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Editorial

Issue 51 includes several articles about Roman or Roman period textiles and costumes, as well as an interesting article about New World textiles which we thought will interest the readers from a technical point of view. Furthermore the craft of fulling is revealed to us though some very early texts from Mesopotamia. As usual, we include several conference reviews and information one new books and forthcoming conferences and other events of interest to textile scholars.

This year we have successfully applied for financial help to the increasing production costs of ATN from the Nordic Board for Periodicals in the Humanities and Social Sciences, NOP-HS. During the procedure ATN was externally reviewed, and we thank the reviewers for their positive assessment but also many constructive suggestions for changes and improvements. Though ATN is a specialized journal with no direct competitors, the editorial group constantly strive to improve and height the level of ATN so that it can survive in the competition from the many international academic journals. ATN cannot survive without the scientific contributions from the readers and/or the authors, nor without the financial support from the subscribers. It is important to remember, that ANT was started as and still is a forum where news and first thoughts are quickly circulated among scholars and all those with interests in archaeological textile questions. We would like to keep it like this, whilst maintaining the scientific standard as high as possible.

We are still working on making reprints of old issues, and to find suitable solutions for making electronic versions of back issues on our homepage. Copyrights of photographs are always creating problems in the virtual world, but hopefully this issue has been solved for the issues 46 and onwards. Intellectual property is another delicate matter that is important to respect and uphold, as it is the fundament for open minded, academic communication and sharing.

Orit Shamir was the first to send her list of publications to us, as announced in the last editorial, and it is now available on the homepage. We hope that many more scholars will follow her example.

Please make sure to renew your membership for 2011 soon. The website payment for 2011 has only recently been opened and not many of you have paid yet. We will send out a reminder in the beginning of the new year. To keep it simple for you to keep track of the subscription, we will not open the subscription for 2012 before the autumn 2011.

The next Annual General Meeting will be held on the 11th of May 2011 during the NESAT XI conference in Esslingen, Germany. We hope this will ensure the participation of many ATN subscribers.

Suggestions for the agenda should be sent to one of the editors no later than 1st April 2011. If no additional proposals have been sent in by the members, the agenda is as following:

1. Election of a chairperson, if somebody so wishes
2. The report of the board for the period since the previous annual general meeting
3. Presentation and approval of the revised account of 31st of December 2010
4. Decisions concerning individual and institutional subscription fee for the current financial year
5. Election of 3 members of the board and 1 deputy member for the current financial year
6. Election of an auditor and 1 deputy auditor member for the current financial year
7. Miscellaneous

For the statutes of the society, including the voting procedure, please consult:

http://www.atnfriends.com/

We would like to finish this editorial by wishing all out readers and colleagues a happy and prosperous New Year.

The editors

Lena Bjerregaard

Fist-Braided Bands Used as Headgear in Pre-Hispanic Peru

Geographical and Hierarchical Affiliation through Clothing

In the present day Indian communities in Central and South America, geographical affiliation is most often expressed in traditional clothing and especially in the headgear worn. It was no different in pre-Columbian Peru. In Inca society (*c.* 1460-1532), much of the higher status clothing was produced in central workshops. These textiles (*chombi*) all belonged to the Inca king, who distributed the clothing as rewards or bribes. The clothing therefore also indicated hierarchical position. Headgear, on the other hand, apart from indicating hierarchical position also demonstrated geographical affiliation. Several Spanish chroniclers noted that headgear varied among the various ethnic groups in the Inca Empire. The archaeological information available suggests that most of the braided slings and bands discussed in this article probably date to or around the period of the Inca Empire.

Pre-Columbian Ornamental Slings Used as Headgear

A variety of long braided bands and cords were produced in pre-Columbian Peru. Many are in the form of slings, with a central cradle and a cord on each end, with or without a loop on one end. Although they are in the shape of slings traditionally used as weapons, many were intended solely to wrap around the head. In addition, structurally similar rectangular braids without a central cradle were also used to wrap around the head, and larger examples may even have been used as belts. The American archaeological textile collection in the Ethnologisches Museum, Berlin, Germany, includes a large collection of such bands that enable us to study their wide variety, including several types that have not previously been analyzed.

Headbands

The Ethnologisches Museum has about 500 slings, most of which were probably used as headbands: 222 are stated to be from Pachacamac, 60 are from Chuquitanta and 22 from other places around Lima, all on the central coast of Peru, while further 190 have Ica Valley provenience, on the south coast. Most were collected by Wilhelm Gretzer - a German textile merchant living in Peru from 1872 to 1905 - and entered the museum in 1899 and 1906-07. Fifteen of the Ica slings were collected by Eduard Seler, the founder of Mesoamerican studies in Germany and an employee of the Museum für Volkerkunde in Berlin, and registered in the museum in 1910. Unfortunately there is no information concerning the context in which most of the slings were found, but seven 'false' mummy heads (a stuffed cushion arranged on top of the mummy) and six real mummy heads in the collection are wearing a sling as a headband (Fig. 1). Ceramics from both the central and south coasts also frequently show slings used as male headgear (Fig. 2). One sling in the Ethnological Museum collection (V A 66521) has a silver sheet cradle decorated with stamped geometric patterns identical to the braided sling cradles, but is obviously unsuited for use as a weapon.

The use of slings as headbands was recognized at least as early as 1954 by Junius Bird, who noted that "Others [other slings] from late period graves in the Nasca-Ica region, are elaborately designed and prepared, sometimes found as joined pairs, and as such completely non-functional except as headbands" (Bird 1954, 45). Adele Cahlander described the use of elaborate slings in modern Peru as dance accoutrements: "In Incan-style dances in the Cuzco area, fancy slings are sometimes worn at the waist as belts, and sometimes they are swung high in the air between the hands. Elsewhere some are doubled and held between the hands, some are worn from the shoulders, and others are held in one hand" (Cahlander 1980, 7-8). The same author also noted

Fig. 1. Mummy bundle with an ornamental sling around the "false" mummy head. The mummy bundle measure 75 x 50 cm. Ethnologisches Museum, Berlin (V A 28464, Chuquitanta).
Photo: Martin Franken.

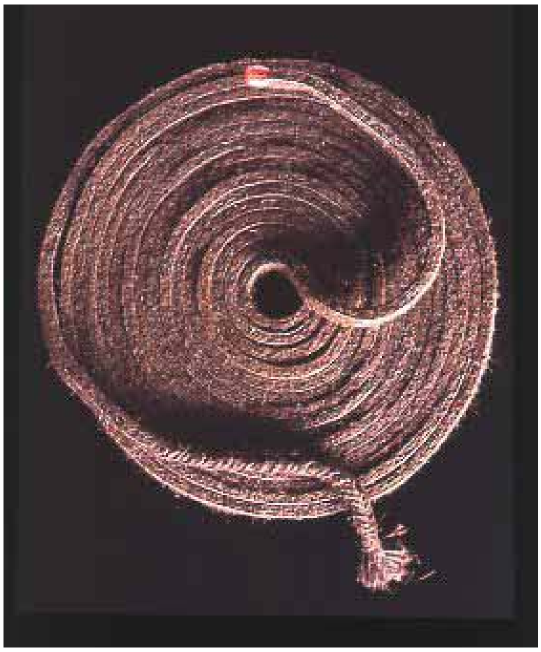

Fig. 3. Inca nobleman's headgear: *Llawt'u*. Made of camelid hair in a regular SZ twist, 2-span float fist-braid. It measures 535 x 1 x 0.5 cm. Ethnologisches Museum, Berlin (V A 21670, Pachacamac).
Photo: Martin Franken.

Fig. 2. Ceramic vessel, 40 cm high, with a sling used as headband. Ethnologisches Museum, Berlin (V A 50930, Pisco). Photo: Martin Franken.

Fig. 4. Coarse headband with 2- and 3-span floats and geometric designs, measuring 140 cm. Ethnologisches Museum, Berlin (V A 47195, Ica).
Photo: Martin Franken.

that the traditional young women's costume in Huancavelica still includes an ornamental sling worn diagonally over the shoulder. These latter uses cannot be verified in the archaeological record, but must be kept in mind as a possibility.

A sling has a central cradle, often made by interlacing over a small number of warp yarns, but sometimes braided or made of a piece of leather. On either end of the cradle there is a round cord that is usually braided, but in some cases is made with tubular interlinking, wrapping, tubular weaving, or is embroidered. Sometimes there is a tassel on both ends. In other cases one end has a loop. In a functional sling used as a weapon, the loop would be slipped over one finger while the other end grasped in the hand. The presence or absence of this loop does not correlate with its function as a sling or a headband, however.

Other types of braided headgear lack a central cradle. The Inca man's *llawt'u* was a long braided cord with a loop on one end but no cradle (Fig. 3). In her article on Inca weaving and costume, Ann Rowe (1980) presents the available information from early Spanish chronicles on the *llawt'u*. Cobo describes it as a braided wool band, the thickness of half a finger and the width of a finger, wound many times around the head, to the width of one hand. Only Incas by descent (belonging to one of the royal lineages) and Incas by privilege (conquered Inca-speaking groups in the vicinity of Cuzco) were allowed to wear it. Garcilaso states that a black *llawt'u* was worn by most Inca men, while the emperor wore a multicolored one. Guaman Poma says that the imperial *llawt'u* was red or green in color. Inca nobles wore a metal plate tied over the *llawt'u* as well as at least sometimes a feather ornament, and for festivals they might wear a flower in their *llawt'u*.

Few actual examples of these headbands are known archaeologically, but the German archaeologist Max Uhle (1903) found several heads with spirally wrapped black braided cords in an Inca context at Pachacamac. The Ethnologisches Museum is fortunate to have two examples, one made in black camelid hair (Fig. 3) and the other in undyed cotton. Both are from Pachacamac and were collected by Gretzer. The archival information states that they both were associated with a mummy head which unfortunately is no longer in the collection.

The third type of headband seems to have no direct relationship to a sling (Fig. 4). These bands have wide and long center sections (60-67 x 3-4.5 cm). They have a round usually braided cord at both ends (which could have been used to tie the band), making their total length 1.20-2 m. These cords end in tassels. The smaller ones were probably headbands and the larger ones belts. Such a band, with a center section only 30 cm long, is wound around the head of a mummified skull in the Ethnologisches Museum (V A 2601). Uhle (1903) refers to Inca style woven bands among the grave finds of the sacrificed women at Pachacamac that are 43-46 cm long as headbands and larger bands as belts. Similar textiles with thick woven bands and round braided cords with tassels at either end have also been found, used as women's belts on Inca figurines and on Inca mountaintop human sacrifices.

Technique and Structure

The round and rectangular braids were first analyzed by the French scholar Raoul d'Harcourt in the 1940s. He accurately described the interworking of the yarns without actually knowing the technique with which these bands were produced. The technique, however, still survives in the highlands of modern Peru and Bolivia where it is used for the round braids on either side of the cradle of herding slings as well as for dance slings. In the late 1970s, Elayne Zorn (1982) managed to learn it in the Macusani area of southern Peru. The technique and structure are wonderfully explained by Adele Cahlander (1980). At about the same time, the Swiss scholar Noémi Speiser learned the technique from a Tibetan herder (Speiser 1983), and she has suggested the name "fist-braiding" for this technique.

Fist-braiding is a simple and ingenious technique done without using any extra tools (Fig. 5). The work is held in the fist, and proceeds upwards – the braided band hangs under the fist and the loose strands over the fist. It employs units of four yarns, two hanging down on one side of the braid and the other two on the opposite side. In each movement, one of these yarns on each side is grasped; the two are twisted and laid down so that one of them is crossed over the top edge of the braid. Then the other two are grasped, twisted and laid down so that one is crossed over the top edge of the braid in the opposite direction from the first. When yarns from each of the parallel groups on two opposite sides of the braid have been similarly treated, those at right angles are then manipulated in the same way.

The basic technique produces a twined structure (Fig. 6). A major group of twining units (of four strands each) is at right angles to another major group of twining units. The elements of one major group enclose those of the other major group and vice versa. As in normal four-strand twining, the elements float over two opposing elements at a time. Although no concise structural term has previously been proposed, Ann Rowe now suggests four-strand 2/2 twin-

Fig. 5. The technique of fist-braiding. Top, four layers of strands are arranged alternately crosswise on top of each other to start the braid. Centre, one set of strands is pinched in the hand while the 8 strands of the other group are loose and ready to be worked, bottom. The loose strands are crossed over the pinched strands. Drawing by Noémi Speiser 1983.

ing at right angles (pers.comm.). If the same number of twining units is used on all sides, a square or round braid is produced, such as are common on the round braids on either side of a sling cradle. Rectangular braids can also be created, however, using one, two, or three twining units in the narrow dimension and a larger number of such units in the wide dimension.

Round and Square Fist-Braided Cords

Round braids made by fist braiding have the same number of strands or twining units on all sides. The braids are continuously rotated in the hand after each group of strands has been twined. For a square braid the direction of twining twist is changed on each side of the braid, between each major group of strands: Z, S, Z, S.

Changing the direction of twining twist at other intervals either horizontally or vertically creates geometric zigzag or diamond patterns (Fig. 7 left and centre left). Changing direction vertically after every second row untwists the yarns and causes the twined structure to disappear so that it more closely resembles interlacing. Further color and design variations are obtained by exchanging elements between adjacent twining units or even between major groups. Some braids have a core running through the center of three by three twining units. Patterns are then created by exchanging twining strands with core strands (Fig. 7 centre left). The round braids may have many colors, and they measure between 1 and 1.5 cm in diameter. They may be made of camelid hair or cotton or both. The cotton is s-spun and the camelid hair 2-plied s-spun, but all yarns are used in bundles to create about 2 mm thick strands.

Flat Braided Sling Cords

One style of sling has flat braids of the same twined structure on either side of a woven, split cradle. These braids have only one twining unit on the narrow sides, while they have 8-30 twining units on the wide sides, for a width of 2-6 cm (Fig. 8). The braids are black and white and made of coarse (about 2 mm diameter), 2-plied s-spun camelid hair yarns. The patterning of the braids is created using the same techniques as for the round braids, alternating the colors and changing the direction of twist at intervals both horizontally and vertically.

The Ethnologisches Museum has six slings of this style, all said to be from Ica. Similar examples in the Musée de l'Homme in Paris were analyzed by Raoul d'Harcourt (1975), and seven examples in The Textile Museum in Washington D.C. were analyzed by Ann Rowe (Cahlander 1980). All the Textile Museum

Fig. 6. The basic structure of a fist-braiding. The strands of the narrow side are stretched horizontally on either side of the braid, and the four-strand units of the wide side are left to illustrate the twined structure of the braid. Photo: Lena Bjerregaard.

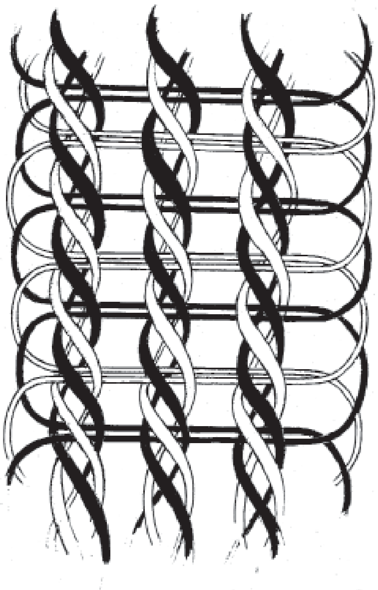

Fig. 8. Structure of a flat fist-braid with only one twining unit on the narrow side and three twining units on the wide side. Drawing by Ulrich Gebauer.

Fig. 7. Three examples of patterned round cords and a llawt'u. The patterning is based on 2-span floats and SZ twist. From left: V A 47195, Ica; V A 23146, Huaco; V A 44693, Pisco; V A 21669, Ethnologisches Museum, Berlin. Photo: Martin Franken.

Fig. 9. Two fine slings with rectangular braided cradles in plant fibre and camelid hair. Top, unpatterned 2/2 twining with alternate SZ twist, 221 cm long. Ethnologisches Museum, Berlin (V A 24920, Chuquitanta), bottom. Sling with 2- and 3-span float patterns 211 cm long. The sling ends at one end with a loop for the finger and at the other in a plant fibre tassel. Ethnologisches Museum, Berlin (V A 47216, Ica). Photo: Martin Franken.

examples are said to be from Chiquerillo, near Palpa in the northern part of the Nazca drainage.
Most of the examples in the Ethnologisches Museum have the end cords started at the ends of the patterned fist-braided sections, but one has the same yarns going through all the way from one end of the sling to the other.

The *Llawt'u*
Two headbands in the Ethnologisches Museum are made by fist-braiding and can be identified as *llawt'u* braids. They have not been analyzed previously. The black camelid hair example (Fig. 3) has ten twining units in the wide dimension and five twining units in the narrow dimension, resulting in 60 strands altogether. The cotton example (Fig. 7 right) has six twining units in the wide dimension and three in the narrow dimension, resulting in 36 strands altogether. The zigzag texture is obtained by alternating the direction of the twining twist of the strands on the wide side of the braid: S, Z, S, Z.
The black camelid hair example is complete: 535 cm long, 1 cm wide, and 0.5 cm thick. At the beginning, it has a 1 cm long red loop, and at the end a 14 cm long oblique interlaced braid of four strands made with the ends of the yarns used to create the rest of the *llawt'u*. The undyed cotton example is in two pieces, together measuring 425 cm. The smaller piece has a 1 cm loop at one end and the larger piece a 16 cm oblique interlaced braid of four strands at one end. A piece is evidently missing between the two fragments, since the catalog card states that the band was originally 605 cm long.
The yarns in both examples are fine (0.5-0.8 mm diameter) 3-plied and s-spun. The manufacture of these braids must have been extremely difficult, since there are no color changes to help determine the succession of the many long thin strands. d'Harcourt (1975, 56) shows an unfinished *llawt'u* in the collection of the Musée de l'Homme in Paris with 42 long yarns wound up in small bundles. Possibly, each bundle was originally marked somehow, so the succession of the yarns was kept evident to the braider as the work was proceeding.

Rectangular Headbands and Belts
The rectangular headbands and belts that are braided are made with camelid hair yarns and have geometric patterning created by changing the direction of the twining twist (Fig. 4). Every other strand is black and is continuously twined with its opposite black strand in two-span floats. In between are two-color diamond-shaped patterns in red, white, or yellow yarns. These patterns are made with three-span floats formed by crossing the upper yarns over the braid instead of the lower ones, as is more common. The diamonds come out in a different color on each side of the braid. After about 2 cm, the colors are interchanged and appear on the opposite side of the braid from before. The band in Figure 4 has two twining units on the narrow sides, which are also worked in a two-color pattern. The outermost twining units in the wide dimension are red.

