeting.

In the course of the two days of the meeting there were 24 oral presentations and 27 poster presentations relating to dyes, dyed textiles and pigments covering a wide range of subjects from Chinese dyes to the early synthetic dyes, from historical and archival studies to various extraction, chromatographic and spectroscopic methods.

While earlier DHA meetings primarily have focused on the chemical aspects of analysis of blue, red and purple, there now seems to be a shift towards an interest in the more subtle but evasive (and not so easy to analyse) yellow and brown dyes, as well as tannins, lichens, mordants and dyeing methods such as the fermentation. Focus may still be on the technical aspects of the chemical analysis of dyes, but this time DHA was truly multi-disciplinary.

Dominique Cardon focused on archival studies in "Colour fashions in Constantinople in the light of some unpublished archives of a Florentine Company end of XVth century", a report on an ongoing research project and Anne Servais talked about the the investigation of 13th to 15th century archival sources on dyes and pigments used by illumination painters: "Painters and shopkeepers:who made brazilwood lake pigments? (XIIIth – XVIth century)". Both speakers stressed the importance of consulting many different sources.

For those interested in the conservation and sustainability of textiles and dyes, there was the Italian project "The short Life of Tannins" aimed at studying the disintegration of tannins presented by Ilaria Degano: "Iron gall dyestuffs – a model study of the degradation of textiles."

Two interesting presentations focused on China: "Dyeing Practice and the Society:A Study of Historical Chinese dyes of the Ming and Qing Dynasties (1386-1911) by Chemical Analysis and History of Art" by Jing Han, PhD student at the CTCTAH and "Yellow silk for Buddha – dye analysis on Tang dynasty textiles from the Famen temple near Xi'an, Shaanxi province, China" presented by Regina Hofmann de Keijzer reporting on a joint Chinese-German project on the conservation of the textile finds from the Famen temple.

Among the many interesting posters two were of special interest to textile archaeologists; a British Museum project, "Colourful textiles from a naturally-mummified medieval body from Sudan", revealed exceptionally well-preserved colours in textile finds from the medieval period (AD 600 -1500). Krista Vajanto and Maarten Van Bommel touched on the question of mordants derived from plants such as clubmoss in their poster "Dyes and possible mordants in miscellanous Finnish archaeological textiles".

The complete list of presentations is available at www.chriscooksey.demon.co.uk/dha/DHA33abstracts.pdf

Ulla Lund Hansen

Traditional Textile Craft - an Intangible Cultural Heritage?

25-31 March 2014, The Jordan Museum and CTR, Amman, Jordan

Initiated and organized by Eva Andersson Strand, Danish National Research Foundation, Centre for Textile Research, University of Copenhagen, and Mary Harlow, University of Leicester in collaboration with Jihad Kafafi, Jordan Museum, the workshop was arranged as a meeting between scholars from across the world representing various traditions of textile research including archaeologists, conservators, craft specialists, linguists, ethnologists, and historians. The different backgrounds of the participants meant that they looked at and asked very different questions regarding ancient textile handicraft, textiles and textile traditions.

An important issue is what the textiles themselves can tell us, and furthermore, what they reveal when combined with other objects, *i.e.* in archaeological excavations and other contexts. The combination of multi-disciplinary scholarship enhances our knowledge of textiles.

The purpose of the workshop was to discuss "textile" in all its aspects from the most ancient times to today. The workshop was divided into four main themes: Definitions of traditional craft-practice and the use of terminology; Relationship of traditional textile craft to modern fashion studies; The use of traditional textile craft and craftsmanship in the interpretation of ancient societies; and preserving traditional textile heritage and making it visible. This division into themes resulted in a very nice flow during the workshop and ensured that the papers and discussions touched upon all aspects of textile research.

First theme. Definitions of traditional craft-practice and the use of terminology

The paper "Visibility and Invisibility… " by Susan Jones was an excellent introduction to the theme "traditional craft" and its contemporary context, how to keep it alive, the varied conditions required for this, and the results and achievements of several completed and current projects. The introduction proved to be highly relevant throughout the workshop and the study tour.

The paper by Laila Tyabji, "Threads & Voices - Traditional Craft in a Globalised World" highlighted through stories and case studies from India the communities behind the craft and illustrated its potential as a mean of empowerment and earning but also the problems that often prevent this potential from being realized: adapting the traditions to contemporary urban markets and global consumers hold dangers and challenges.

Birgitta Nygren and Kerstin Andersson Åhlin gave a paper, "The past, the present, and the future" which illustrated how the National Association of Swedish Handicraft Societies still keeps traditional handicraft alive in Sweden. They discussed how it is organized and functions over the country – very different from what is seen elsewhere in the world. The paper also brought the two earlier papers and their essential problems into focus.

Susanne Lervad, "Textile Terminology and the Concept of Craft" focused on the basic concepts of craft and design and how one can define concepts in relation to each other. A central question is the representation of concepts in a non-verbal or verbal way in order to visualize the often complicated structures in various societies. From the wide perspectives of the earlier papers here we moved to quite another field, where it was demonstrated that knowledge often is tacit and complex both to learn and to maintain, and that non-verbal means are important elements of language to pass on to the next generation.

Second theme. Relationship of traditional textile craft to modern fashion studies

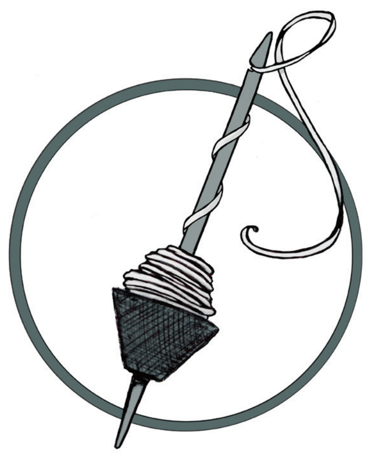
The paper "Defining and Redefining the Traditional in Indian Fashion" by Toolika Gupta, illustrated in a surprising way, how we often think and imagine what the word "traditional" implies. Is it when we want something to become traditional? Or to create an image or identity? Or is it because an item or practice actually *is* traditional? Her research question was "how traditional is traditional after all" in India. The paper focused on traditional Indian menswear and tried to understand the reasons for it becoming "traditional" in roughly 100 years – because of the British Raj – as opposed to previously.

Ameera Saied al Zaben and Najd Sweidan gave a paper on the role of the Jordan Museum in documenting Jordanian Traditional Costumes to preserve them as a part of the inherited cultural heritage. Jordanian costume was described as elegant, original and practical, and is at the same time remarkable for its vast diversity, despite Jordan's relatively small geographical area. This variation reflects different styles of living, *i.e.* the agricultural societies of the north and the Bedouin nomadic and settled communities of the south. The paper was highly interesting and gave the participants a better background for our visits to museums and craft centres over the next few days. The Jordan Museum took upon itself the role of documenting the traditional costumes of Jordan. This research was conducted with the collaboration of the Women's Museum in Denmark and Mrs. Widad Kamel Kawar. The results can be summarized as follows: costumes vary according to age and social level, women's costumes in particular differ according to the material status of the woman, and costumes worn inside the house differ from those worn outside.