Plant Fiber Slings with Braided Cradles
Fifty slings in the Ethnologisches Museum have small braided cradles, 1.5-2 cm wide, 0.5 cm thick, and 22-25 cm long, with the twined structure typically created by fist-braiding (Fig. 9). Six are monochrome or have monochrome areas, made of undyed plant fiber, most likely from the leaves of *Furcraea andina*, a South American plant related to agave. These examples, which are from Pachacamac, have a zigzag pattern created by alternating the twining direction with every twining unit (like the *llawt'u*). The yarns also alternate in direction of twist so that those that are s-spun are Z-twined, and vice versa. Each half of the cradle has four twining units in the wide dimension and two in the narrow dimension. Two of the six have completely monochrome cradles as in Figure 9 top, while two others have patterns in camelid hair on the narrow sides, and the remaining two examples have a patterned section inserted between the two monochrome sides of the cradle.
The remaining slings with braided cradles have more elaborate color patterns using at least some camelid hair yarns (Fig. 9 bottom). The sling shown in Figure 9 bottom has a two-color pattern, but other examples have three-color patterns similar to those found in the rectangular bands discussed above. The use of two twining units in the narrow dimension and red twining units on the outer edges of the wide dimension are also similar to the rectangular bands. It is therefore possible that the two types of objects are similar in date.
Twenty-three additional slings are similar but are composed of two, three, or four such slings joined together by a stitch every 4 or 5 cm along the cradles, and at the finger loops, making a wider sling with two, three, or four finger loops (Figs. 10 and 11). These multiple slings can definitely only be used as adornment, as noted by Junius Bird (1954, 45).
All of these slings often have a short length (3-5 cm) of camelid fiber cord on one end of the cradle, usually fist braided in a round braid with diamond patterns (as in Fig. 9 top). The juncture between the cradle and this colored cord marks the starting point of the sling. In 48 examples, the yarns for the cradle and

Fig. 10. **Camelid hair sling with wrapped cradle and fist-braided side bands with patterns created in 2-float braiding with SZ twists. It measures 280 cm. Ethnologisches Museum, Berlin (V A 47185, Ica). Photo: Martin Franken.**

those for the cord are folded in half over each other, and the two braids are worked in opposite directions. Nineteen examples are similar but have some yarns continuing from the cord into the cradle. Of these, ten have only the red yarns on the narrow sides of the cradle continuing into the cord, while the other nine have some also from the wide sides of the cradle continuing through. The remaining slings have about 5 cm next to one end of the cradle wound around with a cotton yarn, on which camelid hair yarns are worked in a progressive wrapping motion (like soumak), presumably with a needle (Fig. 9 bottom). Of these, the wrapping covers the beginning of the sling in at least six examples, but it seems to cover the end in one example.

The remainder of this cord with the decorated section and the entire cord on the other end are of undyed plant fiber, 3-5 mm in diameter and about 80-90 cm long, braided as a four-strand square or tubular braid (Fig. 12). The end with the decorated cord next to the cradle has a finger loop normally interlaced on two warp yarns in red or black camelid hair yarns. At the other end is an approximately 20 cm long tassel made with the loose ends of the braided plant fibers.

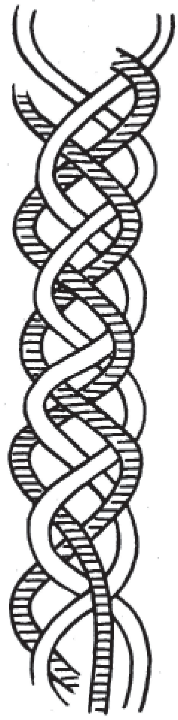

Fig. 12. Square braid with 4 strands. Drawing by Ulrich Gebauer.

Sling Cradles with Three-Span Float Patterns

Sixty-seven of the most elaborate slings in the Ethnologisches Museum have cradles that are exquisitely made with a structure combining two-span and three-span twined floats (Fig. 11). Both d'Harcourt (1975) and Cahlander (1980) described them as if the structure were interlaced in complementary warp weave with three-span floats in alternate alignment, but neither scholar understood the technique by which they were made. As in preceding examples, however, the structure can easily be reproduced with the fist braiding technique, and described as four-strand 3/1 twining in alternate alignment. The cradles are made with undyed 2-plied s-spun plant fiber yarns and red and black 3-plied s-spun camelid hair yarns, both with a diameter of about 0.5 mm. In most other pre-Columbian textiles from Peru, the camelid hair yarns are 2-plied s-spun, but in these braids obviously a stronger yarn was desired. The slings are listed in the catalogue cards of the Ethnologisches Museum, Berlin, from both central and south coast sites: Pachacamac, Chuquitanta, Ica, Pisco, or "by Lima".

The cradles consist of bands about 2 cm wide, 0.5 cm thick, and 20-30 cm long (Fig. 11). These braids normally have 16-20 twining units (always an even number) on the wide dimension and two (occasionally three) twining units on the narrow dimension. Since there are four strands in a twining unit, the braid has a total of 72-92 strands to be manipulated. Only a few consist of one solid braid; most are split in the middle for 15-20 cm. The cords are made in the same manner as for the other braided cradles discussed previously. In many specimens the black camelid hair has disappeared, probably due to the heavy use of an iron mordant for dyeing the fiber. Where the black strands of the wide dimension of the braid are now gone, the strands from the narrow dimension are visible across the braid, greatly confusing the analysis of such bands.

The narrow sides of the cradles are twined in the usual way, either continuously in the same direction,

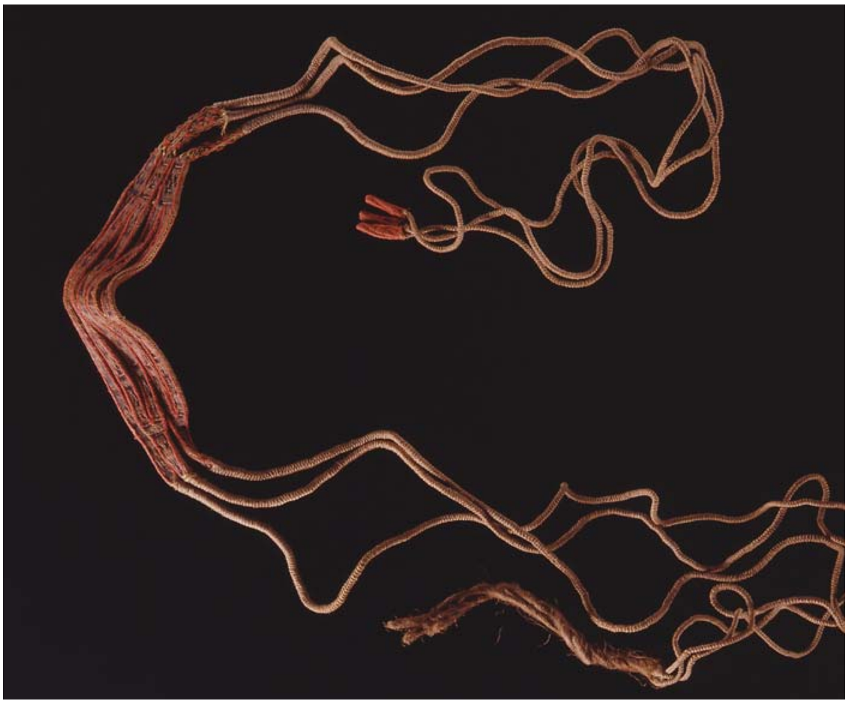

Fig. 11. Three two-and three-span float patterned fine slings joined together. Notice the three finger loops. Altogether this sling is 217 cm long. Ethnologisches Museum, Berlin (V A 42096, Pachacamac). Photo: Martin Franken.

or countered, resulting in a V-shaped pattern. Most of the braids have a red stripe along either edge of the wide sides, which is also twined. The central part of the wide sides have two-color patterns, some created in twined two-span floats, and others in three-span floats in alternating alignment as described above. The direction of the twining twist is only changed in order to change the slant of the design. Figure 7 shows the different kinds of design.

Using the start suggested by Speiser, the strands of the wide side are arranged so that the lower yarns are all one color and the upper ones of the other color (Fig. 13). Using Adele Cahlander's (1980) notation (Fig. 14), this can be diagramed as in Figure 15. Thus the crossings are all the same color (black in Fig. 13 left), and in the next crossing they are the opposite color (white in Fig. 13 right). With this setup, working in the normal fist-braiding technique (crossing the lower strands over the top of the braid), horizontal stripes one two-span float long are created.

To create stripes two floats long, the strands must be rearranged so that those of the same color are all on one side of the braid (Fig. 16 left). To accomplish this, the upper yarns on one side are crossed over the top of the braid, alternately with lower yarns from the other side (Fig. 17a). Once this setup has been done,

Fig. 13. Braiding with single stripes. The dark and the light strands of the wide side of the braid stay in the same layer across the narrow-side strands in the middle. Photo: Lena Bjerregaard.

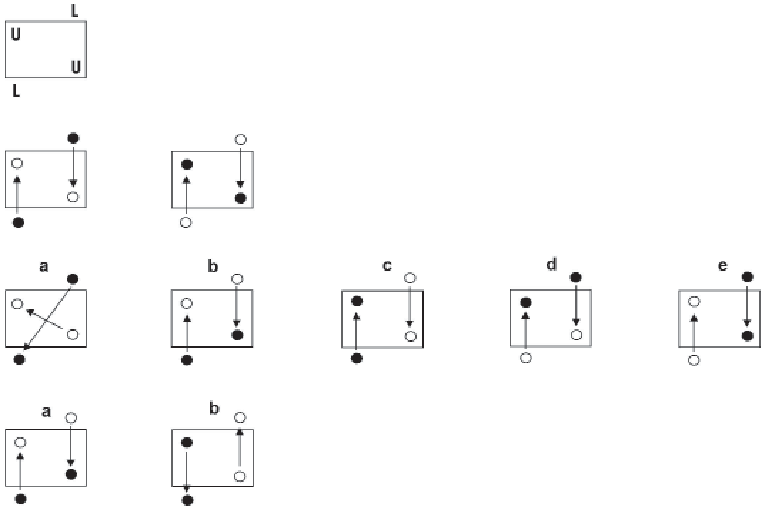

Fig. 14. The movements of strands as presented according to Adele Cahlander's system. U: upper layer of strands. L: lower layer of strands. Black dots: dark strands; Circles: light strands. Drawing after Cahlander 1980.

the two-float long stripes are formed automatically if normal braiding procedures are followed, crossing lower yarns from each side alternately over the braid (consistently in the S direction). The color change occurs by means of the moves illustrated in Figure 17c and 17e, when yarns of the same color are gathered on the same side of the braid (as in Fig. 16 left and right).

The slings, however, are not started using Speiser's technique. Instead, as noted, yarns for two braids are folded in half over each other, back to back. No extra yarn is needed to tie the yarns together. The yarns of each major group in the cradle are divided in half side to side by the yarns emerging to form the cord (or vice versa). Such a start can be clearly seen in the upper sling in Figure 9 and those in Figures 11 and 18, at the ends with the camelid hair braid. While the yarns of the wide sides may begin at a lower point than those for the narrow sides, the upper and lower yarns on each side need to be picked and so one can arrange the yarns in the configuration shown in Figure 17b, without needing to go through the motion illustrated in Figure 17a.

In order to make the patterns in these cradles, when a single color is wanted over a wider area, three-span floats are formed using the technique illustrated in Figure 19. The setup for this technique is the same as for the stripes two floats long (Fig. 17b is the same as Fig. 19a). In Figure 19a the lowers cross the braid in the S direction, while in Figure 19b the uppers cross in the Z direction. The crossing of the lowers (Fig. 19a) forms the binding rows of the three-span complementary floats, while the crossing of the uppers (Fig. 19b) forms the pattern rows.

The interchange of the colors between the two faces of the braid is done the same way as the exchange of colors in the two-float long stripes. That is, the step in Figure 19a is followed by that in Figure 17c instead of Figure 19b. Then the process goes back to Figures 19a and 19b with the colors in their new positions. Thus, there is a row of two-span floats in each color along the line of color change.

The use of three-span floats permits the different colored strands to be manipulated at will. Not only geometric patterns but also free figurative patterns can be created, showing up on either side of the braid in alternate colors (Fig. 18). The examples in the Ethnologisches Museum have geometric or bird designs and one is decorated with llamas.

An additional eight multiple slings joined from three-five slings with narrow cradles (four complete and four fragmentary) are similar to the cradles just discussed but their overall format is slightly different (Fig. 20). The cradles of these slings start with a round, patterned fist braid. The strands are then divided into four groups that two by two are interlaced using plant fiber yarn as weft. This interlacing creates the middle split part of the cradle, about 17 cm long. The strands are then gathered in a square braid of 10-12 cm. These braids are more square than in the other slings discussed, having 6-8 strands on the wider sides and 4-6 on the narrower sides.

After the square set of patterned braids the number of yarns are gradually reduced and covered by a round plant fiber braid of some 65 cm in length, ending in a finger loop. At the other end (*i.e.* the round fist-braided patterned area at the beginning) of the cradle, the yarns for the cord are folded through the start of the patterned cords and braided in the

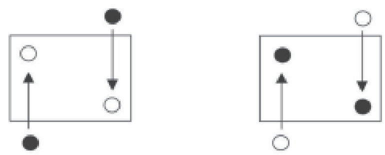

Fig. 15. Diagram for the movements to create single stripes (2-span floats). Repeat these two moves. Drawing by Ulrich Gebauer.

Fig. 16. Braiding with double stripe. Left: The strands of one colour are gathered on one side of the narrow-side strands. Centre: In the next move the strands of the same colour make a cross through the centre of the braid. Right: In the third move all the strands of one colour are gathered on the other side of the centre of the band. Every second time the strands of the same colour are together in one side – every second they cross. Photo: Lena Bjerregaard.

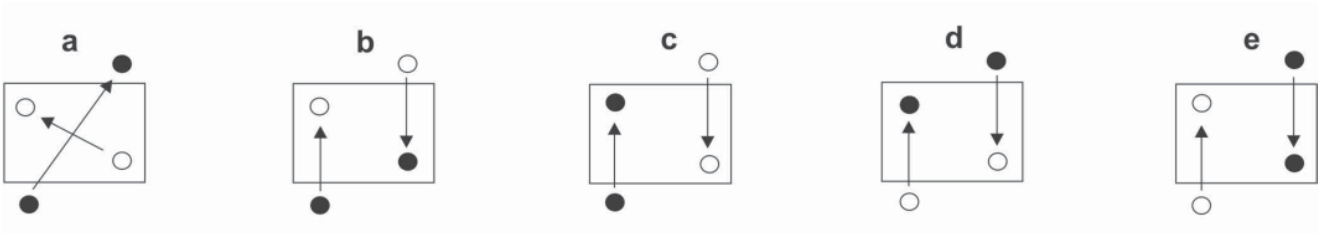

Fig. 17. Diagram for the movements to create double stripes (2-span floats) like in Fig. 16. After these five moves proceed with b, c, d, e, b, *etc*. Drawing by Ulrich Gebauer.

Fig. 18. The fine two- and three-span float cradles have the same figures on both sides but in different colours. Ethnologisches Museum, Berlin (V A 47221, Ica). Photo: Martin Franken.

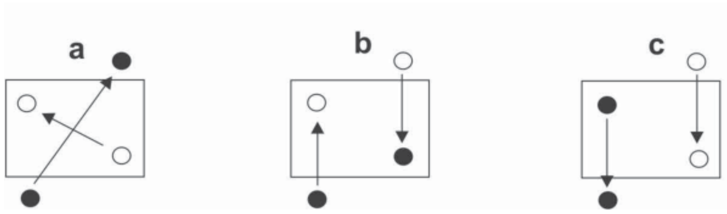

Fig. 19. Diagram for the movements to create three-span floats for continuous colour on one side of the braid. After these three moves proceed b, c, b, c, *etc*. Drawing by Ulrich Gebauer.

Fig. 20. Sling sewn together from five slings. The braids are more square than in the other slings discussed, having 6-8 strands on the wider sides and 4-6 on the narrower sides. Ethnologisches Museum, Berlin (V A 37775, "around Lima"). Photo: Martin Franken.

Fig. 21. Fine two-and three-span float cradles. The weft is visible where the black camelid hair yarns have disintegrated. The fragment measures 38 cm. Ethnologisches Museum, Berlin (V A 42105, Pachacamac). Photo: Martin Franken.

opposite direction, as described for the simpler slings. The plain cords on this end are around 85 cm long, and all the cords are gathered into a single tassel between 5 and 10 cm long. Thus complete length of the pieces is 190-210 cm.

Three to five of these narrow slings are sewn together along the fist-braided parts of the cradle. The wider sides of the square braids of these cradles all have

geometric designs (triangles) in two- and three-span floats. The yarns are natural plant fiber and black and red camelid hair. The black camelid hair yarns are, however, almost or completely disintegrated on all specimens, leaving the horizontal strands from the narrow sides visible (Fig. 21).
One additional fragmentary example is similar to the other eight except that the round and square patterned braids follow each other without any interlacing in between.
These examples illustrate that the versatility of the fist braiding technique, which can form figurative as well as geometric designs, is even more remarkable than had previously been supposed.

Conclusion
The pre-Columbian cultures in South America had no writing system, so what we know about them derives entirely from archaeological items and colonial written sources. The colonial sources inform us as to who wore the *llawt'u*, and we are fortunate to have a match in our collection. Exactly who wore the other types of slings and bands is still not clear. Those described above are of course not the only kind of headgear found in pre-Columbian Peru. The collection in the Ethnologisches Museum includes many unpublished items worthy of extended study. The collection of reed-plaited, turbaned and feathered Ica hats has recently been the topic of a dissertation written by Katalin Nagy, for instance. In her thorough analysis, in which she makes extensive comparisons with ceramic vessels depicting musicians, she suggests that musicians wore at least one type of these hats. My own on-going examination of a collection of exquisitely knotted hairnets from Pachacamac and Ancon indicates that they may have been worn by male weavers (Bjerregaard 2002). Analysis of textiles in museum collections can provide us with a great deal of knowledge about the world's past cultures - from textile crafts to social structures.

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Bibliography
Bird, J. (1954) *Paracas Fabrics and Nasca needlework.* Textile Museum, *Catalogue Raisonné*. Washington D.C.

Bjerregaard, L. (2002) *Pre-Columbian Woven treasures in the National Museum of Denmark*. National Museum of Denmark/ Corpus Antiquitatum Americanensium.

Bjerregaard, L. ed. (2007) *The Textiles from Laguna de los Condores – in the Leymebamba Museum.* Museum Tusculanum, Copenhagen.

Cahlander, A. (1980) *Sling braiding of the Andes. Weaver's Journal Monograph IV*. Boulder.

Cobo, B. (1990) *Inca Religion and Customs.* Austin and London.

d'Harcourt, R. (1975) *Textiles of Ancient Peru and their Techniques*. Seattle.

Emery, I. (1966) *The Primary Structures of Fabrics.* Washington D.C.

Garcilasco de la Vega (1966) *Royal Commentaries of the Incas and General History Of Peru*. 2 vols. Austin and London.

Guaman Poma de Ayala, F. (2001) *Nueva Cronica y Buen Gobierno*. Copenhagen. (www.kb.dk/elib/inss/poma)

Rowe, A. P. (1996) *Inca Weaving and Costume. The Textile Museum Journal*, vols. 34-35, 1995/1996, 4-53. Washington D.C.

Speiser, N. (1983) *The Manual of Braiding. Noémi Speiser*. Basel.

Suarez, G. *Las Hondas del Museo de la Plata.* [unpublished]. Buenos Aires.

Uhle, M. (1903) *Pachacamac: Report of the William Pepper M.D., LL. D., Peruvian Expd. of 1896*. Phipadelphia. Reprinted 1991.

Zorn, E. (1982) *Sling Braiding in the Macusani Area of Peru. Textile Museum Journal*, vols. 10-20, 1980/1981, 19-20; 41-54. Washington D.C.

Karina Grömer

Cloth Qualities from 800 BC-AD 800 in Austria: Context - Development - Handcraft

Introduction
The analysis of Roman period textiles from archaeological contexts in Austria has been a neglected topic for a long time. This paper presents a short overview of the recent research into the subject. To understand Roman period textile production, a wider overview in the centuries before and afterwards is essential. Therefore information about cloth qualities from 800 BC to AD 800 in Central Europe has to be considered in order to explore the pertinent questions. For example, what was the cloth culture of the prehistoric population in the Iron Age and how (and if) did it change with the Roman occupation? Furthermore, what was the impact of the Roman Empire on the trade routes and production structures of the "Romanised" tribes in the Danube Provinces (especially Noricum)? The Empire with its centralised organisation controlled this region for at least 500 years. In the following Migration period (Early Medieval period), many of the cultural and economic achievements of the Roman period were lost and the organisation level of society changed from a centralised one to a more local tribal structure.
In terms of quantities of textiles preserved in Austria for the period in question, the following numbers can be summarised. From the Iron Age there are about 1000 textiles, primarily from the salt mines of Hallstatt and Dürrnberg, preserved in the salt in their organic state. Additionally there are mineralised textiles preserved in burial contexts (Grömer, forthcoming 2011). The collection of data on the Roman period resulted in approximately 150 textiles to date (Grömer, forthcoming), although the chronological distribution of finds is uneven. From the 1st and 2nd centuries AD there are only few finds, e.g. from the settlement of Magdalensberg, and cremation burials in Styria. Most of the Roman period textiles were found in graves dated to the 3rd-5th centuries AD. Finally, the Early Medieval cemeteries (6th-8th centuries AD) provided information about 230 textile finds.
Although these textiles derive from different contexts - graves, salt mines and settlements, they allow us to summarise the information on the cloth qualities and therefore the 'textile culture' that existed in Austria. It is hoped that the growing databases will eventually allow this general knowledge to be applied to special textile contexts and functions.
Various methods of research were applied to this material. For the quality of the textiles the basic aspects of textiles were recorded: the thread count, the yarn diameter, pattern, weave structure, twist of the yarn and colour. Fibre quality analysis was carried out with the help of the microscope. Organic fibres such as those from the salt mines were analysed using light microscopy, while mineralised objects from graves were analysed with the Scanning Electron Microscope. Dyestuff analyses of the salt mine textiles from Hallstatt were done using HPLC (Hofmann-de Keijzer *et al*. 2005).

Cloth Qualities in Iron Age Austria (800-15 BC)
The prehistoric textiles are a key source for understanding the development of the textile craft, because all main textile techniques known already during the Hallstatt period (e.g. different patterning techniques, band weaving, dyeing, twill weaving, various sewing techniques), were used through to Medieval times and even later. A distinction between Hallstatt Period (800-400 BC) and La Tène Period (400-15 BC) is necessary, because during the 1st millennium BC

significant changes took place.
From the Hallstatt Period, Austria has a rich body of textiles from the salt mines on the site of Hallstatt (Fig. 1). The textiles were found in the caves and tunnels of prehistoric mines, where they have been discarded (Kern *et al*. 2009). In the so-called 'heathen's rock', a mixture of salt and the deposit of mining activities (torch-wood, tool handles, leather items, carrying bags, *etc*.), the woven fabrics survived in a perfect organic condition. The salt even preserved the colours. Textiles have been recovered from various find spots within the salt mines. The oldest parts are dated via dendrochronology to the Middle Bronze Age. The majority of textiles however date to the Early Iron Age (Hallstatt Period). The fabrics from the find area "*Ostgruppe*" provide much information about the cloth qualities (Grömer 2005, 20-25). There is a variety of different thread counts and different yarn diameters. There are many fine textiles with 10-15 threads/cm, and even finer ones, for example, a basket weave with 40 threads/cm. The yarn diameter is generally medium-fine (*c*. 0.5 mm), but there are coarser and finer ones. The main fibre at Hallstatt is wool, but there are some rare examples of horse hair used as weft for bands. The Early Iron Age textiles come in a variety of different weaves: tabby, basket weave, different twill variants. There are also many different patterns of stripes or checks created during weaving. Spin patterning was very popular and the change of s- and z-spun yarn was applied in more than 50 of the textiles. It was used in tabbies as well as in twills and basket-woven fabrics. Sometimes there are even combinations of spin patterns and colour patterns. Dyestuff analyses demonstrated the use of woad, madder and several unknown yellow and red dyestuffs. There are indications that different dyeing techniques were used: dyeing the fleece, dyeing the yarn or piece-dyeing the woven cloth (Hofmann-de Keijzer 2010).
For the Hallstatt Period, we know products of different loom types, exemplified again by the salt-mine textiles from Hallstatt. There are narrow rep bands, which were probably made with heddle rods or a rigid heddle. Other band weaves are tablet-woven ribbons and broader bands of 8-15 cm in width. The repp bands and tablet-woven borders are patterned: different colours were used to create stripes, checks and even geometric motifs such as triangles, meanders and so on. The loom used in the Hallstatt Period for larger weaves is of the warp-weighted type. This is indicated by the starting borders and numerous loom weights found on Hallstatt settlements and even in graves (cf. Belanová Štolcová and Grömer 2010, 15-17).
Interestingly, most of this textile creativity is mirrored in contemporary grave finds (due to preservation it is impossible to judge the dyes and colour patterns). Thus, the variety of weave types, thread counts and spin patterns can be found in the grave material from Austria (Grömer, forthcoming 2011), as well as the surrounding countries (e.g. Bender Jørgensen 1992; Banck-Burgess 1999; Rast-Eicher 2008). It is noteworthy that there is a distinction between Eastern and Western Hallstatt culture in some details, such as the use of single and plied yarn. At Hochdorf and Hohmichele in Germany (Banck-Burgess 1999, 55-62) we know of textiles with the "flying thread technique" (*Fliegender Faden*). They are dated to the late Hallstatt Period/early La Tène Period.
To sum up, for the Hallstatt period there is evidence of many different cloth qualities with a wide range of different patterns, structures, thread counts and yarn diameters. Some of these textiles could be the products of specialists (for theoretical implications see Grömer 2010, 223-239). This specialised production is also discussed for the contemporaneous textiles from Italy, from the Pre-Etruscan and Etruscan cultures (see Gleba 2008, 193-194).
From *c*. 400 BC onwards, in the La Tène period, changes in textile quality are discernible (Stöllner 2005; Grömer, forthcoming 2011). There are over hundred La Tène period textiles from Austria, mainly from the salt mine on the Dürrnberg near Hallein (Catalogue of K. von Kurzynski in Stöllner 2002; Stöllner 2005) and some from graves. At Dürrnberg, the textiles were embedded in the salt deposit and, similar to Hallstatt, the textiles were preserved in their organic state with bright yellow, red and blue colours.
Although the context and the preservation are very similar in Hallstatt and Dürrnberg, the cloth culture of the latter presents a completely different picture (Fig. 2). The dominant type of weave in the La Tène period is tabby, with twill used less frequently and usually of the 2/1 variety. The more complex weave types like the zig-zag, herringbone or lozenge twill have almost disappeared. Some patterned weaves do exist from Dürrnberg, but not in the numbers known for the Hallstatt period. Spin pattern is not common among the Dürrnberg material. In terms of fibres there appears to be a change from the use of wool as the main fiber to predominantly flax.
Grave material from the Middle and Late La Tène indicates that most fabrics were produced in tabby weave, and there are only a few examples of twill (Belanová 2005). This shift to a common use of tabby is visible also in southern Germany and Switzerland (Rast-Eicher 2008). Generally from the La Tène period

Fig. 1. Textile mosaic from Hallstatt. © Karina Grömer.

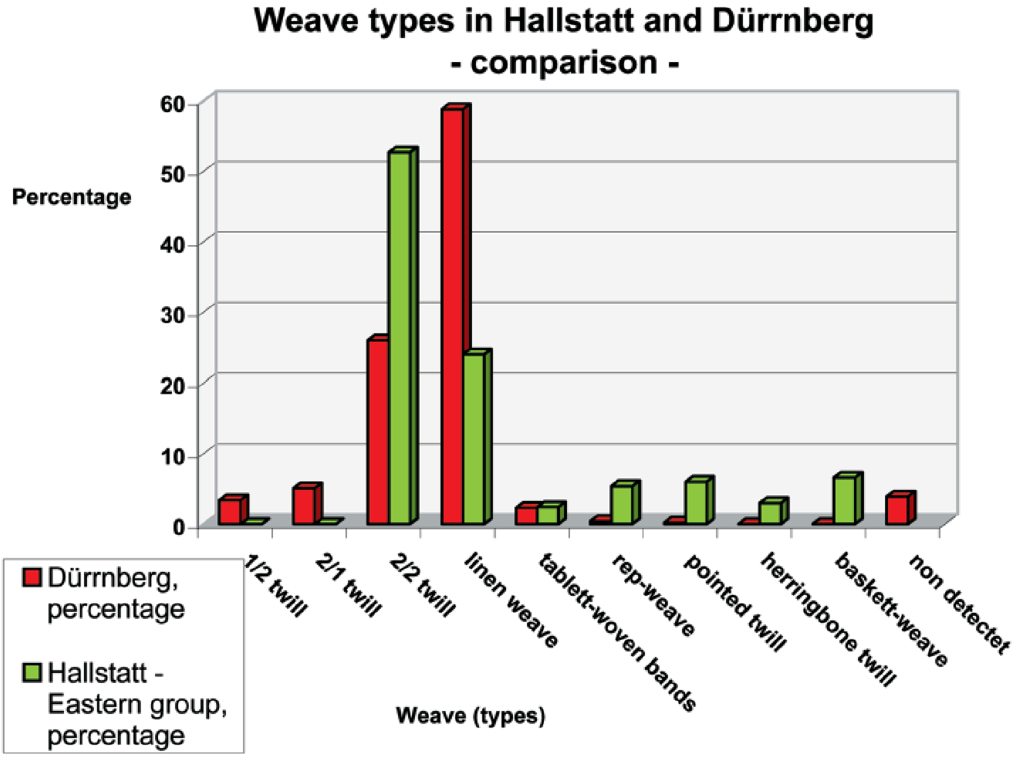

Fig. 2. Statistics about weave types from Hallstatt and Dürrnberg (e.g. Stöllner 2005)

onwards there is a more reduced repertoire of cloth types, but still in good quality. The textiles look standardised with yarn diameters of 0.3-0.6 mm.
If we look at La Tène tools (Belanová Štolcová and Grömer 2010), there is a similar change from the Hallstatt to La Tène period. Hallstatt period spindle whorls are well made tools, they have varied shapes and are heavily decorated, mirroring the creativity of the producer or owner/user. In contrast to these carefully produced Hallstatt whorls, the Middle and Late La Tène whorls appear standardised and are often made of reused potsherds. This kind of "recycling" is an indication that the design was of no interest. The beauty of a tool, the pride in working with it seems to have diminished. The spindles were just intended to be efficient for a maximum output, which is a completely different way to think about the craft. Furthermore, during the La Tène period the number of loom weights found in settlements diminishes compared to the Hallstatt period. It is possible that a two-beam loom or some other loom type without weights was used beside the warp weighted loom. This evidence gives us a hint of the organisation of textile handcraft in the La Tène period. The uniform textiles and the standardisation of tools could be seen in connection with an incipient mass production (serial workshop production) during the La Tène Period (von Kurzynski 1996, 36; Grömer 2010).
In connection to this issue, later written sources are of interest. Livy (Liv. 21,31,8; cited after Timpe 1981, 54) writes, that the Allobroges, a Celtic tribe inhabiting parts of present-day Eastern France (between the Rhone, Isère and Genfersee) supplied textiles to the soldiers of Hannibal during the Second Punic War (218-201 BC). Such a system, to supply goods for the army, requires more than household activity. Production of such a mass of textiles requires more advanced organisation structures.

Cloth Qualities in Roman Austria (15 BC to the 5th century AD)

During the 1st century BC, the Romans added the areas north of the Alps to their empire as the new provinces Noricum, Pannonia, Raetia and Germania. In the archaeological record of Central Europe new types of tools appear in the Roman period: the wool comb and new types of distaffs and spindles (with spindle hooks: Fig. 3). Examples of these tools have been found in Austria, *e.g.*, at the site of Magdalensberg (Gostenčnik 2009, fig. 5 and 7). Those new tools indicate different techniques of preparing the wool and spinning it: with a fine wool comb it is possible to produce a very regular wool fleece, which can be spun into a high quality thread. The spindle hooks

Fig. 3. Spindle hooks from Magdalensberg (e.g. Gostencnik 2009).

suggest a different way of spinning (Fig. 4). Thus, while iconographic evidence from the Iron Age depicts a type of low-whorl spindle where the whorl is fixed on the lower part of the spindle shaft, a spindle hook is used on a high-whorl spindle, as known from the eastern and southern Mediterranean area (e.g. Egypt; Barber 1991, Fig. 2.6 or 2.40), where those tools may have originated. The way of spinning differs between a low-whorl and a high-whorl spindle. The former is turned with the fingers on the top of the spindle shaft, while the latter is rolled along the thigh. This is depicted for a sitting position as well as for a standing one (Barber 1991). Spinning technique, learned by tradition from childhood, is sort of 'embodied knowledge', and would not change (if there is no significant reason). Both techniques produce the same kind of threads. This suggests that the new spinning tool arrived with the people from other parts of the Roman Empire, who settled in the new provinces next to the native populations.
In contrast to this interesting tool evidence the extant Roman period textiles from Austria found in graves and on settlements (Grömer, forthcoming) do not demonstrate many new characteristics. In terms of weave types, the picture is similar to Late La Tène period textiles. Tabby is the main weave type from the 1st to the 4th centuries AD. Sometimes, we found repp and basket weave. Twill is very uncommon and appears mainly in the 5th century AD. The yarn diameter is usually 0.2-0.3 mm, which is on average finer than is known for the Iron Age. There are just a few coarser fabrics. As yarn diameter, the thread count is standardised ranging between 15 and 20 threads/cm. The textiles are of a fine and high quality. The raw material includes both wool and bast fibre, presumably flax.
In terms of patterning there is not much evidence. Unfortunately we do not know of colour patterns from the grave finds, because the textile fragments are mineralised. Spin pattern has almost disappeared. The textiles from settlements like Magdalensberg (Grömer 2009, fig. 1) survived under waterlogged conditions and have darkened in colour (Fig. 5). There is just one Late Antique textile from Austria with surviving colour. It is a large piece of cloth (45x26 cm) which was kept at the Basilica of Lorch in Enns as wrapping for the relics of St. Florian, who was martyred on the 4th of May AD 304. It is a medium-fine linen tabby with blue stripes, crossing each other (Ubl 1997, 223, Kat.Nr. IV/S-1). The estimated date of the textile (based on the context) is the 5th century AD (not yet proven by ^{14}C-analysis).
Recently, an interesting find came to light from the excavations at the Archaeological Parc Carnuntum. It is a sarcophagus burial of a woman from the Roman municipio (Rauchenwald 2009). On her upper body gold threads and other fibres (maybe silk) were found. Further investigation is necessary on this extraordinary find, but it demonstrates that the highest quality textiles were known in Roman Austria, especially for the Roman upper classes. This differs substantially from the very simple cloth types of the local people in the Danube region which are similar to the Middle and Late La Tène textiles.

Cloth Qualities in Early Medieval Austria (Migration Period, 6th-8th centuries AD)

With the arrival of different tribes and the breakdown of the Roman Empire, the "textile culture" in Austria changes. The Bavarians and Alamans in particular used a rich variety of textiles. Fom Austria the Bavarian cemeteries Rudelsdorf (Hundt 1977) and Schwanenstadt (Hundt 2002) are representative of this phenomen. Beside the simple tabbies, different twill variants reappear, including newly introduced *Rippenköper* and *Kreuzköper*. Spin and other patterns are also found. There is a reappearance of patterning techniques with floating threads, as is known from the Celtic burials like Hochdorf. Early Medieval examples have been found at Rudelsdorf.
Thus, from the 6th century onwards, Austria sees the return of the Iron Age creativity in weave structures

Fig. 4. Low whorl and high whorl spindle and their use (ethnographic exsamples from Bulgaria and Saudi Arabia). © Karina Grömer.

and patterns. Even the textile cloth qualities range in the way seen during the Iron Age. The average yarn diameter is about 0.3-0.5 mm, *e.g.* from Schwanenstadt (Hundt 2002).
A different cloth culture can be recognised among the Avars, who entered Eastern Central Europe from the Asian Steppes in the 6th century AD. Here we find a reduced repertoire of weave types. As exemplified by the Avar graveyard Zwölfaxing (Grömer and Müller 2008), we usually have tabby, seldom basket weave and repp. There is linen tabby and wool cloth of finer quality with 0.2-0.3 mm yarn, with coarser ones with yarn diameters of 0.5-0.8 mm yarn being less frequent. In Zwölfaxing, there is a textile with a pattern made with floating threads.