Anna Falk's paper reconsidered the traditional pattern-making illustrating a new "zero waste" perspective in fashion design. It illustrated how textile traditions and cultural values can be embedded in future fashion business, among other things, because today's fashion industry has an urgent need for sustainable solutions. By studying different models of conceiving and using textiles in the past, where one had to optimize the use of fabric, we acquire knowledge that can be applied to the ways we deal with contemporary issues like fabric waste and a rapidly changing fashion industry. The "zero waste" method facilitates future upgrading and recycling of the textile, thus answering to the need of sustainability and slow fashion.

Theme 3. The use of traditional textile craft and craftsmanship in the interpretation of ancient societies

This day concerned traditional textile craft and craftsmanship. The first paper by Eva Andersson Strand introduced "Experimental Textile archaeology – a link to the past?" by describing textile archaeology as a research field covering many different aspects of the past. It was underlined that textiles and textile production have always had an economic, social and cultural impact on societies, and how important it is to include this in our general interpretations of the past. Archaeological textile research began by studying the preserved textiles, but more recently textile tools and production have come into focus. It is a great challenge to transfer modern knowledge to the interpretation of tools and production in ancient societies, and one can never assume that the tools and the techniques were exactly the same 1000 or 2000 years ago. Experimental archaeology is a very good method, based on traditional craft, to further modern research. For example, the work with spindle whorls from Viking Age sites, such as Hedeby in North Germany and Birka in Sweden have produced crucial knowledge of relations between spindle whorls, type



TRADITIONAL TEXTILE CRAFT - AN INTANGIBLE CULTURAL HERITAGE

The Jordan Museum & CTR 2014

of wool and type of textile – in a quite unexpected way – so that the weight of a spindle whorl can illustrate the type of thread and textile produced. Moreover, the time consuming nature of textile production is now revealed by new research into the relation between the type of thread produced, the weaving and the finished textile. The paper also discussed, from a source-critical perspective, the possibilities and limitations of using experimental archaeology in textile archaeological research.

The following presentation by Linda Olofsson on "Spinning in the Past and the Present" illustrated how in an archaeological context and by the mean of experimental archaeology, one can handle questions put to the archaeological record and test them in practice. The main questions were how prehistoric tools were used and what type of yarn and textiles they could have produced. Archaeological finds of spindles, spindle whorls and loom weights were the point of departure for these reconstructions and tests. The reconstructed spindles were tested using different spinning techniques inspired from local traditions, ranging from northern Sweden to southern Greece. Different steps in the *chaîne opératoire* of textile production were also systematically tested: 1. selection and preparation of wool; 2. production of yarn; and 3. production of cloth. Spinning experiments illustrated the relationship between a given amount of wool, weight of spindle whorl, type of thread (thickness) and lengths of spun thread. In addition, the valuable research on the shape and weight of loom weights for a specific use was demonstrated. The results from the projects help in understanding prehistoric production processes and societies.

Joanne Cutler's paper on textile production in Bronze Age Crete, more precisely in the Neopalatial period (c. 1750-1490 BC) was based on Linear B texts on tablets and loom weights. The few surviving Neopalatial texts indicate that the Mycenaean palace textile industry developed out of an already established Minoan textile production system. The paper illustrated how research on textile technology and craft knowledge combined with other strands of evidence have given new insight into the dynamics of textile production in Neopalatial Crete and the types of textiles that could have been made. Using the approach developed at CTR has provided new information that one site on Crete had a great variety of textiles based on the weight and shape of the loom weight, while at Knossos a dense fabric was produced in the protopalatial period and quite a different fabric was produced in neopalatial times. All in all, the loom weights illustrate both regional and site diversity in textile fabrication.

Cécile Michel gave a paper on how to estimate textile production in an Old Assyrian household with the help of experimental archaeology. It investigated the methodology used when combining the results of experimental archaeology with textual data, and underlined the limitation of this interdisciplinary research. Cuneiform texts detail the textile production

Participants at workshop, Jordan 2013 (Photo: Camilla Ebert).

in large Mesopotamian workshops from Ur III (21st century BC) or in Old Babylonian palaces (18th century BC), and the archaeological material documents the private sphere with the discoveries of spindle whorls and loom weights in houses. In contrast, at Aššur, the Old Assyrian level (19th-18th century BC) has not been excavated, but to understand the textile production in this city, we rely exclusively on the thousands of letters sent by the Assyrian women to their family members in Anatolia. Their textile production had two goals: clothing family and household members, and fuelling the long distance trade with high quality textiles. The sale of textiles in Anatolia generated revenues for the women at home. Experimental archaeology based on traditional textile crafts and archaeological textile tools, carried out by CTR, provides data which can be used together with the textual documentation to estimate the number of textiles produced by a household estimated to 25 pieces of textile (depending of the number of women in the household).

Mary Harlow introduced her paper, "History and Textiles. Making the Everyday Visible", in the context of her future research, with information on the Roman male toga measuring 4.2 x 4.8 m, elliptical in shape and made of fine wool. We have no knowledge of what type of loom it was made on (at least 5 m wide), but it is estimated that it required 40 km of thread, 900 hours of spinning, and all in all, the production took 1000 to 1200 hours equivalent to 120 days. Using this example, she demonstrated how textiles and clothing are a self-evident part of the lived world in prehistoric and historic times. The paper surveyed where and in what context textile production is taken seriously and how much more work we still have to do to ensure that textile production, from raw material to finished cloth, becomes one of the "big themes" of ancient history alongside other themes, such as food production, military conflicts and the lives of "great men". The paper gave reason for deep reflection on the textile world's significance and challenges to scholarship in terms of a fibre revolution, new gender roles, the situation of the homes, the specialization of craft and changes of landscapes.

Mary Petrina Boyd spoke of "the Madaba Plains Project, Tall al 'Umayri", located c. 15 km south of Amman, an excavation she undertook in 1984-2012. The excavations revealed material from Early Bronze to Hellenistic and Roman times: including finds of animal bones, bone-needles, spindle whorls, a few loom weights - all showing that textile production took place within the domestic sphere, although no textile fragments were excavated.

Aspects of textile production in Iron Age Transjordan (800–600 BC) were illustrated by Jeanette Boertien through her excavation results from the sites Deir 'Alla, Tell Mazar and Khirbet al-Mudayna (in Moab). In Deir 'Alla, excavated loom weights show that in a single room there could be several looms. Furthermore there were remains of hemp yarn and hemp cloth. In the temple complex at Khirbet al-Mudayna with three altars, among others, an incense altar, was found a weaving room with around 100 loom weights, wool, linen yarn and baskets archaeological finds of spindles, spindle whorls and loom weights - a fascinating find demonstrating the role of textile production in the society of Ammon and Moab between 800-600 BC. It also shed light on the question of whether weaving for a temple or a shrine actually was practised in Iron Age Jordan.

Sophie Desrosiers illustrated the reconstruction of a remarkable textile tradition beginning, at least, during the 1st millennium BC with a case study from the Andes. The territory occupied by the Inca comprises two main climatic regions: a dry desert Pacific coast where thousands of pre-Columbian textiles, mainly in cotton and camel fibers, were preserved, and the moisture-rich extensive mountain range of the Andes where very few textiles have been preserved, but instead where beautiful and meaningful weaving traditions continue to today. By examining the principles of the present highland weaving traditions and earlier evidence among the archaeological textiles and other art forms bearing textile designs, which are preserved on the coast of Peru, it has been possible to reconstruct the highland textile traditions.