Conclusions
To conclude, in Hallstatt period Austria there is a very creative textile art with different weaves, patterns and cloth qualities. From the Middle La Tène period on (earlier at the site Dürrnberg), the textiles and even tools become more standardised, indicating mass production or serial workshop production. As mentioned above, the written sources indicate that the Allobroges traded textiles with other tribes as well as with the army of Hannibal in the First Punic War. That means that the mass production in this region did not start with the Roman occupation. Rather, when the Romans came, they found these structures in the organisation of textile handcraft in place and used them.
In Roman times, the cloth culture changes little - there are uniform and easily produced weaves like tabby in standardised, but fine qualities. The period sees an introduction of new tools, perhaps in connection with people arriving from the Mediterranean parts of the Roman Empire. Remarkable are textile finds with gold threads and silk, illustrating the new Roman fashion and extensive trade routes.
After the collapse of the Roman Empire, the variety known in the Iron Age textile culture returns. Especially the Germanic tribes like the Alamans or Bavarians used a wide range of textiles, including a wide range of weaves, twill variants, spin patterns, patterns with floating threads etc.
This quick overview of cloth cultures in Austria demonstrates that the history of textile craft is not just a development from simple weave types to

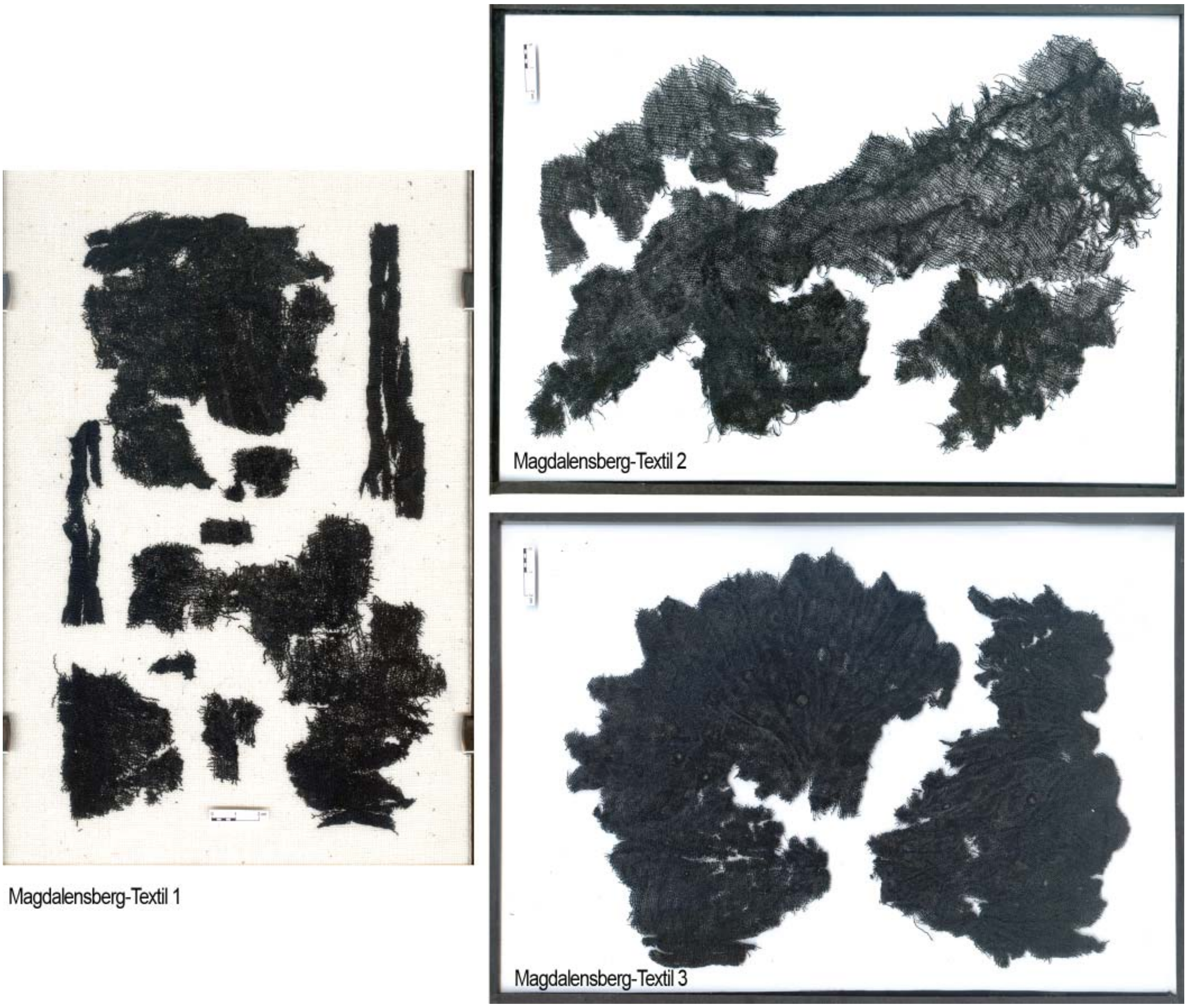

Fig. 5. Textiles from Magdalensberg, Carinthia. © Karina Grömer.

complicated ones. It also follows other dynamics; it is a matter of tradition and innovation, as well as the level of production organisation. It is influenced by the contact between different peoples and cultures. Once the collection of data is completed, the next lines of inquiry will involve the investigation of cloth qualities according to different contexts (graves, settlements, working areas like salt mines) as well as according to gender and age of their wearers (in graves) and according to the function of the objects (clothing, wrappings and shrouds in graves, "recycled" textiles etc.).

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Bibliography
Banck-Burgess, J. (1999) *Hochdorf IV. Die Textilfunde aus dem späthallstattzeitlichen Fürstengrab von Eberdingen-Hochdorf (Kreis Ludwigburg) und weitere Grabtextilien aus hallstatt- und latènezeitlichen Kulturgruppen.* Forsch. und Ber. zur Vor- und Frühgeschichte in Baden-Württemberg 70, Stuttgart.

Barber, E. J. W. (1991) *Prehistoric Textiles. The development of cloth in the Neolithic and Bronze Age with special Reference to the Aegean*. Princeton 1991.

Belanová, T. (2005) The state of research of La Tène Textiles from Slovakia and Moravia. In P. Bichler, K. Grömer *et al.* 2005 (eds.), *"Hallstatt Textiles" Technical Analysis, Scientific Investigation and Experiment on Iron Age Textiles*. BAR Int. Series 1351, Hadrian Books, Oxford: 175–189.

Belanová Štolcová and K. Grömer (2010) Loom-Weights, Spindles and Textiles – Textile Production in Central Europe from the Bronze Age to the Iron Age. In E. Andersson Strand, M. Gleba, U. Mannering, C. Munkholt and M. Ringgaard (Hrsg.), *North European Symposium for Archaeological Textiles X*. Ancient Textiles series Vol. 5, Oxford, Oxbow Books: 9-20.

Bender Jørgensen, L. (2005) Hallstatt and La Tène Textiles from the Archives of Central Europe. In P. Bichler, K. Grömer *et al.* 2005 (eds.), *"Hallstatt Textiles" Technical Analysis, Scientific Investigation and Experiment on Iron Age Textiles*. BAR Int. Series 1351, Hadrian Books, Oxford: 133–150.

Gleba, M. (2008) *Textile Production in Pre-Roman Italy*. Ancient textiles Series Vol. 4, Oxford.

Gostenčnik, K. (2009) Die Stadt auf dem Magdalensberg, ein Zentrum der Textilwirtschaft im frührömischen Noricum. *Carinthia* 199, 23-60.

Grömer, K. (2005) The Textiles from the prehistoric Salt-mines at Hallstatt. In P. Bichler, K. Grömer, R. Hofmann-de Keijzer, A. Kern und H. Reschreiter (eds.), *"Hallstatt Textiles" Technical Analysis, Scientific Investigation and Experiment on Iron Age Textiles*. BAR Int. Series 1351, Hadrian Books, Oxford, 17-40.

Grömer, K. (2009) Gewebe vom Magdalensberg – Zeugnisse römischer Weberei. In *Carinthia* 199, 61-68.

Grömer, K. (2010) *Prähistorische Textilkunst in Mitteleuropa - Geschichte des Handwerks und der Kleidung vor den Römern.* Veröffentlichungen der Prähistorischen Abteilung des Naturhistorischen Museums 4, Wien.

Grömer, K. (forthcoming 2011) Austria in Bronze and Iron Age. In M. Gleba and U. Mannering: *Textiles in Context. New Research on Ancient Danish and European Textiles.* Oxbow books, Oxford.

Grömer, K. (forthcoming 2012) Spätantike Textilien in Österreich - ein Vorbericht zu den Analysen im Rahmen des EU-Projektes DressID. *Akten des 13. Österreichischer Archäologentag am 25.-27. Februar 2010 in Salzburg*.

Grömer, K. (forthcoming 2011) Aussagen zu Sozialstruktur und Identität anhand spätantiker und frühmittelalterlicher Textilfunde in Österreich. In A. Krenn-Leeb (Hrsg.) *ZEITENwandel - Siedlungs- und Sozialstrukturen zwischen Spätantike und Hochmittelalter. Internationales ÖGUF-Symposium Oktober 2009 in Mauterndorf. Archäologie Österreichs Spezial.*

Grömer, K. and Müller, S. (2008) Textiles from the Avar graveyard Zwölfaxing II, Austria. *ATN* 46, 17-21.

Hofmann-de Keijzer, R., van Bommel, M. R. and Joosten, I. (2005) Dyestuff and element analysis on textiles from the prehistoric salt mine of Hallstatt. In P. Bichler, K. Grömer, R. Hofmann-de Keijzer, A. Kern und H. Reschreiter (eds.), *"Hallstatt Textiles" Technical Analysis, Scientific Investigation and Experiment on Iron Age Textiles*. BAR Int. Series 1351, Hadrian Books, Oxford, 55-72.

Hofmann-de Keijzer, R. (2010) Färben. In K. Grömer, K. *Prähistorische Textilkunst in Mitteleuropa - Geschichte des Handwerks und der Kleidung vor den Römern.* Veröffentlichungen der Prähistorischen Abteilung des Naturhistorischen Museums 4, Wien, 143-162.

Hundt, H.-J. (1977) Gewebereste aus den Reihengräberfeldern von Rudelsdorf, Hafeld und Schlatt. In: *Baiernzeit in Oberösterreich*. Oberösterreichisches Landesmuseum, Katalog Nr. 96, Linz, 139-146.

Hundt, H.-J. (2002) Die Textilreste aus den Gräbern von Schwanenstadt. In V. Tovornik, *Das bajuwarische Gräberfeld von Schwanenstadt, Oberösterreich.* Monogr. zur Frühgesch. u. Mittelalterarch. 9, 57-60.

Kern, A., Kowarik, K., Rausch, A. and Reschreiter, H. (2009) *Kingdom of Salt. 7000 years of Hallstatt*. Veröffentlichungen der Prähistorischen Abteilung 3, Verlag des Naturhistorischen Museums Wien 2009.

Rast-Eicher, A. (2008) *Textilien, Wolle, Schafe der Eisenzeit in der Schweiz*. Antiqua 44, Basel.

Rauchenwald, A. (2009) Ein Krug der Form Isings 126 - XXL. *Archäologie Österreichs* 19/2, 22-23.

Stöllner, Th. (2002) *Der prähistorische Salzbergbau am Dürrnberg bei Hallein II. Die Funde und Befunde der Bergwerksausgrabungen zwischen 1990 und 2000.* Dürrnberg-Forschungen Bd 3, Rahden/Westf.

Stöllner, Th. (2005) More than Old Rags – Textiles from the Iron Age Salt-mine at the Dürrnberg. In P. Bichler, K. Grömer, R. Hofmann-de Keijzer, A. Kern and H. Reschreiter (eds.), *Hallstatt Textiles – Technical Analysis, Scientific Investigation and Experiments on Iron Age Textiles*, Archaeopress – British Archaeological Reports S1351, Oxford, 161-174.

Timpe, D. (1981) Das keltische Handwerk im Lichte der antiken Literatur. In H. Jahnkuhn *et al*. (eds.), *Das Handwerk in vor- und frühgeschichtlicher Zeit*, Teil I. Göttingen, 36–62.

Ubl, Hj. (1997) *Katalog zur Schausammlung „Roemerzeit" des Museums Lauriacum-Enns.* Forschungen in Lauriacum Sonderbd. I/2, Enns-Wien.

von Kurzynski, K. (1996) *„... und ihre Hosen nennen sie bracas". Textilfunde und Textiltechnologie der Hallstatt- und Latènezeit und ihr Kontext.* Internationale Archäologie 22. Verlag Marie Leidorf.

Richard Firth

Fulling Agents Supplied to a Fuller's Workshop in Garšana

The aim of this note is twofold. Firstly, it sets down the fulling agents supplied to the workshop of a fuller in Garšana (2032-2026 BC), which was a town in the Umma district of Mesopotamia in the Ur III period. Secondly, it considers the role of these fulling agents within the work of the fuller.

The fulling agents are recorded on the Neo-Sumerian tablets published by Owen and Mayr (2007). Many of the Ur III tablets were not excavated using archaeological procedures and were sold as antiquities and, as a consequence, there is now even doubt about the geographical location of Garšana. Thus, it is most unlikely that the list of records described is complete. Nevertheless, there is a sufficient number of tablets to give a clear indication of the fulling agents used by the fuller of Garšana. The aim of this note is to make this information more readily available to students of ancient textiles.

The Sumerian term for fuller is ^{lú}ázlag, which can be literally translated as 'textile man'. The name of the fuller of interest at Garšana is |PÙ. ŠA|-a-ku-um and his name appears repeatedly in connection with the receipt and dispatch of textiles and with the receipts of fulling agents and equipment for fulling.[1] This particular fuller has been selected from the inscriptions of the Ur III period because of the extent of preservation of the records dealing with his supplies and their lack of ambiguity.

Table 1 is a summary of the 20 records of supplies of fulling agents to |PÙ. ŠA|-a-ku-um. These records extend over the 7 years, from the 6th year of the reign of Šu-Sin to the end of the 3rd year of the reign of Ibbi-Sin (*i.e.* 2032-2026 BC). The dates are given according to the year of the reign of Šu-Sin and his successor, Ibbi-Sin; the Roman numerals record the month.

It is important to emphasise that these impressive quantities of fulling agents were supplied to a single fulling workshop during the course of only 7 years. Furthermore, as already noted, these form only part of the total used because of the nature of the excavation and preservation of these records.

In addition to these agents for fulling, this fuller received reed baskets, a 30 litre trough (CUSAS 3, 595), a hand mill (CUSAS 3, 601) and an eight-runged ladder (CUSAS 3, 808). There were also mid-ribs of palm-fronds, poplar branches, charcoal and wooden planks (CUSAS 3, 779), at least some of which would very probably have been used as fuel.

The next step is to give a brief description of the

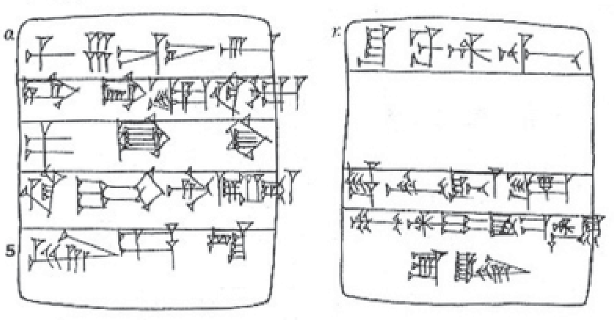

Fig. 1. AUCT 1 458. Tablet from Drehem, line illustration. Courtesy of Marcel Sigrist, the Cuneiform Digital Library Initiative.

purpose of these fulling agents. This is primarily based on the discussion given by Waetzoldt (1972, 168-174). The *im-bábbar* is literally translated as white earth. However, by considering the wider uses of this material, I find it most likely that it is powdered gypsum (Firth 2010). In the context of fulling its use was to serve as an abrasive to give a felted surface to the woven, woollen fabrics.[3]

The alkalis and oils combine together to form the soapy solution which was required to wash the textiles. In the present example, the oils listed are sesame oil and pig fat. In his discussion, Waetzoldt (1972, 169) quotes instances where the oils used were listed as oil, "good oil", sesame oil and pig fat. However, at Drehem, where a large proportion of the tablets list livestock, it is perhaps not surprising that the "oil" product that is most readily available for the fulling process is butter (*ì-nun*).[4] It is worth quoting Levey (1954; see also 1959, 122-123) here:

> Soda and potash were used from plant and wood ash as the most common washing substances in the household, for the cleansing of both clothes and the body. Furthermore, soap plants are found in great abundance in the Near East. The soapwort is a very common sapless shrub growing between Koum and Teheran. *Salsola kali*, the soda plant grows near the Dead Sea today and is common in Syria Egypt, and Arabia. Egyptian soda and potash, to some extent in modern times, is made from the ash of *Mesembrianthemum copticum* and *M. nodiflorum*. The horned alkali plant, *Salicornia*, or *kali* as it is called by the Arabs, found in the deserts east of Palmyra, El-'Asha, and Nejd, is still burned to an ash for its alkali. The horned alkali plant has thus been used for over 5000 years for this purpose.

Waetzoldt (1972, 159) has shown that the ratio of oil to alkali used for the fulling process was approximately 1:5. However, the absolute quantities of oil and alkali used per kilogram of textiles appeared to vary widely, with the quantity of alkali varying from 0.37 to 1.86 litres. The amount of soapiness was obviously governed by the amounts of fulling agents used.

The fullers were also issued with large quantities of barley. It is suggested by Waetzoldt (1972, 174 and footnote 127) that the barley was used to make a beer and that the enzymes from the beer would have a cleaning effect (analogous to that in modern biological detergents). However, it is noted by Gordon (1982, 3, 24) that "oatmeal has a similar drawing and absorbing power to fuller's earth" and was sometimes used for fulling in the textile industry (although, in practical terms, it is less satisfactory than fuller's earth because it is difficult to rinse out). In principle, it seems possible that some of the barley issued to fullers could have been milled into a meal and used in this way rather than as a beer. This suggestion is supported by the receipt by the fuller of a hand mill (CUSAS 3, 601).

The wool was used by the fuller for finishing the textiles. On tablet ITT 2 902+6850 from Girsu, the amount of wool allocated for the finishing of specific textiles is listed explicitly. In this case, it is evident that the weight of wool for finishing is much smaller than the weight of wool in the textiles. The obvious inference is that the wool was used to repair weaknesses in the textile and for any sewing that was required. However, on tablets ITT 3 6606 and ITT 5 6858, the quantities of wool listed are sufficient for decorative features, although Waetzoldt suggests that it is unlikely that such work fell within the direct competence of the male fullers.

Notes

1. |PÙ. ŠA|-a-ku-um occasionally appears as |PÙ. ŠA|-a-kum. In Owen and Mayr 2007, this name is transcribed as *puzur*$_4$*-a-gu*$_5$*-um* or a close variant. The transcriptions of the Sumerian texts used in this paper are based on the listings in the Cuneiform Digital Library Initiative (CDLI) database: http://cdli.ucla.edu/.

2. It is noted that the quantity of sesame oil listed on CUSAS 3, 774 is 1 (aš) gur (300 litres) which is 15 times the next largest delivery of sesame oil (on CUSAS 3, 820). Therefore, there is a possibility that there is an error in the recording of this quantity.

Tablet	Date	Fulling Agents
CUSAS 3, 595	ŠS 6 X	5 litres sesame oil 30 litres pig fat 300 litres 'horned' alkali 60.5kg white earth
CUSAS 3, 621	ŠS 7 III	[n]+120 litres 'horned' alkali
CUSAS 3, 630	ŠS 7 V	60 litres alkali
CUSAS 3, 638	ŠS 7 VI	750 litres barley 7.5 kg wool
CUSAS 3, 642	ŠS 7 VIII	30 kg white earth
CUSAS 3, 665	ŠS 8 II	10 kg wool (5th quality guz-za)
CUSAS 3, 689	ŠS 8 VIII	90 kg white earth
CUSAS 3, 695	ŠS 8 X	35 kg white earth 5 litres sesame oil
CUSAS 3, 699	ŠS 8 XII	0.625 kg wool (5th quality) 3.42 litres sesame oil 30.5 litres 'horned' alkali 11.5 kg white earth
CUSAS 3, 705	ŠS 9 I	1.18 litres sesame oil 52.25 litres 'horned' alkali 4.5 kg white earth 0.0625 kg wool (5th quality)
CUSAS 3, 712	ŠS 9 IV	10 litres sesame oil 10 litres pig fat
CUSAS 3, 733	ŠS 9 IX	[o.n.n] 'horned' alkali
CUSAS 3, 768	IS 1 XI	1200 litres 'horned' alkali 60 kg white earth
CUSAS 3, 770	IS 1 XII	10 litres sesame oil
CUSAS 3, 774	IS 2 II	300 litres sesame oil 30 kg alkali 'bricks' 300 litres 'horned' alkali
CUSAS 3, 785	IS 2 V	30 kg white earth
CUSAS 3, 791	IS 2 VII	180 litres alkali 60 kg white earth
CUSAS 3, 809	IS 2 XII	20 litres sesame oil 300 litres 'horned' alkali
CUSAS 3, 820	IS 3 XI	300 litres barley
CUSAS 3, 822	IS 3 XII	10 litres pig fat

Table 1: Receipts of fulling agents by |PÙ. ŠA|-a-ku-um

Material		Quantity
im-bábbar (im-babbar)	white earth (gypsum)	381.5 kg
naga si-è	'horned' alkali	2302.75 litres
naga	Alkali	240 litres
sig$_4$ naga	bricks of alkali	30 kg
ì-geš [2]	sesame oil	364.6 litres
ì-šáh	pig fat	50 litres
še	Barley	1050 litres
siki	wool (usually 5th quality)	18.2 kg

Table 2: Total quantities of fulling agents received by |PÙ. ŠA|-a-ku-um

3. It is important to stress that *im-bábbar* (white earth) is gypsum (calcium sulphate) and not fuller's earth (which is hydrous aluminum silicate containing magnesium, calcium, and other constituents). This conclusion is based on the use of *im-bábbar* in other contexts (Firth forthcoming).

4. PDT 1, 91 lists 7 litres of butter and 48 kg of white earth; PDT1, 369 lists 15 litres of butter. AUCT 1, 458 (Fig. 1) lists both butter and ga-àr, which is a powdered or finely grated sun-dried curd cheese (Halloran 2006, 69). In this case, this is being expended by the fuller, I-din-èr-ra, and so it is not clear whether the powdered curd-cheese was used, in lieu of oil, for fulling.

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Bibliography

Firth, R. J. (forthcoming) A discussion on the use of im-bábbar by the craft workers of ancient Mesopoamia.

Gordon, B. (1982) *The Final Steps: Traditional Methods and Contemporary Applications for Finishing Cloth by Hand*. Loveland, CO.

Halloran, J. A. (2006) *Sumerian Lexicon*, Los Angeles
Levey, M. (1954) The early history of detergent substances. *Journal of Chemical Education* 31, 521-524.

Levey, M. (1959) *Chemistry and Chemical Technology in Ancient Mesopotamia*. Philadelphia.

Owen, D. I. and Mayr, R. H. (2007) *The Garšana Archives. Volume 3*. Cornell University Studies in Assyriology and Sumerology (CUSAS). Bethesda, MD.

Waetzoldt, H. (1972) *Untersuchungen zur Neusumerischen Textilindustrie*. Studi Economici e Tecnologici I. Rome.

Orit Shamir and Naama Sukenik

The Christmas Cave Textiles Compared to Qumran Textiles

Figure 1. The Christmas Cave. Photo: R. Porat.

Introduction
The subject of the textiles from Qumran is regrettably under-represented in the voluminous academic literature devoted to the archaeology of the site and the nearby caves. The site is one of the first in Israel where remains of textiles were found. This fact heightens the importance of the Qumran textiles, but it also calls attention to the scant knowledge about this field of study at the time of those first finds in the 1950s. The textile finds at Qumran were stored in an inappropriate facility, without careful records and documentation, and this situation continued for nearly 50 years. The publication of the relevant data has still not been completed and some of the textiles have been dispersed to a variety of locations (Bélis 2003, 207-276).

The first textiles from the site of Qumran that were subject to scientific analysis had been taken for examination even before the systematic organized excavations of de Vaux in the 1950s. These textiles were collected at Cave 1 in 1949 by de Vaux and Harding and published by Crowfoot in 1955 (Crowfoot 1955). Although this was only a preliminary publication of information about the 77 textiles that were found in Cave 1, it had great importance for the next stages of research. It appears that during the excavations, most of the textiles were stored in one of the rooms at the Rockefeller Museum in Jerusalem where all of the Qumran finds were kept together. There were many additional textiles in the collection of the École Biblique, and scraps of other textiles traveled with the researchers to England, Jordan (the Amman

Figure 2. Linen textile, Chalcolithic period, tabby weave, No. 577053. Photo by Clara Amit, Israel Antiquities Authority.

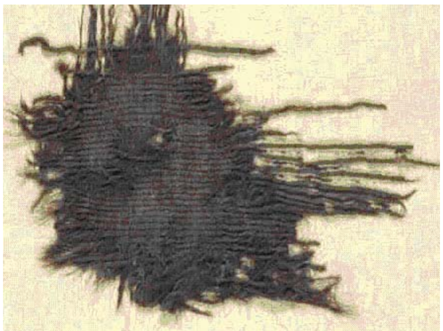

Figure 3. Goat hair textile, Roman period, No. 577006. Photo Clara Amit, Israel Antiquities Authority.

Figure 4. Wool textile decorated with red band, Roman period, probably part of a tunic, No. 577004. Photo Clara Amit, Israel Antiquities Authority.

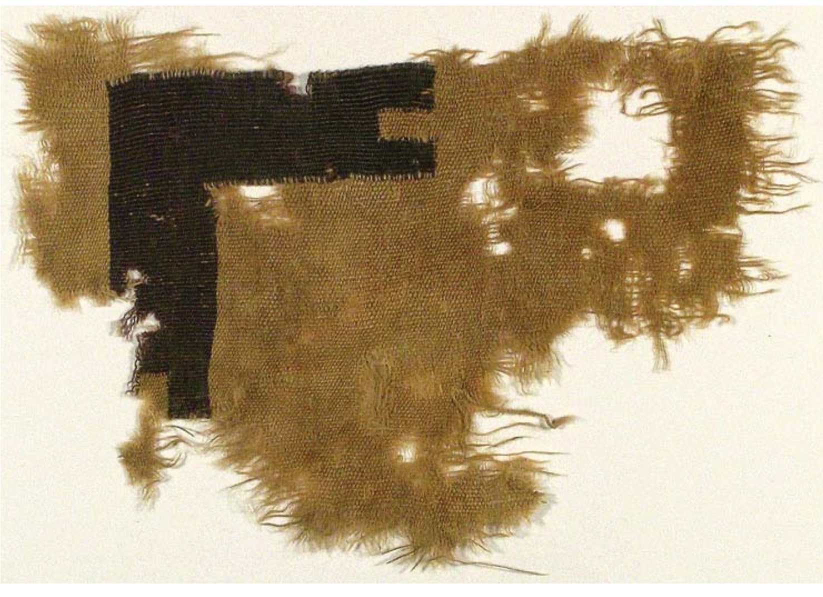

Figure 5. Wool textile, Roman period, mantle decorated with gamma-shaped pattern, No. 577000. Photo Clara Amit, Israel Antiquities Authority.

Archaeological Museum), and to various private collections throughout the world. The textiles were placed in cardboard boxes, at times without even a record of their exact provenance, and they were stored under conditions that were unsuitable for organic materials. It was only in 1998 that a preliminary classification was made of the materials at the Rockefeller Museum, by Humbert and Chambon. In the early 2000s, the various textiles were transferred from the Rockefeller Museum to the collection of the Israel Antiquities Authority (IAA), and in 2003, Bélis published an article on another 130 textiles, mostly from Cave 8, Cave 11, and the Christmas Cave (Fig. 1), and some of unknown provenance (Bélis 2003, 277-286). The textiles were examined by Bélis before cleaning. As a historian, she emphasized such issues as the material relationship between the manuscripts and the textiles (Bélis 2003, 209, 229-41), rather than technical details. Later the textiles were cleaned by Vinitzky at the IAA for the first time, and examined and catalogued in primary report by Shamir (2006b). At present there are hundreds of textiles in the IAA collection which came from the Qumran region (Shamir 2006a, 2006b, but when the 2006b article was published we didn't know that the Christmas Cave is not part of Qumran Caves).

To summarize, the published textiles that were found in Qumran and its vicinity are as follows:

1. From the caves: Crowfoot published only the textiles from Cave 1, presented below. Bélis published textiles from Cave 8, Cave 11, and the Christmas Cave, and some of unknown provenance.
2. From Tomb 1 in the southern cemetery of Qumran: 3 minute linen remnants adhering to metal.
3. From locus 96: A few carbonized linen textiles were preserved.

The Christmas Cave Textiles

Among the textiles that were kept at the Rockefeller Museum was a large group of textiles that were unusual for Qumran. Most of them were made of wool, and some were dyed or decorated with bands or a gamma-shaped design in a broad range of colors including red, purple, black, blue and green. The marking QCC - Qumran Christmas Cave - written on these textile bags indicated their origin.

The cave was first discovered on Christmas day in 1960 by Allegro as part of the investigations he conducted in his quest for the Copper Scroll treasures. Allegro described his visit to the cave in his popular book *Search in the Desert* (Allegro 1964). In his book, Allegro discussed in detail how he found several items in the cave: a bronze coin from the Bar Kokhba period, Roman pottery sherds, and pieces of leather; he also reported finding textiles in different colors: red, blue, and yellow. Several months after his first visit to the cave, Allegro conducted an excavation to the cave. However, this excavation was never published in a scholarly journal. The textiles were listed in a preliminary manner only and were not systematically photographed. Furthermore, although the discoveries clearly showed that the Christmas Cave served as a cave of refuge during the Bar Kokhba Revolt, the textiles were sent to the Rockefeller Museum and registered together with finds from the Qumran Caves (Porat *et al*. 2007). Bélis (2003) was the first to realise that this was a unique group and noted that the textiles in the assemblage from the Christmas Cave are different from the textiles that were found at Qumran, both in their colours and in the material they were made of. However, Bélis did not address the relative dating of the textiles with respect to the other artifacts found in the cave.

In 2007 the cave was investigated again, as part of a survey conducted by Porat, Eshel, and Frumkin. The cave is located in the bottom section of Kidron valley and doesn't belong to Qumran caves (Fig. 1). The excavators examined the numerous finds, which included sherds of clay vessels, two bronze coins, textile fragments, food remains, and metal objects. They determined that the finds in the Christmas Cave are not related to the Qumran Caves. They also concluded that the human activity in the cave began in the Chalcolithic Period, and that the cave later served as a hiding place for refugees fleeing the Romans at the end of the revolt leading to the destruction of the Temple, and again in the last stages of the Bar Kokhba Revolt in AD. 135 (Porat *et al*. 2007).

A total of 255 ancient textiles from the Christmas Cave were catalogued by Shamir (2006a), of which 184 are dated to the Roman period, 71 to the Chalcolithic period, and 5 to the Medieval period. A few are modern, including some made of cotton. The assemblage from the Roman period includes 113 wool, 63 linen, and 8 goat hair textiles.

Ben-Yehuda and Murphy (2010 - *ATN* 50) based their investigation on our research about these textiles, but did not pay attention to the dating of the artifacts. Textiles nos. 583019, 585786 and 58544 are from the Chalcolithic period, while no. 582812 is dated to the Roman period. None of the ropes are dated because they did not change significantly during these periods at Judean Desert.

Christmas Cave Chalcolithic Textiles

The preservation state of the Chalcolithic textiles from the Christmas Cave is relatively good: most of them are not worn (they were not used a lot), and

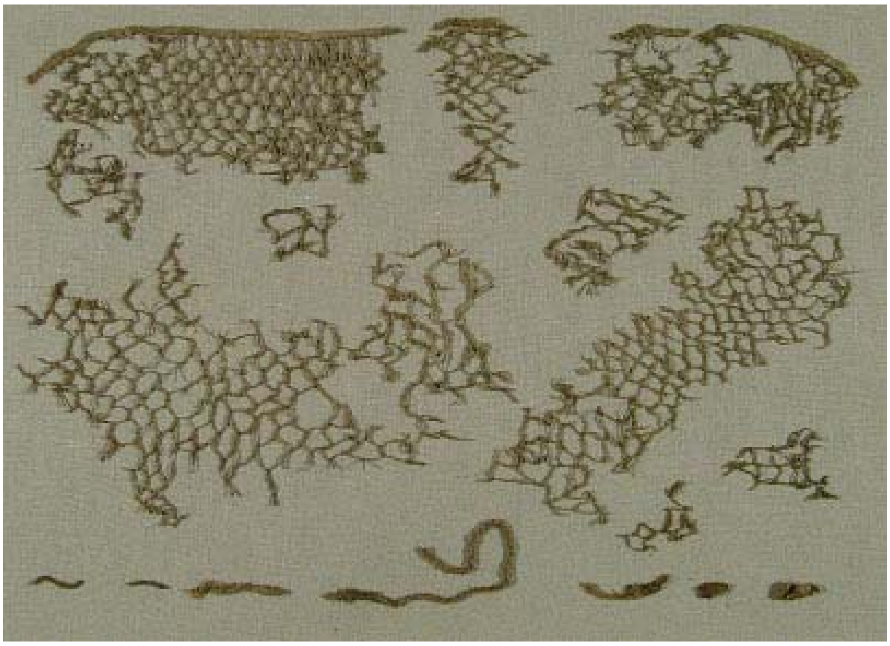

Figure 6. Linen hairnet, No. 577048. Photo: Clara Amit, Israel Antiquities Authority.

they were not damaged by insects. All the textiles are made of undyed, unbleached linen (Fig. 2). Their present color ranges from off-white to cream to beige to brown. No wool textiles dated to the Chalcolithic have ever been found in Israel.

The threads are s-spun, sometimes plied in a final S twist for better cohesion. This is typical for the Chalcolithic period. In some textiles the threads are very fine and delicate - in others they are crude. A few have threads of varied thickness in the same cloth. The predominant weaves are various tabby weaves. This serves to confirm that the textile crafts were already very advanced and accomplished in the 5th-4th millennium BCE.

Among the fragments are narrow, cut, band-like specimens, probably used for tying or bandages. They resemble the Chalcolithic textiles from Judea Desert caves such as the Cave of the Treasure (Bar-Adon 1961) and the Cave of the Warrior (Schick 1998).

Christmas Cave Roman Textiles

Roman textile fragments made of wool, linen and goat hair (Fig. 3) were discovered at the Christmas Cave. Some of the wool items are parts of tunics (Fig. 4) or mantles (Fig. 5). There is also a hairnet made of linen (Fig. 6). The finds at the Christmas Cave indicate a similarity in dress and patterns of decoration to the Roman world.

The Homogeneous Nature of the Qumran Textiles

The new finds from the Christmas Cave and the conclusion that they are not connected to Qumran make a significant contribution to the study of the Qumran textiles. It can now be determined that all of the textiles that are known from the excavations at Qumran are made of linen and no textiles of wool or any other material were found there. This is true not only for the textiles from Cave 1 examined by Crowfoot but also for all of the textiles today in the IAA collection. Textiles from Qumran Cave 8 were not brought to the IAA and so were not available to us for examination. However the material from Qumran Cave 11 was brought to the IAA from the École Biblique, and this included 58 linen textiles from the Roman period. In addition, during excavations conducted by Prof. Patrich in the 1980s, 8 textiles dated to the Roman period were found in Cave 11, all made of linen (Patrich, Arubas and Agur 1988-89).

The homogeneous nature of the Qumran textiles was manifested not only in the use of the same raw material – linen – but also by the simplicity of the textiles. As mentioned previously, the Qumran textiles were free of any colored decoration, except for those textiles that were used as scroll wrappers and featured a geometric pattern dyed in blue (Crowfoot 1955, 27-29), which is not familiar from other sites. The lack of decoration on most of the textiles is understandable due to the fact that linen does not easily absorb dye, with the exception of the blue dye.