Vanessa Workman ended the morning session with a paper on copper mining sites from the Iron Age (11th – 9th century BC) in the Southern Levant, where small fragments of textiles were recovered on the sites of Faynan, Timnan and Serebit Bir Nasib.

Theme 4. Preserving traditional textile heritage and making it visible.

The afternoon session began at the TIRAZ: Widad Kawar Home for Arab Dress with presentations/discussions by Widad Kamel Kawar, Collector of Jordanian and Palestinian ethnic and cultural arts, Jordan; Layla Pio, Expert on Oriental Textile Art, Jordan and Aysar Akrawi, Executive Director of the Petra National Trust, Jordan.

Fatma Marii and Nihad Hendawi presented the conservation and preservation techniques for the textile collections at the Jordan Museum representing Jordan's traditional and modern life, which includes collections of clothes, rugs and other traditional textile accessories. The lecture described the way they were kept in temporary storage before moving to the permanent location of the museum. The problems and challenges that conservators and curators encountered in order to preserve the textile collection at the museum, and the solutions and procedures that were taken for their continued preservation and maintenance were presented and discussed in this paper.

The session on the conservation of textiles continued with Maj Ringgaard's paper on the preservation of the Danish textile heritage. Denmark possesses a unique collection of prehistoric costumes and textiles mainly from bogs and burials. The textiles are recovered from anoxic, waterlogged areas, surroundings that prevent rot, decay, and thus possess a unique ability to preserve textile fibres until they are again exposed to oxygen. Denmark has a long experience in preservation and conservation of archaeological textiles – as well as historical textiles. It is important that conservators conduct research into the effects of different conservation methods and optimizing treatments and their effects on preservation of the fragile textiles. An important issue is drying the finds without causing deformation and shrinkage. Most often, the textile finds are freeze dried, and in recent years slow freeze drying at atmospheric pressure have been introduced. Also, appropriate storage fascilities were mentioned.

The conservation papers were followed by a paper by Anna Karatzani about the use of metal threads in the decoration of ecclesiastical and secular textiles in Greece. Interwoven metal threads (i.e. gold thread) are traditionally associated with the use of silk and are extensively used from the Byzantine era onwards (although known long before). Most of the woven examples have been destroyed, and only a few examples have survived to demonstrate the types of metal threads as well as the embroidery techniques used. These embroideries have allowed the study, documentation and investigation of metal thread types used for decoration of ecclesiastical and secular objects.

Gillian Vogelsang-Eastwood gave a paper on another kind of textile decoration: North African and Middle Eastern Embroidery and informed listeners that The Textile Research Centre in Leiden is preparing a detailed study of embroidery in North Africa and the Middle East. "The Encyclopedia of Embroidery from the Arab World" (forthcoming) looks at the production, use and social context of embroidery divided into three sections: basic introduction to embroidery, ancient and historical embroideries, and regional embroidery from North Africa and the Middle East, Morocco to Iraq. The working methodology is relevant to the study of other aspects of material culture in North Africa and the Middle East.

Jorie Johnson thereafter gave a paper on "Felt Making Achievements" from Central Asian nomadic survival until now, as the traditional Silk Road craft of felt making took a new turn towards the end of the 20th century. The first seven thousand years bore little functional change, but in the last 40 years, after its rebirth in the American contemporary textile art scene, the technique has developed immensely due to freedom in expanding concepts and the availability of finer, dyed wools.

Kerstin Andersson spoke about "Why are People doing Textile Tours?" Since the middle of the nineties she has cooperated with the National Association of Swedish Handicraft Societies and made guided tours specialized in textiles and other kinds of handicrafts. She talked about the destinations, the participants and the means of the journeys.

Valentina Gamba from UNESCO presented a paper on "Empowering Rural Women in the Jordan Valley: a project linking textile production and development".

The workshop was followed by an excursion between the 28th-31st March where severeal textile crafts and training centres and some cultural heritages were visited.

www.conferences.saxo.ku.dk/traditionaltextilecraft/
www.traditionaltextilecraft.dk

Charlotte Rimstad

Three CCCC International Workshops

In November 2013, The National Research Foundation's *Centre for Textile Research* (CTR) established a new research programme: *Costumes, Clothing, Consumption and Culture* (CCCC). The programme, run in collaboration with the National Museum of Denmark, was directed by the dress historian Paula Hohti, a Marie Curie Research Fellow at the CTR, and it was meant to provide a platform for early modern scholars and graduate students associated with the Centre to meet and discuss dress and textile research within an interdisciplinary academic framework. The group included five PhD students and a network of about 15 established scholars from Denmark, Sweden, Finland, Great Britain and India, including archaeologists, art historians, museum conservators and economic historians.

The First CCCC Workshop: Luxury, Commodity and Trade

The first workshop took place in Copenhagen on the 21st and 22nd November 2013. Its main focus was the theme of luxury, commodity and trade in the First Global Age. Five PhD students presented their individual projects, beginning with Charlotte Rimstad, who talked about her then upcoming PhD project '17th-century clothes of Copenhagen'. Next was Vivi Lena Andersen, whose project, 'Between cobbles, bunios, shoe lasts and fashion', focusses on shoes from the medieval and early modern periods. Peter Andreas Toft introduced the group to his project, 'Between fur and silk - clothing, creolisation, and cultural encounters in Greenland 1700-1930' and Vibe Maria Martens continued with 'Indian textiles in seventeenth and eighteenth century Denmark: Colonialism and the rise of a global consumer culture'. After the lunch break, Karolina Hutkova presented her project 'The British silk connection: The English East India Company´s Bengal silk 'enterprise', 1757-1812' and Toolika Gupta continued with her talk about 'The effect of British Raj on Indian fashion (clothing and textile preferences) of the early twentieth century'. The day ended with a plenary talk by Professor Giorgio Riello, University of Warwick, concerning 'Luxury or commodity? The success of cotton fabrics in the First Global Age'. After a concluding discussion in which we deliberated a number of issues such as our different approaches to terminology, meanings of luxury and theoretical frameworks applied in research on the global textile trade, a small reception and dinner took place in a restaurant at Islands Brygge, Copenhagen.

On the second day, the PhD students met with Paula Hohti in order to discuss the broader aspects of the project, and the possibilities for the research students within the CCCC group. They then visited the local museum at Amager, which exhibits an interesting collection of dress worn by Dutch settlers of the 16th century. Guided by Laila Glienke and the museum's director Ingeborg Philipsen, the delegates were shown a wide range of stunning costumes, from pleated skirts to richly decorated caps and scarfs, some of which are still used on special occasions in the local community.