By joining the archaeological finds, a picture emerges of a group that separated itself from the nearby Jewish population not only by physical distance but

also by its outward appearance (Magness 2002, 196; Shamir 2006b).
Qumran, undoubtedly a Jewish site, yielded only linen textiles. This is in contrast to other sites. Of approximately 2000 textiles from the Roman period discovered in Israel, 35% are linen, the other materials are sheep's wool, goat hair and camel hair.
The archeological finds, which show the eschewal of dyed wool and the simplicity of the textiles from Qumran, is compatible with the literary sources that describe the clothing of the Essenes. In his description of the Essenes, Josephus wrote: "Riches they despise…for they make a point of keeping a dry skin and always being dressed in white" (*The Jewish War*, 2.122). Also, "In their dress and deportment they resemble children under rigorous discipline. They do not change their garments or shoes until they are torn to shreds or worn threadbare with age" (*The Jewish War*, 2.126). Philo described the collective nature of their dress: "And not only is their table in common but their clothing also" (*Hypothetica*, 11.12). The choice of the Qumran Community to wear white clothing is discussed at length by Tigchelaar 2003. The archeological finds indeed seem to reinforce what both Josephus and Philo wrote, that their habitual clothing was the same for everyone and it was characterized by simplicity and a lack of colored ornamentation. The Essene Sectarians - dwellers of Qumran - wore only nondyed linen garments which they considered to be pure. This is indicative of the anti-Roman culture attitude of the Sectarians, a political statement or conservative reaction against contemporary society.

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Bibliography

Allegro, J. M. (1964) *Search in the Desert*. London.

Bar-Adon, P. (1971) *The Cave of the Treasure - The Finds from the Caves*. Jerusalem.

Bélis, M. (2003) Des Textiles, catalogues et commentaires. In J. B. Humbert Op and J. Gunneweg (eds.), *Khirbet Qumrân et 'Aïn Feshkha II*, 207-276. Fribourg.

Crowfoot, G. M. (1955) The Linen Textiles. In D. Barthelemy and J. T. Milik, *Discoveries in the Judaean Desert* I*: Qumran Cave*, 18-38. Oxford.

Magness, J. (2002) *The Archaeology of Qumran and the Dead Sea Scrolls*. Eerdmans.

Patrich, J., Arubas, B. and Agur, B. (1988-89) Judean Desert, Cave Survey – 1986/1987. *Excavations and Surveys in Israel* 7-8, 92-95.

Porat, R., Eshel, H. and Frumkin, A. (2007) Remnants from the Time of the Revolts against the Romans - from Caves in the Lower Nahal Qidron Region. In *Mehqarei Yehuda v'Shomron*, Issue 18, 231-264. Ariel. (in Hebrew)

Shamir, O. (2006a) *Textiles in the Land of Israel from the Roman Period till the Early Islamic Period in the Light of the Archaeological Finds*. Unpublished PhD dissertation, Institute of Archaeology, The Hebrew University.

Shamir, O. (2006b) Textiles and Garments from Qumran – Chalcolithic and Roman Periods. In J. Gunneweg, C. Greenblatt and A. Adriens (eds.), *Bio- and Material Cultures at Qumran*, 285-296. Stuttgart.

Schick, T. (1998) The Textiles. In T. Schick (ed.), *The Cave of The Warrior A Fourth Millennium Burial in The Judean Desert*, 6-22. Jerusalem.

Tigchelaar, E. J. C. (2003) The White Dress of the Essenes and the Pythagoreans. In Florentino García Martínez and Gerard P. Luttikhuizen (ed.), *Jerusalem, Alexandria, Roma: Studies in Ancient Cultural Interaction in Honour of A. Hilhorst*, 301-321. Leiden.

Yadin, Y. (1963) *Finds from the Bar Kokhba Period in the Cave of Letters.* Jerusalem.

Chris Verhecken-Lammens

Piecing together a Roman linen tunic

Roman tunics were selected from various collections for the investigation in the Study Group (Colour and Dating) of the European Dress-ID project (see De Moor *et al.* in this issue). Among them is half of a tunic (ACO. Tx. 2477) from the Errera collection of the Royal Museums of Art and History, Brussels. Up until now this object was in storage because of its very fragile condition. In the past the tunic seams were loosened, resulting in a long flat piece of linen fabric. The original shape is hence lost, but a photo in the catalogue (Errera 1916, cat. 48) shows half of a tunic cut from neck slit to the hem. This is rather unusual and reminded me of two half-tunics at the Whitworth Art Gallery in Manchester. I have analysed these tunics and one of the features that caught my attention was the way they were cut. The two tunics were cut not along the shoulder line but vertically leaving a right or left part of the tunic (Pritchard 2006, 77-78 fig. 4.25(a) inv. T.1994.130, and fig. 4.26(a) inv. T.1994.131). Because of the special shape, the suspicion arose that one of the tunics of Manchester could be the matching part of the one in Brussels. Since tunics Manchester T.1994.131 and Brussels ACO. Tx. 2477 both have the same special features, we were able to bring the two parts together virtually (Fig. 1).

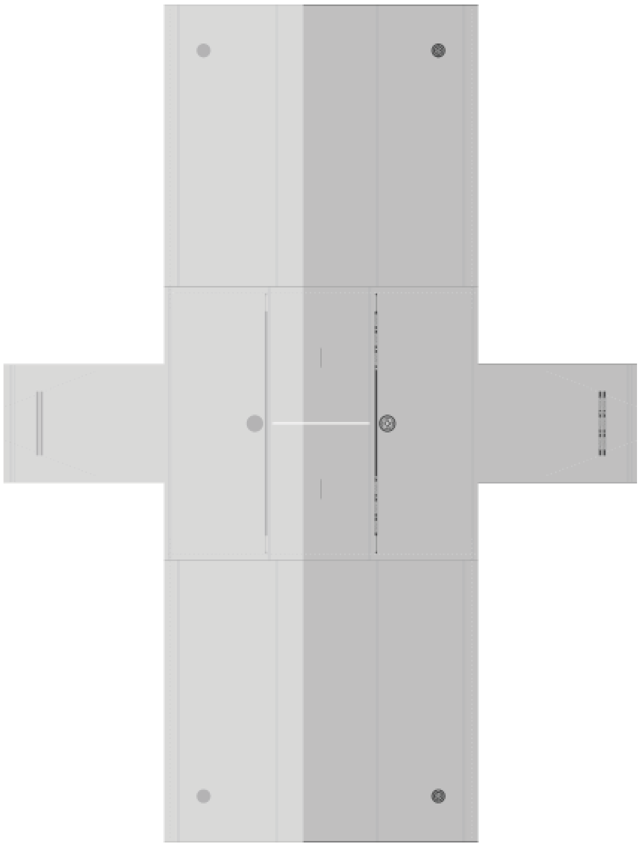

Fig. 1. Drawing of the original linen tunic: left side - ACO. Tx. 2477 , right side - T.1994.131. ©Whitworth Art Gallery, The University of Manchester.

Description of the tunic (Manchester T.1994.131 and Brussels ACO. Tx. 2477)

Originally the tunic was 128 cm high and 92 cm wide and was woven in three parts. The loom width of the fabric is 88 cm. Warp and weft are s-spun, unusually fine, glossy linen threads. The balanced tabby weave has 20-22 warp threads and 22-24 weft threads per cm with a simple selvedge. The decorations consist of narrow (0.5 cm) clavi ending above the waist tuck, double sleeve bands, shoulder medallions (5 x 5.5 cm diam) and 4 small medallions (1.7 x 2.2 cm diam) on the hem. To insert the tapestry weave, the warp threads were grouped to weave an extended tabby 2/3 (sleeve bands) or 2/4 and 2/3 (shoulder medallion: Fig. 2) with crossed and dropped threads. The weft, dyed with mollusc purple (see De Moor *et al.* in this issue), is a single (z-spun in sleeve bands) or plied thread (Z2s-spun in medallions), and has 56-60 threads/cm. The flying thread brocading is executed with undyed s-spun wool and s-spun linen thread. The patterning is geometric in the medallions (Fig. 2), using woollen threads for the flying thread technique, but linen threads for the central part and the outer circle line. The clavi have a pattern consisting of two interlaced bands in wool, alternating with lozenges in linen. The linen threads are white and are better visible against the dark purple background than the very thin woollen threads.

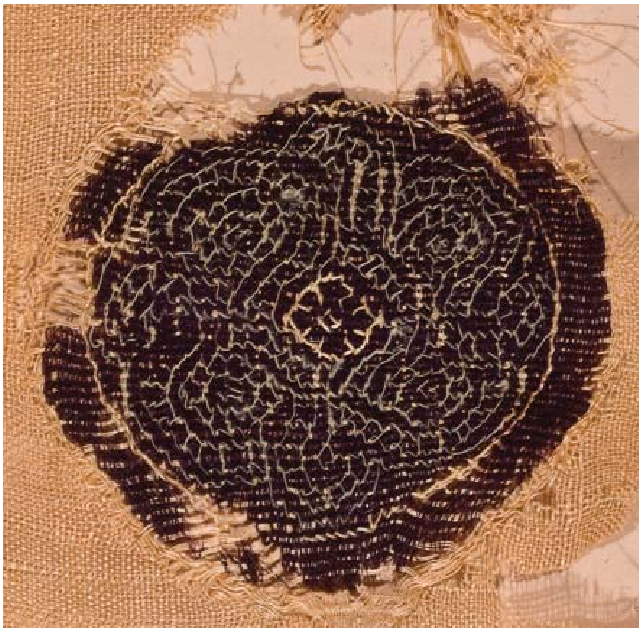

Fig. 2. Shoulder medallion of ACO. Tx. 2477. ©Royal Museums of Art and History, Brussels.

Thanks to the remains of weft floats at the back side of the shoulder medallion, we know that the part from Brussels (ACO. Tx. 2477) was woven first. The weaver started with the sleeve 36 cm wide in the central part of the warp. Two lines of self bands mark the wrist. Two sleeve bands 24 cm wide, in tapestry weave, have open warp threads at both sides near the selvedge. This part was intended to be hidden in the tapered seem of the sleeve. The end of the sleeve (44 cm high) is followed by the start of the upper part of the tunic. In the first picks, a strengthening of the underarm was made by a twined weave over 9 cm (4 cm along the sleeve, the rest on the body side). This is a feature typical for woollen tunics but rarely found in linen tunics (see below). In its present condition, this place has darning stitches of thicker linen threads. The side edges are finished by a wrapped interlocking thread. Two self bands (three sheds of tabby with extra two s-spun linen weft, with 6 tabby sheds in between) are woven from selvedge to selvedge at the side. On the shoulder line, in the middle of the fabric, a medallion has been woven followed by the first clavus.

In the central part next to the clavus are selfbands running along the full width of the fabric. Two of them are shorter and end 20 cm at both sides of the shoulder line. They mark the limit of the neck slit (+/- 30 cm). The neck opening is not woven but cut and hemmed with whipped edges, overcast with a linen Z2s-plied yarn, sewn on the edge along the neck slit. This part of the tunic ends a few cm from the centre.

The two lower parts are woven on top of each other on the same 88 cm wide warp. In both parts, two small medallions (*c*. 2 cm in diameter) are woven along one side of the fabric, near the selvedge of the bottom edge of the tunic. Here too, linen and wool threads are used for the flying thread brocading. Stripes of selfbands in the central part would be regarded as extensions of the clavi. At the waist is a small seam, selvedge to selvedge, joining the upper and lower parts together.

The tunic half Manchester T.1994.131 is the other part of the tunic. It has the same features as the first half, but with a few cm more of the central section with a short red woollen thread in the centre of the tunic below the neck. This part of the tunic still has the original side seams from the lower edge up to the waist tuck. From there, the warp threads of the edges are secured from unravelling by a wrapped, interlocking thread.

Discussion

The tunic part Manchester T.1994.131 has been considered to be from the Byzantine period (Pritchard 2006, 80). This is not surprising because until now linen tunics woven in parts on a small loom have been dated to *c*. 5th century AD. The balanced tabby ground weave of the tunic, the cut rather than a slit-woven neck opening, as well as the inwoven red threads are all features attributed to this period. An unusual characteristic for linen tunics is the underarm reinforcement. Tunics with similar features are known from other collections:

1) Royal Museums of Art and History, Brussels: ACO. Tx. 2482, a tunic woven in three parts, has underarm strengthening and tapestry decoration with s and z-spun purple wool.
2) Whitworth Art Gallery, Manchester: T. 1992.5, a child's linen tunic with underarm strengthening, red thread marks but applied decorations.
3) Whitworth Art Gallery, Manchester: T. 1994.130, a tunic woven in one piece, balanced tabby weave, starting border at the side, underarm strengthening, red thread marks, purple z-spun wool and wool and linen threads for the flying thread brocading.
4) Victoria and Albert Museum, London: 631-1886, a tunic woven in one piece, with underarm strengthening, red thread marks and purple z-spun wool.
5) Victoria and Albert Museum, London: 530B.1974, a tunic woven in one piece, underarm strengthening, red marks and

6) purple z-spun wool.
7) Katoen Natie, Antwerp: of the 8 the complete linen tunics only 1 has underarm strengthening (inv. 1143) and red thread marks on the shoulder line.

Tunic part Brussels ACO. Tx. 2477 was selected for the dating and dye analysis. Although already in 1916 Isabella Errera dated it to the 3rd-5th century AD (Errera 1916, 19-20 cat. 49) the fragmentary tunic has been registered as part of the textiles from the tomb of Colluthos and his wife, dated on the basis of papyri to the middle of the 5th century AD. Gayet's description, both in his exhibition catalogue (Gayet 1900, 9) and his auction catalogue (Gayet 1901, 11) is rather vague, but it is possible that we may identify our tunic with the one Gayet describes as following: "D'autres suaires, à médaillons foliacés, violets avec esquisse nervée blanche, complètent l'ensemble. Pour Cécilia (sic), la tunique est de mousseline de lin à ornements bleus. La robe, de fine laine jaune, porte un décor à peu près semblable, petits médaillons posés sur les épaules et le bas de la jupe, enfermant des entrelacs, profilés en blanc". The tunic is indeed woven in very fine linen which at first was thought to be wool, also by us, because of its texture and colour.

Conclusions

The special shape of the half-tunics in Brussels (ACO. Tx. 2477) and in Manchester (T.1994.131) was the first hint to link them together. Indeed, the technical features proved that the two parts originally belonged to the same tunic. The Brussels part (ACO. Tx. 2477) has been dated to the Roman period (see De Moor *et al.* in this issue). This indicates that technical features such as the balanced tabby weave, the cut neck slit and the in-woven red threads, until now regarded to be of the Byzantine period, were already applied in Roman times. The Manchester half-tunic (T.1994.131) has found its counter-part in Brussels (ACO. Tx 2477). But where is the other part of the second Manchester half-tunic (T.1994.130)?

Acknowledgments

I am very grateful to Frances Pritchard who invited me to study the tunics at the Whitworth Gallery in 1997. My sincere thanks to Mieke Van Raemdonck, curator of "Islam and Christian Art from the East", RMAH, Brussels, for her support and for the information on the history of the garment.

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Bibliography

Errera, I. (1916) *Collection d'Anciennes Étoffes Égyptiennes.* Bruxelles.

Gayet, A. (1900) *Notice relative aux objets recueillis à Antinoë pendant les fouilles exécutées en 1899-1900 et exposés au Musée Guimet du 12 décembre 1900 au 12 janvier 1901*. Paris.

Gayet, A. (1901) *Antiquités égyptiennes. Nécropole pharaonique. Nécropole romaine, vente aux enchères publiques, Musée Guimet, 17 Juin 1901*. Paris.

Pritchard, F. (2006) *Clothing Culture: Dress in Egypt in the First Millennium AD.* Manchester.

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Radiocarbon Dating and Dye Analysis of Roman Linen Tunics and Dalmatics with Purple Coloured Design

Introduction

Immediately after the start of DressID project (see Schieck and Tellenbach in this issue) a sub-project on radiocarbon and purple dye analyses of Roman dresses from Egypt was initiated by the Study Group 4 (Colours and Dating). The idea was to assemble groups of 'similar' garments or dress accessories, with "similar" meaning: made of the same basic material(s), having the same shape, same decoration or pattern, same technique and same colour. Firstly, we concentrated on a series of linen tunics and dalmatics with purple-coloured decoration, a type that is known from numerous representations in mosaics and wall paintings of Roman times in the Mediterranean area.

Eighteen examples of almost complete or substantial fragments of tunics and dalmatics from the Katoen Natie collection in Antwerp, the Sculpture collection and Museum of Byzantine Art in Berlin, the Royal Museums for Art and History in Brussels, the Gustav-Lübcke-Museum in Hamm, the British Museum and the Victoria and Albert Museum in London, the Whitworth Art Gallery in Manchester, and the Museum for Applied Arts in Vienna were selected and – where possible – classified according to their shape.

Four items are of the typical tunic shape, woven in one piece from sleeve to sleeve (Table 1). One is a sleeveless tunic. Nine objects could be identified as dalmatics (Table 2), a special type of tunic produced in the same manner but fitted out with extra wide sleeves (Pausch 2003, 180-187). The original shape of another seven fragments could not be determined with certainty (Table 3).

The linking element between all tunics and dalmatics is their decoration which is made of purple-coloured wool in tapestry technique, often accompanied by the so called 'flying shuttle'. The decoration is either monochrome or bi-chrome, the latter meaning that the ornaments appear in the natural bright colour of undyed linen on a ground of purple-coloured wool or vice versa.

The decoration of two tunics (SBM 9930 Fig. 1; BM EA 72491 Fig. 5) merely consists of plain purple-coloured stripes. Other garments combine plain stripes with foliate ornaments and geometric motifs (KTN 989 Fig. 14; SBM 9936 Fig. 15; WAG T.1996.92 Fig. 9; BM PE 1955.2-6.10 Fig. 16). Twelve pieces show an interlace pattern (KMKG ACO.Tx 2474 Fig. 11 and ACO. Tx.2477 Fig. 4; WAG T.1995.145 Fig. 7; GLM 1704 Fig. 13; V&A 361-1887 Fig. 6) or an interlace pattern with supplementary geometric and/or foliate motifs (KTN 489 Fig. 12; KMGK ACO.Tx.2485 Fig. 3; WAG T.1994.129 Fig. 8 (tunic) and T.1968.80 (sleeve), MAK T 9890-1952 (1); MAK T 9677-1951 (2); KMGK ACO. Tx 2472 Fig. 2; KMKG ACO.Tx 2467 A-B Fig. 10).

The patterns and motifs occur on both tunics and dalmatics types alike. This means that we cannot distinguish between tunics and dalmatics by their decoration if they are incomplete.

Results of the Radiocarbon Dating

The 18 almost complete or fragmentary tunics and dalmatics were radiocarbon dated (Van Strydonck, Nelson, Crombé *et al*. 1999). Three similar pieces from the Musée du Louvre already radiocarbon dated before the start of this project (Bénazeth, pers. comm.; 2006; Cortopassi 2008) were added in order to obtain 21 tunics and/or dalmatics.

Collection	Inv. no	Object	C14-date Sample no and years BP	C14-date Calendar years (95.4 %)	Bibliographical reference
1. SBM	9930 (Fig. 1)	Front/back of sleeved tunic with plain stripes	KIA-37619, 1815 +/- 25 BP	120-260 AD (94.2 %) 300-320 AD (1.2 %)	Cat. Berlin 2000, 201-203, no 131
2. KMKG	ACO.Tx.2472 (Fig. 2)	Front/back of tunic with stripes and roundels decorated with interlace and leave motifs	KIA-37915, 1715 ± 30 BP (= tunic) KIA-37914, 1810 ± 35 BP (= sewn onto roundels)	250-410 AD 120-330 AD	Errera 1916, 30-31, no 74; Cat. Brussels 1988, fig. 29
3. KMKG	ACO.Tx.2485 (Fig. 3)	Front and back of tunic with geometric pattern and interlace	KIA-37918, 1755 ± 40 BP	130-390 AD	Errera 1916, 9, 27; Cat. Brussels 1988, fig. 30
4. KMKG	ACO.Tx.2477 (Fig. 4)	Fragment of sleeved tunic with interlace pattern	KIA-37923, 1730 ± 30 BP	240-400 AD	Errera 1916, 19-20, no 49
5. BM	EA 72491 (Fig. 5)	Sleeveless tunic with plain stripes	KIA 38657, 1570 ± 25 BP	420-550 AD	Walker and Bierbrier 1997, 177, no 223

Table 1. Tunics.

Collection	Inv. no	Object	C14-date Sample no and years BP	C14-date Calendar years (95.4 %)	Reference
1. V&A	361-1887 (Fig. 6)	Dalmatic with interlace pattern	KIA-38857, 1890 ± 30 BP	50-220 AD	Kendrick 1920, 40-41, no 1, pl 1; Walker and Bierbrier 1997, 178-179, no 227
2. WAG	T.1995.145 (Fig. 7)	Front/back of dalmatic with stripes, clavi and roundels showing interlace patterns	KIA-38474, 1705 ± 25 BP	250-410 AD	Pritchard 2006, 53-55
3. WAG	T.1994.129 (= tunic) (Fig. 8) T.1968.80 (= sleeve)	Fragments of front/back, neck section and sleeves of dalmatic with heart shaped motifs and interlace, roundels with meander and row of dots, red woollen cord around neck	KIA 38476, 1610 ± 25 BP	400-540 AD	Pritchard 2006, 56-57
4. WAG	T.1996.92 (Fig. 9)	Fragment of dalmatic with plain stripes and star motif with meander	KIA-38477, 1670 ± 35 BP	250-440 AD (93.3%); 490-530 AD (2.1%)	Pritchard 2006, 51-52
5. MAK	T 9890-1952	Fragment of a dalmatic with geometric pattern, interlace and foliate motifs	KIA-38475, 1690 ± 25 BP	250-300 AD (16.8%); 320-420 AD (78.6%)	Cat. Vienna 2005, 161-162, no 97
6. KMKG	ACO.Tx.2467 A, B (Fig. 10)	Fragments of two sleeves from a dalmatic with interlace and heart shaped motifs	KIA-39629 / KIA-39630 mean: 1615 ± 21 BP	390-540 AD	Errera 1916, 116, no 43
7. KMKG	ACO.Tx.2474 (Fig. 11)	Sleeve from a dalmatic with interlace pattern	KIA-39826 / KIA-39838, mean: 1760 ± 60 BP	120-410 AD	Errera 1916, 39, no 88
8. KTN	489 (Fig. 12)	Fragment of a dalmatic (sleeve) with interlace pattern and geometric motifs	KIA-37614, 1585 ± 25 BP	410-540 AD	Cat. Zottegem 1993, 111, no 20
9. GLM	1704 (Fig. 13)	Fragment of a dalmatic (sleeve) with interlace pattern	KIA-40433, 1695 ± 30 BP	250-420 AD	Cat. Hamm 2004, 225-226, no 112

Table 2. Dalmatics.

Collection	Inv. no	Object	C14-date Sample no and years BP	C14-date Calendar years (95.4 %)	Reference
1. KTN	989 (Fig. 14)	Fragments of a dalmatic or tunic with plain stripes, foliate motif and red cord around neck	KIA-37615, 1670 +/- 25 BP	260-280 AD (5.5 %); 320-430 AD (89.9 %)	Unpublished
2. SBM	9936 (Fig. 15)	Front/back of tunic or dalmatic with plain stripes and roundels with meander and foliate motifs	KIA-37620, 1625 +/- 25 BP	380-540 AD (95.4 %)	Cat. Berlin 2000, 208-209, no 136
3. BM	PE 1955.2-6.10 (Fig. 16)	Dalmatic or tunic with double stripes with row of fine lozenges and foliate motifs, roundel with lozenges, framed by heart shaped leaves	KIA 38862, 1725 ± 25 BP	240-390 AD	unpublished
4. MAK	T 9677-1951	Fragment of a tunic or - most probably – a dalmatic with interlace pattern, geometric and foliate motifs	KIA-40407, 1685 ± 25 BP	250-300 AD (13.6%); 320-420 AD (81.8%)	www.mak.at (collection online, Late Antique Textiles)
1. ML	E29312	Front/back of a tunic or dalmatic	KIA-28768, 1660 ± 25 BP	260-290 AD (3.4%); 320-440 AD (92.0%)	Cortopassi 2009, 150-151, fig. 1
2. ML	AF5842	Front/back of a tunic or dalmatic	KIA-28767, 1710 ± 25 BP	250-410 AD	Cortopassi 2009, 152-153, fig. 3
3. ML	AF13169	Tunic or dalmatic	KIA-28766, 1680 ± 25 BP	250-300 AD (9.8%); 320-430 AD (85.6 %)	Cortopassi 2009, 151-152, fig. 2

Table 3. Tunics or dalmatics. 1.ML- 3.ML are tunics or dalmatics from the Musée du Louvre which have been radiocarbon dated before the start of this project.

Tables 1, 2 and 3 show the results of the ^{14}C-analyses for each piece. The years BP – the conventional radiocarbon age – means before present *i.e*. before 1950, the start of the radiocarbon dating. The estimated age uncertainty of this radiocarbon age is given as 1 standard deviation, mostly plus/minus 25 years. This radiocarbon age however must be calibrated in order to obtain the calendar ages. This calibration curve relies on the accurate measurement of dendrochronologically absolutely dated tree rings (Bronk Ramsey 1995; Stuiver *et al*. 1998).

The graph of the 21 pieces is shown in Graph 1.

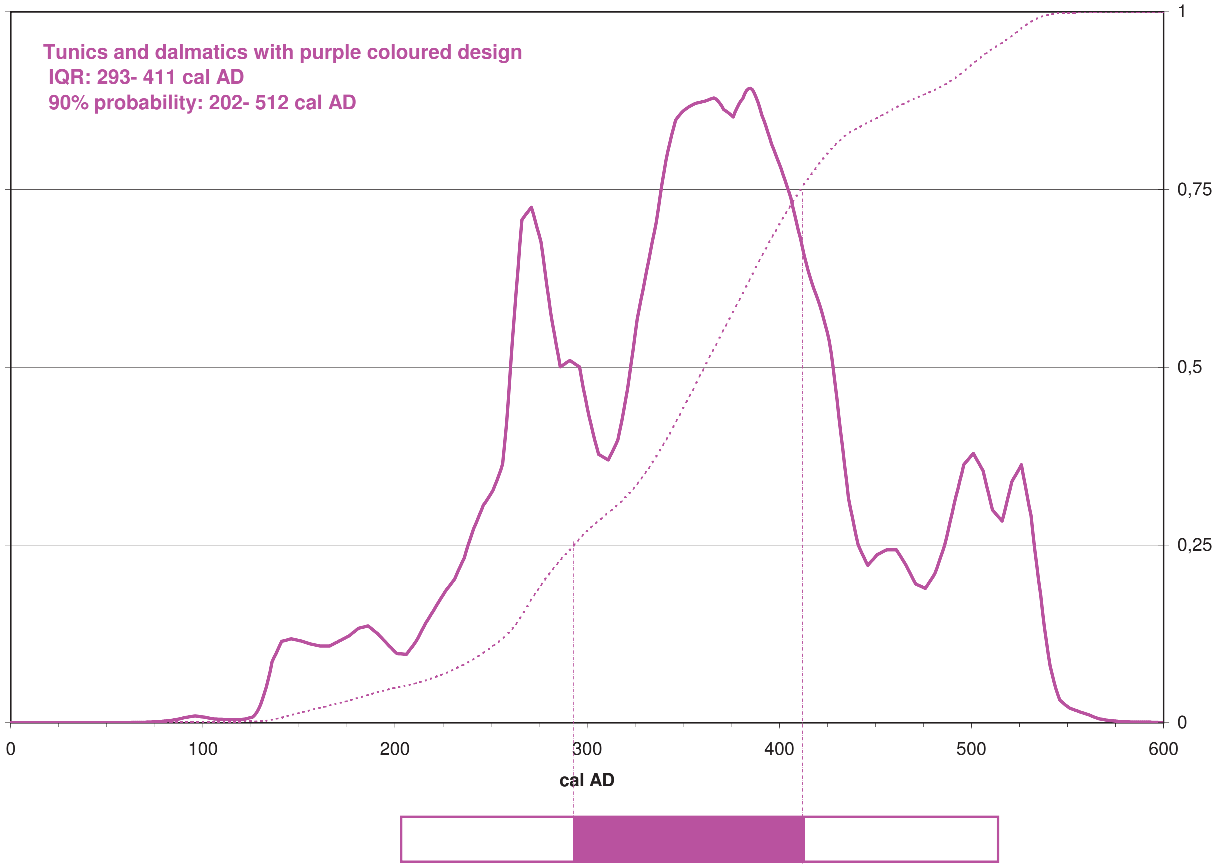
The interquartile range (IQR) of the 21 tunics and dalmatics is between 293 and 411 AD (Aitchison, Ottaway and Scott 1990). The 90 % probability range is between 202 and 512 AD. The IQR which takes into account the middle 50 %, excluding the early and late dates is a stable parameter and can be considered as the flourishing period for these textiles. The 90 % probability range was used instead of the usual 95 % probability range because the latter overestimates the period by a few decades. This was proved by Mark van Strydonck (Van Strydonck 2007).

The interquartile range for the dalmatics – the plain blue rectangle – is between 303 and 434 AD. The 90 % probability range is between 217 and 520 AD.

The interquartile range for the 5 tunics is between 247 and 377 AD – this is the plain red rectangle. The 90 % probability range – the complete red rectangle is between 157 and 516 AD. These tunics were definitively older than the group of 12 woollen tunics radiocarbon dated in 2004 (De Moor, Van Strydonck and Verhecken-Lammens 2004).

Dalmatic V&A 361-1887 caused a particular problem. The calculated calendar age was very early in contrast to those of the other dalmatics, namely between 50 and 220 AD (95.4 % probability). This dalmatic had been glued to a support fabric by means of polyvinylacetate, a petroleum derivate with an infinite radiocarbon age. In the laboratory in Brussels we attempted to remove all of this glue but apparently a little amount of it remained in the fibres, resulting in this early date. A second sample was taken from a section where the dalmatic very probably had not been in contact with the glue. The calendar age (95.4 % probability) from the second radiocarbon analysis is between 130 and 340 AD.

Tunic ACO.Tx.2472 is a special case. The basic tunic (ACO.Tx.2472B) provided a radiocarbon date of 1715 ± 30 BP (KIA-37915) and a calendar age (95.4 % probability) between 250 and 410 AD (68.2 % probability: 250-300 (24.9 %) and 320-390 (43.3 %)).



Graph 1. Sum probability and integrated probability distribution of 21 tunics and dalmatics.

The sewn-on decorations (ACO.Tx.2472A) were separately woven and reused to decorate the tunic ACO. Tx.2472 (Van Raemdonck, pers. comm. 2010), and therefore resulted in a different date. The radiocarbon date for these pieces is 1810 ± 35 BP (KIA-37914), the calendar age is 130-250 AD with 68.2 % probability, and 120-330 AD with a probability of 95.4 %. The sewn on decorations were not included in the graphic of this group of tunics and dalmatics as we do not know to what textile they belonged originally.

The radiocarbon date of dalmatic ACO.Tx.2474 was also problematic. The first radiocarbon date was 1520 ± 25 BP, (KIA-38158) (calendar date (95.4 %) probability: 430-490 AD (19.8 %), 500-610 AD (75.6 %)), which was unacceptably young. Therefore, two more samples were taken from this dalmatic (KIA-39826: 1805 ± 25 BP, 135-235 AD (95.4%) and KIA-39838: 1720 ± 35 BP, 240-410 AD (95.4 %)). The difference between these two dates is too important to be caused by the inherent statistical uncertainty. Similar cases in which repeated measurements do not give coherent results do exist but are very rare, *i.e.* not more than 1 % of all cases. Although we cannot be absolutely sure, the most probable explanation might be the presence of modern (natural) fibres from conservation or from the support fabric. Such fibres cannot be removed chemically. If these fibres cannot be recognized microscopically they will give a later date than expected (Van Strydonck *et al*. forthcoming 2011).

Although the tunics showed a tendency to be slightly earlier than the dalmatics, the difference was not significant. There was a substantial overlapping of the interquartile ranges and even more of the 90 % probability ranges. The number of tunics – only five – was rather small to obtain reliable results.

It is regrettable however that we also have a group of seven pieces in cases of which – due to their fragmentary condition – we were not sure whether they were tunics or dalmatics. The interquartile range of this group is between 336 and 401 AD, the 90 % probability range between 268 and 477 AD.

If we compare the three groups – tunics, dalmatics and tunics or dalmatics – we see a substantial overlapping of the interquartile ranges and surely of the 90 % probability ranges.

Inv. N° / Collection	Sample n° / Analysis n°	Sample Description	Anthraquinone dye constituents	Indigoid dye constituents	Biological dye source specification
Tunics					
ACO.TX 2472 / KMKG	09896 / 01, 07/221008/01	purple wool	+ag, 23 al, 38 pu	39 in	red dye source from *Rubiaceae* family and indigo/woad
	09896 / 02, 02/231008/01	purple wool, medallion	6 al, 55 pu	39 in	red dye source from *Rubiaceae* family and indigo/woad
ACO.TX 2485 / KMKG	09896 / 05, 05/231008/01	purple wool	+ag, 19 al, +xp, 56 pu	24 in	red dye source from *Rubiaceae* family and indigo/woad
9930 / SBM	09896 / 08, 07/231008/01	purple wool	+ag, 22 al, + xp, 62 pu	14 in, 1 ir	red dye source from *Rubiaceae* family and indigo/woad
EA 72491 / BM	09896 / 19, 07/090309/01	purple wool	+ag, 18 al, 74 pu	8 in	red dye source from *Rubiaceae* family and indigo/woad
ACO.TX 2477 / KMKG	09896 / 04, 04/231008/01	purple wool	-	73 in, 20 mbi, 7 xbir	Mollusc purple (*Hexaplex trunculus* type)
Dalmatics					
ACO.TX 2474 / KMKG	09896 / 03, 03/231008/01	purple wool	12 al, +xp, 72 pu	16 in	red dye source from *Rubiaceae* family and indigo/woad
489 (DM 20) / KTN	09896 / 06, 06/231008/01	purple wool	17 al, 62 pu	21 in	red dye source from *Rubiaceae* family and indigo/woad
T.1996.92 / WAG	09896 / 15, 10/051108/01	purple wool	8 al, 70 pu	22 in	red dye source from *Rubiaceae* family and indigo/woad
T.1995.145 / WAG	09896 / 16, 11/051108/01	purple wool	12 al, 74 pu	14 in	red dye source from *Rubiaceae* family and indigo/woad
T 361-1887 / V&A	09896 / 12, 03/041108/01	purple, fine wool	+ag, 12 al, +xp, 64 pu, 1 xp'	21 in, 1 ir	red dye source from *Rubiaceae* family and indigo/woad
	09896 / 13, 05/041108/01	purple, coarse wool	+ag, 11 al, +xp, 65 pu	22 in, 2 ir	red dye source from *Rubiaceae* family and indigo/woad
T 9890-1952 / MAK	09896 / 17, 02/061108/01	purple wool	6 al, 67 pu	27 in	red dye source from *Rubiaceae* family and indigo/woad
1704 / GLM	09896 / 21, 04/121009/01	purple wool	12 al, 84 pu	4 in, +ir	red dye source from *Rubiaceae* family and indigo/woad
T.1994.129 / WAG	09896 / 14, 09/051108/01	purple wool	20 al, +xp, 49 pu	31 in	red dye source from *Rubiaceae* family and indigo/woad
Tunics or dalmatics					
989 / KTN	09896 / 09, 08/231008/01	blue wool	+ag, 21 al, +xp, 54 pu	24 in, 1 ir	red dye source from *Rubiaceae* family and indigo/woad
9936 / SBM	09896 / 07, 04/221008/01	purple wool	+ag, 15 al, +xp, 65 pu	19 in	red dye source from *Rubiaceae* family and indigo/woad
PE 19552-6.10 / BM	09896 / 20, 08/090309/01	purple wool	+ag, 6 al, 84 pu, +xp	10 in	red dye source from *Rubiaceae* family and indigo/woad
T 9677-1951 / MAK	09896 / 18, 03/061108/01	purple wool	+ag, 20 al, 61 pu	19 in	red dye source from *Rubiaceae* family and indigo/woad

Table 4. Results of the dye analysis for each purple wool sample (relative ratios of components are calculated after the peak areas integrated at 255 nm; al: alizarin, pu: purpurin, ag: anthragallol, xp: xanthopurpurin, xp': xanthopurpurin like spectra, in: indigotin, ir: indirubin, mbi: 6-bromo indigotin and xbir: brominated indirubin).