The Second CCCC Workshop: The Materiality of Clothing – Under the Surface

While the first workshop focused on the PhD projects within the CCCC, the second workshop concentrated mainly on archaeological objects. This took place on the 27th and 28th May 2014. The aim was to explore the materiality of textiles and clothing, focusing on the objects themselves. The questions addressed were: How can experimental archaeology help academics in historical research? Can archaeological finds support and/or challenge written sources in art history and other disciplines – and vice versa? How do we go about creating meaningful multidisciplinary approaches? The questions were examined at a guided tour at the National Museum's Renaissance exhibition by conservator Maj Ringgaard, with special attention given to textiles and footwear. Afterwards, a tour through the exhibition *The Past beneath Our Feet* took place at the Museum of Copenhagen, guided by Vivi Lena Andersen, who also conducted a hands-on session on archaeological footwear and textiles together with Charlotte Rimstad and Maj Ringgaard. After a break in the museum café "Tante T", the shoemaker Kenneth Elsgaard demonstrated the old craft of making shoes with tarred and waxed threads of flax for sewing with pigs bristles. Then Alice Dolan presented her project 'From seed to cloth: Making a sheet in aighteenth-century Britain' and after a brief discussion the day ended with dinner at Madklubben on Vesterbrogade, Copenhagen.

The next day, the CCCC group visited the National Museum's Conservation Department in Brede, where Maj Ringgaard presented the archaeological textiles and footwear in the museum's storage facilities. At Brede delegates had the opportunity to see a large collection of the extremely well preserved dress items from the early modern period, including stockings, hats and gloves. After lunch, one group went to the Centre for Textile Research in order to listen to our keynote speaker, John Styles, speak on 'What was cotton in eighteenth-century Britain?' In the concluding discussion that followed, the proceedings of the past two days were summed up, including a discussion, among other things, of how archaeologists and historians can benefit from each other's' methods, and how the term 'fashion' can be defined in historical contexts.

The Third CCCC Workshop: The Global Trade of Textiles and Clothing in the Early Modern Period: Exchange, Meaning and Materialities

Organised by Karolina Hutkova and Giorgio Riello at the Global History and Culture Center, University of Warwick, the third CCCC workshop took place in the UK at the University of Warwick the 27th and 28th November 2014. Given the theme of 'Global Trade of Textiles and Clothing in the Early Modern Period', it was unsurprising that most of the participants were historians, with only a few archaeologists and conservators present.

The conference began at 3 pm, so foreign participants had time to arrive and check into their hotels. After a welcome speech by Giorgio Riello and Karolina Hutkova, the speakers of the first session, Emma Rogers, Meha Priyadarshini, William Farrell and Jutta Wimmler, introduced the audience to subjects on Global textile fluxes. Especially trade between India and Europe was emphasised, but the important trade between Europe and West Africa as well as the connections between India and Mexico were also discussed. Afterwards the keynote speaker, Barbara Karl, gave a talk about Indian embroideries in a European context. The evening ended with dinner at the Restaurant La Gusta on the University campus.

The next day included four sessions, the first being about sartorial connections between Europe and the Near East. The speakers Stefania Montemezzo, Gwendolyn Collaço and Marloes Cornelissen talked about subjects such as the relationships between Venice and the Near East, urban identity based on costume albums and auctions of different goods at the Dutch embassy in Istanbul. The next session included the speakers Kazuo Kobayashi, Jody Benjamin and Katharine Frederick, who focused on the textile trade between West Africa and Europe. After lunch, it was time to debate the impact of Indian cottons in Europe, with Gabi Schopf giving a talk about travelling sales agents in 18th-century Europe and Chris Niestratz discussing the rivalry between the English and the Dutch East India Companies. Vibe Maria Martens then posed the important question of how to combine actual textile finds with the terminology of textiles used in the written sources – a problem that many historians and archaeologists face. In the very last session, Anka Steffen, Evelyn Korsch and Nynne Just Christoffersen spoke about the European textile trade in a global context, raising important questions such as the meaning and importance of imitations in textiles. The day ended with a general discussion of global textile trade. We were all amazed by the rich variety of research projects currently being carried out internationally within the field.

After these three very different workshops and conferences, the CCCC programme has now established a multidisciplinary network of historians, archaeologists and conservators, which also in the future will benefit from the many individual research projects included.

Beatrix Nutz

Crafting Textiles from the Bronze Age to AD 1600: A Tribute to Peter Collingwood

10–11 October 2014, London, Great Britain

In October 2014 the Early Textiles Study Group held their 14th conference at the Wellcome Collection Conference Centre in London in honor of Peter Collingwood, organized by Frances Pritchard. Sixteen speakers from ten different countries gave fourteen presentations on three main topics: tablet weaving, sprang and braiding. The conference started with commemorative words on "Peter Collinwood, the weaver and his legacy" by Linda Theophilus, curator of the exhibition *Peter Collingwood: Master Weaver (*Warwick Arts Centre). The presentation listed Peter Collingwoods achievements, his art and his influence on the studies of textile arts, history and archaeology. In the course of the conference most speakers expressed how Collingwood's work had influenced their own research, some regretting that they never had the opportunity to meet him.

The following papers treated various aspects of textile crafts from the earliest known tablet woven bands from the Bronze and Iron Age salt mines at Hallstatt "Tablet bands with stripes, meanders and triangles – Bronze and Iron Age textile art from the salt mines in Austria", presented by Karina Grömer (Vienna), to sixteenth century bobbin-made borders "From narrow 4-strand plaits to lattice-worked bobbin-made borders", introduced by Lena Dahrén (Stockholm). Talks on tablet weaving included the presentation on "Lions, goats and scraps – tablet-woven bands from Fort Miran in the Taklamakan desert" by Lise Ræder Knudsen (Denmark), "Longobard brocaded bands from the Seprio: Production, Movement and Status" by Paola De Marchi (Milan) and Alessio Palmieri-Marinoni (New York), "Evidence of tablet-weaving from Viking-age Dublin" by Frances Pritchard (Manchester) and "The so-called Palermo bands" by Regula Schorta (Riggisberg).

During lunch break demonstrations on ply-split braiding (Julie Hedges), loop braiding (Joy Boutrup), tablet weaving (Ruth Gilbert) and sprang (Carol James) provided opportunity for discussion and the possibility to try some of the techniques.

The first day of the conference ended with the presentation by Agata Ulanowska (Warsaw) on "Aegean Bronze Age Techniques – a teacher's perspective for their possible reconstruction with students". At the University of Warsaw experimental archaeology is applied both as a teaching method and as a research tool.

The following conference day started with a presentation and demonstration by Katrin Kania (Germany) on "The Story of Twist – Spinning as a Historical Craft" and continued with discussions on sprang "Features and Analysis of Sprang Hairnets" by Anne Kwaspen (Antwerp), "Tight-fitting Clothing in Antiquity and the Renaissance – Experimental Reconstruction using the Sprang Technique" by Carol James (Canada) and Dagmar Drinkler (Munich) and "Structural analysis in the context of archaeology and the history of technology – sprang hairnets and braided girths" by Hero Granger-Taylor (London). Carol James certainly captured the attention of her audience by wearing one of her reconstructed Renaissance sprang hose thus giving a vivid demonstration on its properties. The afternoon was spent with talks on braiding techniques such as loop braided laces and Turk´s heads knots "Braided strings and Turk´s heads knots" by Joy

Boutrup (Denmark) and bobbin lace by Lena Dahrén. The last speech of the conference offered insight into three textile techniques found on 15th century textiles "One thread – Three Techniques. Needle lace, finger-loop braided laces and sprang at Lengberg Castle, East Tyrol" by the author of this review. The two day event successfully brought together scholars of various textile crafts with ample time for networking and exchange of information and knowledge in addition to commemorating the much missed textile artist, scholar and author of fundamental books, Peter Collingwood. We would like to thank Frances Pritchard for a very well organized and fruitful conference.

Recent publications

***Prehistoric, Ancient Near Eastern & Aegean Textiles and Dress: An Interdisciplinary Anthology* (2014) edited by Mary Harlow, Cécile Michel and Marie-Louise Nosch. Ancient Textiles Series Vol. 18, Oxford: Oxbow Books**

Textile and dress production, from raw materials to finished items, has had a significant impact on society from its earliest history. The essays in this volume offer a fresh insight into the emerging interdisciplinary research field of textile and dress studies by discussing archaeological, iconographical and textual evidence within a broad geographical and chronological spectrum. The thirteen chapters explore issues, such as the analysis of textile tools, especially spindle whorls, and textile imprints for reconstructing textile production in contexts as different as Neolithic Transylvania, the Early Bronze Age North Aegean and the Early Iron Age Eastern Mediterranean; the importance of cuneiform clay tablets as a documentary source for both drawing a detailed picture of the administration of a textile industry and for addressing gender issues, such as the construction of masculinity in the Sumerian kingdoms of the 3rd millennium BC; and discussions of royal and priestly costumes and clothing ornaments in the Mesopotamian kingdom of Mari and in Mycenaean culture. Textile terms testify to intensive exchanges between Semitic and Indo-European languages, especially within the terminology of trade goods. The production and consumption of textiles and garments are demonstrated in 2nd millennium Hittite Anatolia; from 1st millennium BC Assyria, a cross-disciplinary approach combines texts, realia and iconography to produce a systematic study of golden dress decorations; and finally, the important discussion of fibres, flax and wool, in written and archaeological sources is evidence for delineating the economy of linen and the strong symbolic value of fibre types in 1st millennium Babylonia and the Southern Levant. The volume is part of a pair together with Greek and Roman Textiles and Dress: An Interdisciplinary Anthology edited by Mary Harlow and Marie-Louise Nosch

ISBN: 9781782977193

Price: £ 38.00

www.oxbowbooks.com/oxbow/prehistoric-ancient-near-eastern-aegean-textilea-and dress.html

***Römische Textilien in Noricum und Westpannonien im Kontext der archäologischen Gewebefunde 2000 v. Chr. – 500 n. Chr. in Österreich* (2014) by Karina Grömer (with contributions by Annette Paetz gen. Schieck, Eva Steigberger, Kordula Gostenčnik), Austria Antiqua 5, Graz, Uni-Press Graz Verlag GmbH**

Textilien hatten in der römischen Welt eine große Bedeutung – ob als Kleidung zum Ausdruck von Identitäten, zur Versorgung der Armee, als Luxusgut zur Repräsentation oder als ganzer Wirtschaftssektor. Dennoch waren bisher Gewebe durch ihre schlechte Erhaltbarkeit im archäologischen Fundgut in Österreich nicht gut sichtbar. Dieses Buch stellt nun einen Beitrag zur Grundlagenforschung zum Thema Textilien und Textilproduktion im Römischen Reich dar, wobei auch die vorrömischen Wurzeln thematisiert werden. Hauptteil ist der umfangreiche Katalog, der textile Funde mit all ihren technologischen Details aus dem Gebiet des heutigen Österreich vorstellt, aus einem Zeitraum zwischen 2000 v. Chr. und 500 n. Chr. Die Analyse dieser Funde zeigt ihre vielfältige Verwendung, aber auch Hinweise zu ihrer Herstellung. Die Textilgeräte, die aus römischen Siedlungen und Gräbern erhalten sind, bieten gemeinsam mit verschiedenen Bild- und Schriftquellen einen guten Einblick in die Textilproduktion der römischen Provinzen Noricum und Pannonien. Dieses Buch entstand im Rahmen des Forschungsprojektes DressID „Clothing and Identities – New Perspectives on Textiles in the Roman Empire“ (2007–2012).

Textiles and textile production have been of great importance in the Roman world. They had different purposes, as clothing to express different identities, as supplies for the army or as representative luxury goods. Textile production was an important economic sector within the Empire. Nevertheless, the preservation conditions for textiles are poor in Europe and therefore such organic finds are underrepresented in the archaeological record. This monograph is a part of the ground research in this field. Textiles and textile production in the Roman Empire are addressed as well as their roots in prehistory. The main part of this book is a comprehensive catalogue of textiles from the present day Austria within a time-span between

2000 BC and AD 500, which describing the analytical details of the finds. Context analysis is carried out in order to understand their function, but also how the textiles were produced. Textile tools from settlements and graves as well as iconographic and written evidence provide an insight into textile craft in the Roman provinces Noricum and Pannonia. This book is a result of the research project DressID "Clothing and Identities – New Perspectives on Textiles in the Roman Empire" (2007–2012).
ISBN 978-3-902666-31-4
Price: € 49,90
verkauf@unipress-graz.com

***Fashionable Encounters: Perspectives and trends in textile and dress in the Early Modern Nordic World* (2014) edited by Tove Engelhardt Mathiassen, Marie-Louise Nosch, Maj Ringgaard, Kirsten Toftegaard and Mikkel Venborg Pederson. Ancient Textiles Series Vol. 14, Oxford: Oxbow Books**
At the heart of this anthology lies the world of fashion: a concept that pervades the realm of clothes and dress; appearances and fashionable manners; interior design; ideas and attitudes. Here sixteen papers focus on the Nordic world (Denmark, Norway, Sweden Finland, Iceland, the Faroe Isles and Greenland) within the time frame AD 1500–1850. This was a period of rapid and far-reaching social, political and economic change, from feudal Europe through political revolution, industrialisation, development of international trade, religious upheaval and technological innovation; changes impacting on every aspect of life and reflected in equally rapid and widespread changes in fashion at all levels of society. These papers present a broad image of the theme of fashion as a concept and as an empirical manifestation in the Nordic countries in early modernity, exploring a variety of ways in which that world encountered fashionable impressions in clothing and related aspects of material culture from Europe, the Russian Empire, and far beyond. The chapters range from object-based studies to theory-driven analysis. Elite and sophisticated fashions, the importation of luxuries and fashion garments, christening and bridal wear, silk knitted waistcoats, woollen sweaters and the influence of the whaling trade on women's clothing are some of the diverse topics considered, as well as religious influences on perceptions of luxury and aspects of the garment trade and merchant inventories.
ISBN: 9781782973829
Price: £ 38.00
www.oxbowbooks.com/oxbow/fashinable-encounters.html

***Archaeological Footwear. Development of shoe patterns and styles from Prehistory till the 1600's.* (2014) by Marquita Volken. Spa-Uitgevers**
After 20 years of research, the principles for making ancient shoe patterns have been rediscovered. The knowledge of how to make a shoe pattern was certainly the ancient shoemaker's most closely guarded secret, passed from master to apprentice but never written down.
Now, this comprehensive guide to European archaeological footwear will soon be published. It is richly illustrated with drawings and photographs of archaeological leather shoe finds and shoe reconstructions.
A catalogue presents each named shoe style along with the cutting patterns used, a concise description and a full list of the published examples. The volume also includes a short history of calceological studies, case studies, the fundamental research methods and an overview of shoe sole/upper constructions for archaeological leather shoes.
ISBN-10: 9089321179
ISBN-13: 978-9089321176
Price: € 50
www.spa-uitgevers.nl/Webwinkel-Product-64218013/Archaeological-Footwear.html?sid=jao30846h3494ivtoeh4kunrh2&Lng=en

***Catalogue of the footwear in the Coptic Museum (Cairo)* (2014) by André J. Veldmeijer and Salima Ikram. Leiden: Sidestone Press**
This catalogue presents the ancient Egyptian footwear in the collection of the Coptic Museum in Cairo. The catalogue contains detailed descriptions and measurements, photographs and drawings. Each description of a footwear category is followed by short discussions, addressing topics such as typology and dating. In addition a fairly large corpus of comparative material is presented as well, none of which has been published before. The present work will form an important resource for future study.
This catalogue is one of the results of the Nuffic Tailor Made Training for the curators of the Coptic Museum in Cairo, jointly organized by the Netherlands-Flemish Institute in Cairo and the American University in Cairo in close collaboration with the Bibliotheca Alexandrina, the Coptic Museum Authorities and the Ministry of State for Antiquities Affairs.
ISBN: 9789088902536
Price: € 49,95
www.sidestone.com/bookshop/catalogue-of-the-footwear-in-the-coptic-museum-cairo

***A stich in time: Essays in Honour of Lise Bender Jørgensen* (2014) edited by Sophie Bergerbrant and Sølvi Helene Fossøy. Gotharc Series 4, Gothenburg University Press (print on demand)**

Professor Lise Bender Jørgensen is a prominent textile researcher in Scandinavia. Her wide-ranging interests in technical advances leading to new methods of investigation and theoretical approaches to textiles, as well as to many periods and geographical regions, are all reflected in the variety of contributions to this collection of essays written in her honour.

This book contains 18 articles and starts with two short reflections on Lise and her life. The articles in the book are divided into different themes. The first theme, Science, Theory, Methodology and Prehistoric Textiles, includes all the articles which deal with methodological, theoretical and conservation related questions on textile archaeology. The second section, Social Aspects of Prehistoric Textiles, deals with a range of questions one might ask of material related to textile production, such as how it was made and used. The articles are arranged in chronological order within this theme, from the Bronze Age to the Early Modern period, with a main focus on the Roman Period.

ISBN 978-91-85245-56-9

Price: 400 DKK ~ 53,60 EUR

www.webshophum-dk.ku.dk/shop/a-stitch-in-1068.html

***Fundmassen. Innovative Strategien zur Auswertung frühmittelalterlicher Quellenbestände* (2013) edited by Sebastian Brather and Dirk Krauße. Materialhefte zur Archäologie in Baden-Württemberg, Stuttgart: Theiss**

In der archäologischen Forschung stellt die Aufarbeitung großer Fundkomplexe stets eine besondere Herausforderung dar. Zeitnahe Vorlagen wissenschaftlich bedeutender Quellenbestände sind heute aufgrund der begrenzten finanziellen und personellen Ressourcen sowie dem ständigen Fundzuwachs nur noch durch innovative Konzepte zu gewährleisten. Konventionelle Aufarbeitungen führen unweigerlich zu einer überlangen Zeitspanne zwischen Ausgrabung und Publikation und mittelfristig zur Verzögerung oder gar zum Ausbleiben wissenschaftlicher Fundvorlagen. Denkmalpflege und Wissenschaft stehen daher vor der Herausforderung, neue Lösungswege zu finden.

Diesem Problem stellt sich seit 2009 ein von der Deutschen Forschungsgemeinschaft gefördertes Projekt zur Publikation und Analyse des großen frühmittelalterlichen Gräberfeldes von Lauchheim »Wasserfurche«. Ausgehend von diesem Forschungsvorhaben fand vom 8. bis zum 10. November 2011 eine vom Landesamt für Denkmalpflege im Regierungspräsidium Stuttgart und dem Institut für Archäologische Wissenschaften, Abteilung Frühgeschichtliche Archäologie und Archäologie des Mittelalters, der Albert-Ludwigs-Universität Freiburg im Breisgau initiierte internationale Tagung zu diesem Thema statt. Im Vordergrund standen die Bewältigung großer Fundmassen, der Einsatz neuer technischer Verfahren zur Dokumentation wie der Computertomographie sowie in der Konservierung und die sich daraus ergebenden wissenschaftlichen Perspektiven.

In diesem Tagungsband sind die Beiträge zusammengefasst, die konservatorische, wissenschaftliche und übergeordnete Konzepte zur Aufarbeitung und Auswertung von Fundmassen vorstellen.

ISBN: 978-3-8062-2872-4

Price: € 25

www.theiss.de/index.html?/detail.php?n=1573&ref=/1_denkmalpflege.php

***Reconstructing Ancient Linen Body Armor: Unraveling the Linothorax Mystery* (2013) by Gregory S. Aldrete, Scott M. Bartell and Alicia Aldrete. Baltimore: John Hopkins University Press**

Alexander the Great led one of the most successful armies in history and conquered nearly the entirety of the known world while wearing armor made of cloth. How is that possible? In Reconstructing Ancient Linen Body Armor, Gregory S. Aldrete, Scott Bartell, and Alicia Aldrete provide the answer.

An extensive multiyear project in experimental archaeology, this pioneering study presents a thorough investigation of the linothorax, linen armor worn by the Greeks, Macedonians, and other ancient Mediterranean warriors. Because the linothorax was made of cloth, no examples of it have survived. As a result, even though there are dozens of references to the linothorax in ancient literature and nearly a thousand images of it in ancient art, this linen armor remains relatively ignored and misunderstood by scholars.

Combining traditional textual and archaeological analysis with hands-on reconstruction and experimentation, the authors unravel the mysteries surrounding the linothorax. They have collected and examined all of the literary, visual, historical, and archaeological evidence for the armor and detail their efforts to replicate the armor using materials and techniques that are as close as possible to those employed in antiquity. By reconstructing actual examples using authentic materials, the authors were

able to scientifically assess the true qualities of linen armor for the first time in 1,500 years. The tests reveal that the linothorax provided surprisingly effective protection for ancient warriors, that it had several advantages over bronze armor, and that it even shared qualities with modern-day Kevlar.
Previously featured in documentaries on the Discovery Channel and the Canadian History Channel, as well as in U.S. News and World Report, MSNBC Online, and other international venues, this groundbreaking work will be a landmark in the study of ancient warfare.
ISBN-10: 1421408198
ISBN-13: 978-1421408194
Price: $ 29.95
www.jhupbooks.press.jhu.edu/content/reconstructing-ancient-linen-body-armor

***Why Leather? The Material and Cultural Dimensions of Leather* (2014) edited by Susanna Harris and André J. Veldmeijer. Leiden: Sidestone Press**
This pioneering volume brings together specialists from contemporary craft and industry and from archaeology to examine both the material properties and the cultural dimensions of leather. The common occurrence of animal skin products through time, whether vegetable tanned leather, parchment, vellum, fat-cured skins or rawhide attest to its enduring versatility, utility and desirability. Typically grouped together as 'leather', the versatility of these materials is remarkable: they can be soft and supple like a textile, firm and rigid like a basket, or hard and watertight like a pot or gourd. This volume challenges a simple utilitarian or functional approach to leather; in a world of technological and material choices, leather is appropriated according to its suitability on many levels. In addressing the question Why leather? authors of this volume present new perspectives on the material and cultural dimensions of leather. Their wide-ranging research includes the microscopic examination of skin structure and its influence on behaviour, experiments on medieval cuir bouilli armour, the guild secrets behind the leather components of nineteenth-century industrial machinery, new research on ancient Egyptian chariot leather, the relationship between wine and wineskins, and the making of contemporary leather wall covering.
The Archaeological Leather Group promotes the study of leather and leather objects from archaeological and other contexts. The Group aims to provide a focus for the investigation of leather, and to develop new research by bringing together a broad range of knowledge and experience both practical and academic. Leather is explored through its manufacture, function, context, processing, recording, conservation, care and curation. Members come from a variety of disciplines and include archaeologists, historians, conservators, artefact specialists, materials engineers and leather workers. The Group normally meets twice a year and organises one scholarly meeting in the spring, and visits a museum, working tannery or other place of leather interest in the autumn. The Archaeological Leather Group Newsletter is published twice a year, and the website maintains a comprehensive and expanding leather bibliography.
ISBN: 9789088902611
Price: € 29,95
www.sidestone.com/bookshop/why-leather

***Der Kirchenschatz von St. Leonhard in Frankfurt. Goldschmiede- und Textilkunst 16. bis 20. Jahrhundert* (2013) by Karen Stolleis. Regensburg: Schnell und Steiner**
Der Bestand umfasst an die achtzig Gold- und Silberwerke und ebenso viele kostbare liturgische Gewänder, die zum großen Teil aus Hofkleidern des 18. Jahrhunderts entstanden sind. Die prachtvollsten Geräte und Paramente stammen aus den säkularisierten Frankfurter Klosterkirchen der Karmeliter und Dominikaner. Deren liturgische Ausstattung ging im frühen 19. Jahrhundert in den Besitz der katholischen Pfarrkirchen über.
An die beiden einführenden Kapitel zur Geschichte des Kirchenschatzes und zu seiner kunsthistorischen Bedeutung schließen sich zwei ausführliche Kataloge zu den liturgischen Geräten und Textilien an. Schwerpunkte bilden Augsburger Gold- und Silberarbeiten, dazu eine große Sammlung von Altarleuchtern sowie Messgewänder aus seltenen Gold-, Silber- und Seidenstoffen. Unter diesen befinden sich Stiftungen der Fürsten von Thurn und Taxis und ihres höfischen Umfelds sowie des vermögenden Stiftsherrn Georg Brentano.
Der großzügig gestaltete und reich bebilderte Band präsentiert das einzigartige Ensemble in seiner Vielfalt und Kostbarkeit.
ISBN: 978-3-7954-2515-9
Preis: € 49,95
www.schnell-und-steiner.de/artikel_7049.ahtml

***Greek and Roman Textiles and Dress: An Interdisciplinary Anthology* (2014) edited by Mary Harlow and Marie-Louise Nosch. Ancient Textiles Series Vol. 19, Oxford: Oxbow Books**
Twenty chapters present the range of current research into the study of textiles and dress in classical

antiquity, stressing the need for cross and inter-disciplinarity study in order to gain the fullest picture of surviving material. Issues addressed include: the importance of studying textiles to understand economy and landscape in the past; different types of embellishments of dress from weaving techniques to the (late introduction) of embroidery; the close links between the language of ancient mathematics and weaving; the relationships of iconography to the realities of clothed bodies including a paper on the ground breaking research on the polychromy of ancient statuary; dye recipes and methods of analysis; case studies of garments in Spanish, Viennese and Greek collections which discuss methods of analysis and conservation; analyses of textile tools from across the Mediterranean; discussions of trade and ethnicity to the workshop relations in Roman fulleries. Multiple aspects of the production of textiles and the social meaning of dress are included here to offer the reader an up-to-date account of the state of current research. The volume opens up the range of questions that can now be answered when looking at fragments of textiles and examining written and iconographic images of dressed individuals in a range of media.
This volume is part of a pair together with Prehistoric, Ancient Near Eastern and Aegean Textiles and Dress: an interdisciplinary anthology edited by Mary Harlow, Cécile Michel and Marie-Louise Nosch.
ISBN: 9781782977155
Regular Price: £ 38.00
www.oxbowbooks.com/oxbow/greek-and-roman-textiles-and-dress.html.

***Leatherwork from Qasr Ibrim (Egypt). Part I: Footwear from the Ottoman Period* (2013) by André J. Veldmeijer. Leiden: Sidestone Press**
Throughout its long history, stretching from the 25th Dynasty (c. 752-656 BC) to the Ottoman Period (c. 1500-1811 AD), Qasr Ibrim was one of the most important settlements in Egyptian Nubia. The site has produced an unprecedented wealth of material and due to the – even for Egypt – extraordinary preservation circumstances, includes objects that are made of perishable organic materials, such as wood, leather, and flax.
The present volume focuses on one of these groups: footwear that is made from leather and dated to the Ottoman Period. The footwear, recovered during the years that the Egypt Exploration Society worked at the site, is described in detail, including a pictorial record consisting of photographs and drawings (both technical and artist's impressions). This is the first time that Ottoman footwear from Egypt (and outside of Egypt) has been analyzed in detail. The preliminary analysis focuses on footwear technology, within the framework of the Ancient Egyptian Footwear Project (AEFP; see www.leatherandshoes.nl). A broader interpretation will be combined with the results of the analyses of the finds from the other epochs of Qasr Ibrim's history, such as the age of Christianity and the Meroitic Period.
ISBN: 9789088900969
Price: € 79,95
www.sidestone.com/bookshop/leatherwork-from-qasr-ibrim-egypt

***Textiles and the Medieval Economy: Production, Trade, and Consumption of Textiles, 8th–16th Centuries* (2014) edited by Angela Ling Huang and Carsten Jahnke. Ancient Textiles Series Vol. 16, Oxford: Oxbow Books**
Archaeologists and textile historians bring together 16 papers to investigate the production, trade and consumption of textiles in Scandinavia and across parts of northern and Mediterranean Europe throughout the medieval period. Archaeological evidence is used to demonstrate the existence or otherwise of international trade and to examine the physical characteristics of textiles and their distribution in order to understand who was producing, using and trading them and what they were being used for. Historical evidence, mainly textual, is employed to link textile names to places, numbers and prices and thus provide an appreciation of changing economics, patterns of distribution and the organisation of trade. Different types and qualities of cloths are discussed and the social implications of their production and import/export considered against a developing background of urbanism and increasing commercial wealth.
ISBN: 9781782976479
Price: £ 35.00
http://www.oxbowbooks.com/oxbow/textiles-and-the-medieval-economy.html

***Silk for the Vikings* (2014) by Marianne Vedeler. Ancient Textiles Series Vol. 15, Oxford: Oxbow Books**
The analysis of silk is a fascinating topic for research in itself but here, focusing on the 9th and 10th centuries, Marianne Vedeler takes a closer look at the trade routes and the organization of production, trade and consumption of silk during the Viking Age. Beginning with a presentation of the silk finds in the Oseberg burial, the richest Viking burial find ever discovered, the other silk finds from high status

graves in Scandinavia are discussed along with an introduction to the techniques used to produce raw silk and fabrics. Later chapters concentrate on trade and exchange, considering the role of silk items both as trade objects and precious gifts, and in the light of coin finds. The main trade routes of silk to Scandinavia along the Russian rivers, and comparable Russian finds are described and the production and regulation of silk in Persia, early Islamic production areas and the Byzantine Empire discussed. The final chapter considers silk as a social actor in various contexts in Viking societies compared to the Christian west.
ISBN: 9781782972167
Price: £ 14.00
www.oxbowbooks.com/oxbow/silk-for-the-vikings-44994.html

***Drawing the threads together. Textiles and footwear of the 1st millennium AD from Egypt. Proceedings of the 7th conference of the research group 'Textiles from the Nile Valley' Antwerp, 7-9 October 2011* (2013) edited by Antoine De Moor, Cäcilia Fluck and Petra Linscheid. Lannoo Publishers, Tielt.**
This richly illustrated book contains the papers read at the conference Textiles of the Nile Valley . The first part is devoted to textiles from excavations, the second part of the book covers research on textiles in public collections, the third part carries articles concerning textile techniques and radiocarbon dating. The last parts are dedicated to iconographical studies and special items of costume and footwear.
ISBN: 978-94-014-1083-0
Price: € 100
www.lannoo.com

***Textile Production and Consumption in the Ancient Near East: archaeology, epigraphy, iconography* (2013) edited by Marie-Louise Nosch, Henriette Koefoed and Eva Andersson Strand. Ancient Textiles Series Vol. 12, Oxford: Oxbow Books**
In the past, textile production was a key part of all ancient societies. The Ancient Near East stands out in this respect with the overwhelming amount of documentation both in terms of raw materials, line of production, and the distribution of finished products. The thirteen intriguing chapters in Textile Production and Consumption in the Ancient Near East describe the developments and changes from household to standardised, industrialised and centralised productions which take place in the region. They discuss the economic, social and cultural impact of textiles on ancient society through the application of textile tool studies, experimental testing, context studies and epigraphical as well as iconographical sources. Together they demonstrate that the textile industries, production, technology, consumption and innovations are crucial to, and therefore provide an in-depth view of ancient societies during this period. Geographically the contributions cover Anatolia, the Levant, Syria, the Assyrian heartland, Sumer, and Egypt.
ISBN: 9781842174890
Price: £ 32.00
www.oxbowbooks.com/oxbow/textile-production-and-consumption-in-the-ancient-near-east.html

***Wool Economy in the Ancient Near East and the Aegean: From the Beginnings of Sheep Husbandry to Institutional Textile Industry* (2014) edited by Catherine Breniquet and Cécile Michel. Ancient Textiles Series Vol. 17, Oxford: Oxbow Books**
The history of the Ancient Near East covers a huge chronological frame, from the first pictographic texts of the late 4th millennium to the conquest of Alexander the Great in 333 BC. During these millennia, different societies developed in a changing landscape where sheep (and their wool) always played an important economic role. The 22 papers presented here explore the place of wool in the ancient economy of the region, where large-scale textile production began during the second half of the 3rd millennium. By placing emphasis on the development of multi-disciplinary methodologies, experimentation and use of archaeological evidence combined with ancient textual sources, the wide-ranging contributions explore a number of key themes. These include: the first uses of wool in textile manufacture and organization of weaving; trade and exchange; the role of wool in institutionalized economies; and the reconstruction of the processes that led to this first form of industry in Antiquity. The numerous archaeological and written sources provide an enormous amount of data on wool, textile crafts, and clothing and these inter-disciplinary studies are beginning to present a comprehensive picture of the economic and cultural impact of woollen textiles and textile manufacturing on formative ancient societies.
ISBN: 9781782976318
Price: £ 35.00
www.oxbowbooks.com/oxbow/wool-economy-in-the-ancient-near-east.html

***Unwrapping Ancient Egypt* (2014) by Christina Riggs. EPUB eBook, London-New York-Sydney: Bloomsbury Academic**

In ancient Egypt, wrapping sacred objects, including mummified bodies, in layers of cloth was a ritual that lay at the core of Egyptian society. Yet in the modern world, attention has focused instead on unwrapping all the careful arrangements of linen textiles the Egyptians had put in place. This book breaks new ground by looking at the significance of textile wrappings in ancient Egypt, and at the way their unwrapping has shaped the way we think about the Egyptian past. Wrapping mummified bodies and divine statues in linen reflected the cultural values attached to this textile, with implications for understanding gender, materiality and hierarchy in Egyptian society. Unwrapping mummies and statues similarly reflects the values attached to Egyptian antiquities in the West, where the colonial legacies of archaeology, Egyptology and racial science still influence how Egypt appears in museums and the press.From the tomb of Tutankhamun to the Arab Spring, Unwrapping Ancient Egypt raises critical questions about the deep-seated fascination with this culture – and what that fascination says about our own.

ISBN: 9780857856777

Price: £ 24.99

www.bloomsbury.com/uk/unwrapping-ancient-egypt-9780857856777/#sthash.KkcKRvkI.dpuf

Websites

The National Museum of Denmark, in collaboration with the National Museum of Greenland and the Museum of Cultural History, Oslo have published a new skin costume database. The online database shows high-resolution photos and detailed information of outstanding and historic skin costumes from the indigenous peoples in Greenland, North America, North Scandinavia and Siberia. Through the website easy access is given to these rich museum collections. Museums with similar collections, small or large, are invited to join the website. For more information contact Anne Lisbeth Schmidt (*anne.lisbeth.schmidt@natmus.dk*).
www.skinddragter.natmus.dk/startenglish

Girl's parka made from gut skin. Collected in East Greenland by H.J. Rink 1854 (Photo: The National Museum of Denmark)

In connection with the temporary exhibition about fur at the National Museum of Denmark in Copenhagen, the Department Ancient Cultures of Denmark and the Mediterranean have launched a new webpage about "Fur in Prehistory and Antiquity".
www.natmus.dk/en/historisk-vicen/pels-i-oldtiden-og-antikken/

CinBA, Creativity and Craft Production in Middle and Late Bronze Age Europe, online database,
www.cinba.net/outputs/databases/textiles

PhDs

Julia Galliker was awarded PhD in History by the Centre for Byzantine, Ottoman and Modern Greek Studies at the University of Birmingham, for her dissertation "Middle Byzantine Silk in Context: Integrating the Textual and Material Evidence".

Lise Ræder Knudsen was awarded PhD in Conservation by the School of Conservation, The Royal Danish Academy of Fine Arts, Denmark for her dissertation "Teknologihistorisk analyse af brikvævning fra ældre jernalder".

General Information

Guidelines to Authors
The ATR 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 ATR'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. Authors' guidelines can be found at www.atnfriends.com

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 invited specialists.

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

Please submit contributions by post to:
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The Saxo Institute
University of Copenhagen
Karen Blixensvej 4,
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Or by electronic mail to the editors:
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