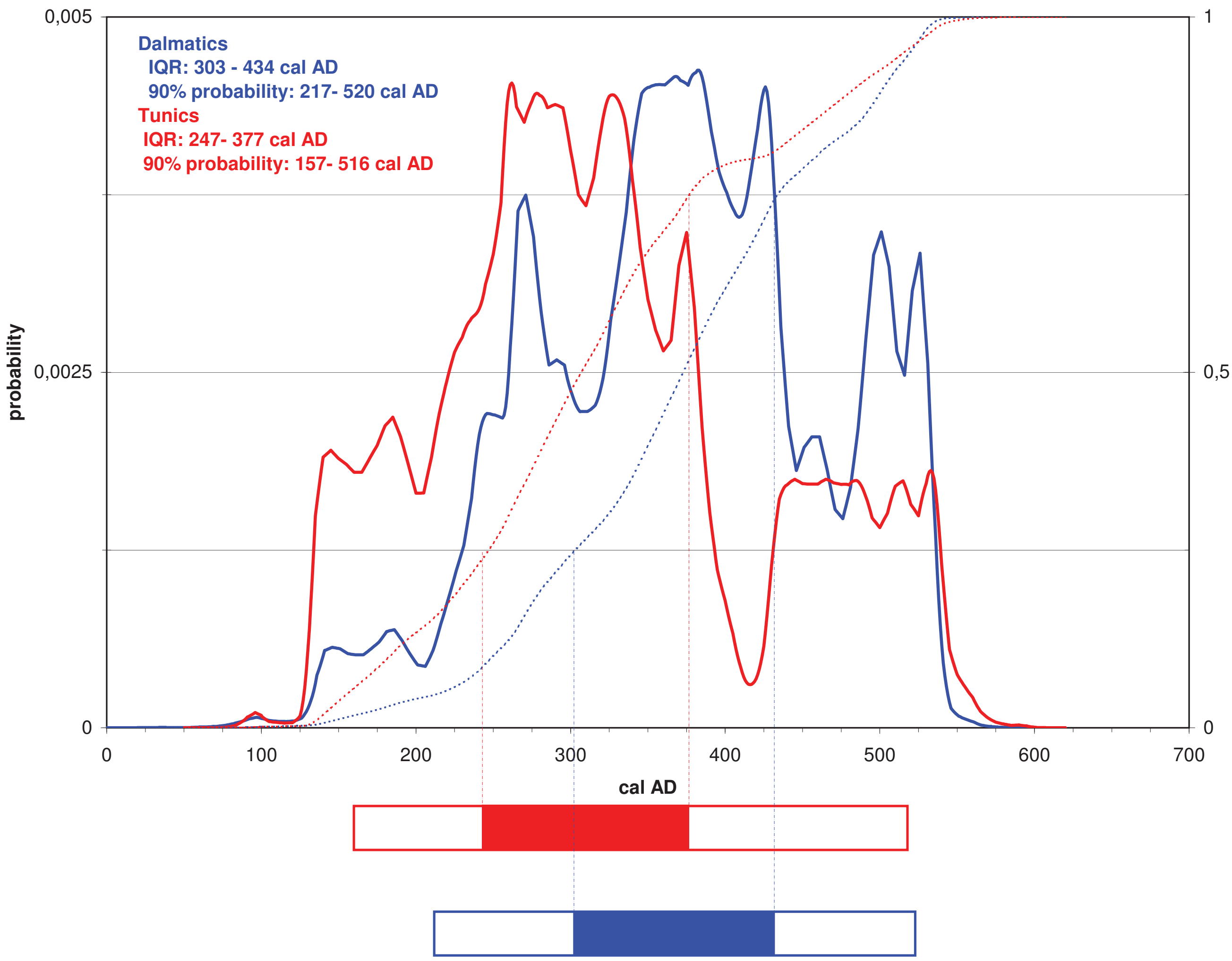
Dye Analyses

Nineteen purple coloured woollen decoration threads from 17 of the fragmentary tunics and dalmatics under study were analysed with HPLC-DAD for the identification of organic dyes. Chromatographic analysis was carried out after extraction of the dyes from the wool fibres using acidified methanol. Full description of the applied technique was published before (Wouters 1985). Table 4 shows the outcome of the dye analyses for each sample, expressed by means of the relative ratio of both the anthraquinone (column 4) and the indigoid (column 5) dye constituents found after integration at 255 nm. Column six gives the interpretation towards the possible vegetable or animal sources applied for dyeing.

Table 4 presents the results of the dye analysis for

Objects	Relative content alizarin: range	Indigotin + indirubin: Mean value (sd)	Alizarin + purpurin: Mean value (sd)
Roman Egyptian purple tunics and dalmatics (n=18)	7-38	21 (9)	79 (9)
Roman Egyptian purples (n=22)	0-23	8 (5)	92 (5)
'Coptic' Egyptian purples (n=4)	10-37	9 (5)	91 (5)

Table 5. Comparison between the analytical composition of dyestuffs in the purple tunics and dalmatics and other studies of purple Roman and 'Coptic' Egyptian textiles. A. Range of the relative content of alizarin (= the relative ratio between alizarin and purpurin calculated from integration values of the peak areas at 255 nm). B. Mean value and standard deviation (sd) of the relative ratio between the indigoid and the madder dyestuffs (all calculations based on the integration values of the peak areas at 255 nm). Data collected from Wouters 2009.



Graph 2. Sum probability and integrated probability distribution of 9 dalmatics and 5 tunics.

Fig. 1. SBM 9930. © Staatliche Museen zu Berlin - Stiftung Preußischer Kulturbesitz. Photo Antje Voigt.

Fig. 2. KMGK ACO.Tx.2472. © Royal Museums for Art and History, Brussels.

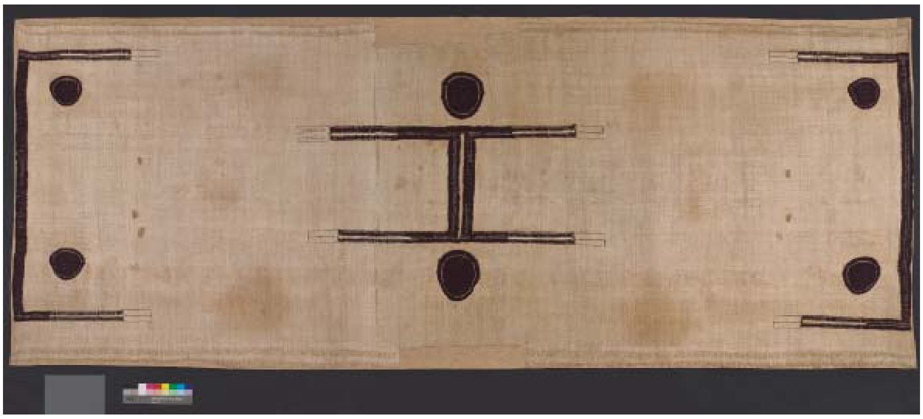


Fig. 3. KMGK ACO.Tx.2485. © Royal Museums for Art and History, Brussels.

Fig. 4. KMKG ACO.Tx.2477. © Royal Museums for Art and History, Brussels.

Fig. 5. BM EA 72491. © Trustees of the British Museum.

Fig. 6. V&A 361-1887. Photo © Victoria and Albert Museum, London.

Fig. 7. WAG T.1995.145. © The Whitworth Art Gallery, The University of Manchester.

Fig. 8. WAG T.1994.129 © The Whitworth Art Gallery, The University of Manchester.

Fig. 9. WAG T.1996.92 © The Whitworth Art Gallery, The University of Manchester.

Fig. 10. KMKG ACO.Tx.2467 A-B. © Royal Museums for Art and History, Brussels.

Fig. 11. KMKG ACO.Tx.2474. © Royal Museums for Art and History, Brussels.

Fig. 12. KTN 489. © Collection Katoen Natie, Antwerp.

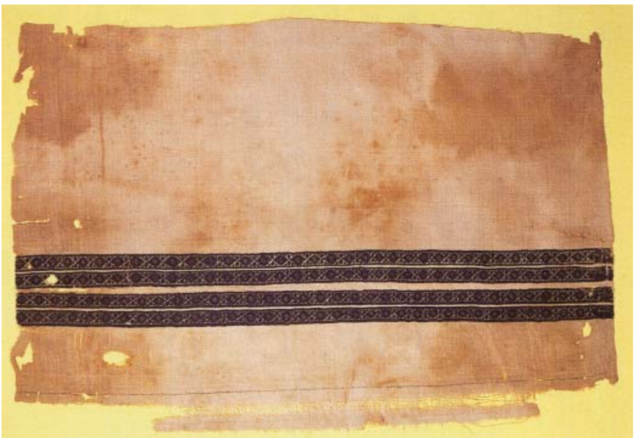


Fig. 13. GLM 1704. © Gustav Lübcke Museum, Hamm.

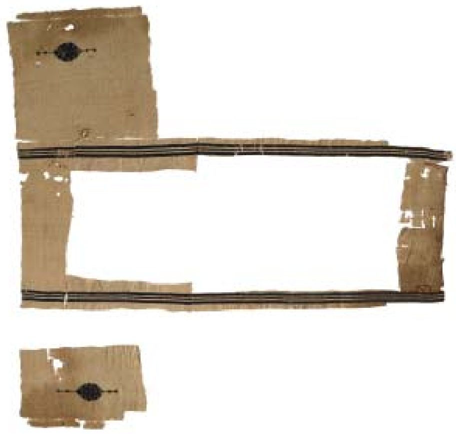


Fig. 14. KTN 989. © Collection Katoen Natie, Antwerp.

Fig. 15. SBM 9936. © Staatliche Museen zu Berlin - Stiftung Preußischer Kulturbesitz. Photo: Antje Voigt.

Fig. 16. BM PE 1955.2-6.10. © Trustees of the British Museum.

each purple wool sample (relative ratios of components are calculated after the peak areas integrated at 255 nm; al: alizarin, pu: purpurin, ag: anthragallol, xp: xanthopurpurin, xp': xanthopurpurin like spectra, in: indigotin, ir: indirubin, mbi: 6-bromo indigotin and xbir: bromated indirubin).

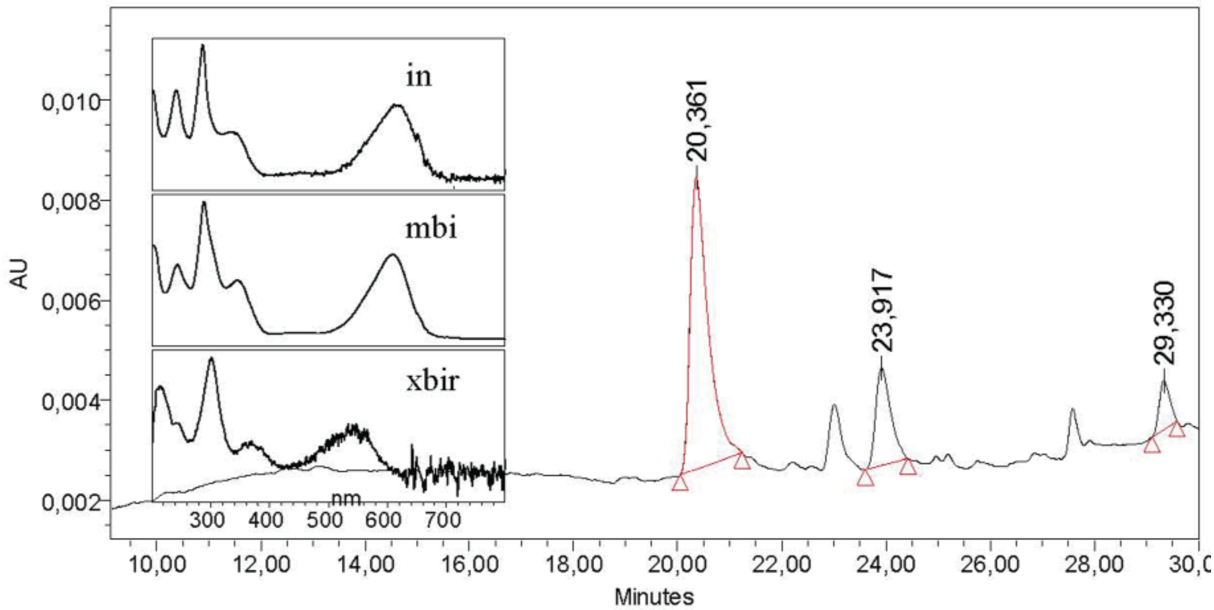
All purple-coloured threads from the tunics and dalmatics were found to be dyed in a similar way except one, the purple from ACO.Tx.2477 from KMKG. The detection of anthraquinone dye components alizarin (al), purpurin (pu) and the minor components anthragallol (ag) and xanthopurpurin (xp) is indicative for the use of the roots of a red dye source belonging to the *Rubiaceae* family. Indigoid components indigotin (in), sometimes in combination with the isomer indirubin (ir) refers to a vat dyeing with an indigo source (*Indigofera* species or *Polygonum* species) or with woad (*Isatis tinctoria* L.). As the same dye constituents are found after chromatographic analyses of the extracts of woad or indigo dyed fibres, no distinction can be made between both sources. Historically, both types were known in Egypt during the period under consideration (Forbes 1956, 108-110).

In the purple woollen thread used for the small decorations of the tunic ACO.Tx.2477, brominated indigoid constituents were identified in the presence of indigotin: 6-bromo indigotin (mbi) and bromated indirubin (xbir). Such brominated indigotin or indirubin components are the evidence for the use of an indigoid dye source of animal origin, commonly named mollusc, shellfish or Murex purple. The most important species used in antiquity were *Bolinus brandaris* (L. 1758, old name *Murex brandaris*) and Hexaplex *trunculus* (L. 1758, old name *Murex trunculus*) but also *Stramonita haemastoma* (L. 1766, old names *Thais* or *Purpura haemastoma*), the latter present only on the Atlantic coast. The dye was mentioned by Pliny the Elder in his *Naturalis Historia* (Forbes, 1956, 117). *Bolinus brandaris* is better known as the spiny dye-murex, as it has grooves and spines on the outside of the shell. This species is found at the depth of 9-200 m in shallow bays of the Mediterranean coast. *Hexaplex trunculus*, also called the banded dye murex can be found on the Mediterranean as well as on Atlantic coasts, on cliffs between the stones or muddy bottoms at a depth of 2-130 m, while *Stramonita haemastoma* inhabits shallow coasts of North African coastal areas and western Atlantic coasts, at a depth between 1 and 9 m.

The colouring material produced by enzymatic reaction of the hypobranchial glands from *B. brandaris* and *S. haemastoma* is mainly 6, 6′-dibromoindigotin, in the former species together with minor quantities of 6, 6′-dibromoindirubin, while from the *H. trunculus* mollusc, mainly indigotin and 6, 6′-dibromoindigotin are formed and minor quantities of indirubin. It is the presence of indigotin which is the cause of the more bluish coloration of the latter shellfish dye (Hofenk de Graaff 2004, 264-266). In the 1990s, pigments (stains) and vat dyes prepared from these three mollusc species were investigated by Wouters in order to characterise the analytical composition of the dyestuffs using HPLC-DAD analyses (Wouter 1992). More recent research on the analytical protocol for indigoid dyes was published by Koren (2008).

The HPLC-DAD result of the shellfish purple coloured fibres is presented in Graph 3, showing the chromatogram and the UV-Vis absorbance spectra of the identified peaks of indigotin and the two brominated constituents. The actual analytical composition of the dyestuffs in the present sample, with mostly indigotin, can be considered as indicative for the use of molluscs from the banded dye murex (*H. trunculus)* rather than from the two other species. However, it is preferable not to make any definite assignment considering that not much is known yet about the influence of the methods of harvesting, the dyeing process, the natural ageing and the way of extraction of the dyestuffs from the dyed fibres, on the analytical composition of the dyestuff found in archaeological fibres.

In ancient Rome, the use of mollusc or Tyrian purple was restricted to members of the royal family and the court. As true purple dyeing was so expensive, other dyestuffs were often used to mimic the royal purple. One of these methods is the production of purple hues by means of top dyeing with madder of premordanted and indigo vat dyed fibres. This must have been a very popular procedure in Egypt, as concluded in previous studies of Egyptian textile fragments dated in the Roman (Wouters *et al*. 2008) and 'Coptic' period (Wouters 1993). The recent results in the present series of linen tunics and dalmatics are in complete correspondence with these conclusions. A more in-depth study (Table 5) of the analytical composition of the madder source, by means of calculating the relative ratio between the two components alizarin and purpurin (calculated from integration values obtained at 255 nm) demonstrates that a relative content of alizarin ranges between 7 and 38. The very low relative amount of alizarin found in the purple samples from the tunics and dalmatics is consistent with the earlier studies of purple-dyed fibres from Roman and 'Coptic' period Egyptian textiles and confirms the differences in composition between the threads dyed in purple and the other colours, obtained by a madder dyeing alone or in combination with other dyes (Wouters 2009).



Graph 3. Chromatogram and spectra of dye components from purple wool fibres (KIK-IRPA sample code: 09896/04) from ACO.TX 2477 dyed with mollusc purple (integration at 288 nm): indigotin (in; 20.4 rt); 6-bromo-indigotin (mbi; 23.9 rt) and brominated indirubin (xbir; 29.3 rt).

Conclusion

Egyptian purple dyeing, a two-step dyeing process consisting of the top dyeing with a madder type of dye on premordanted and indigo or woad dyed fibres, was the overall procedure applied for the purple-coloured woollen threads from the 17 Roman dresses from Egypt.

This way of producing a high quality, though 'false' Royal purple can clearly be considered as very characteristic for purple dyeing in Egypt. Evidenced by the numerous purple decorations of Egyptian textiles in which it was found, this more economic way of purple dyeing was clearly applied on a large scale in Egypt and during a very long time span, covering the entire 1st millennium AD. Very few exceptions using true mollusc purple have been found. In this series, tunic ACO.Tx.2477 (Graph 3) with very narrow *clavi* was the only piece dyed with true purple. This could probably be expected. Because true purple was extremely expensive one can assume that it was mostly used sparingly. True purple was also detected in two other pieces with tiny decorative elements in the collection of Katoen Natie (De Moor, Verhecken-Lammens and Verhecken 2009, 166-167: inv. KTN 1475, 14C-dating: 420-550 AD (95.4 % probability) and 194-195, inv. KTN 620/DM139, 14C-dating: 660-780 AD (95.4 % probability)). Small sized decorations are often – in addition to the visual colour – an indication for the use of this precious dyestuff.

Acknowledgements

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Abbreviations

BM	London, British Museum
GLM	Hamm, Gustav-Lübcke-Museum
KMKG	Brussels, Koninklijke musea voor kunst en geschiedenis
KTN	Antwerp, Katoen Natie
MAK	Vienna, Museum für Angewandte Kunst
ML	Paris, Musée du Louvre
SBM	Berlin, Skulpturensammlung und Museum für Byzantinische Kunst
V&A	London, Victoria and Albert Museum
WAG	Manchester, The Whitworth Art Gallery

(1) For an image see: http://www.sammlungen.mak.at/sdb/do/start.state, link: Spätantike Textilien, no 195.
(2) For an image see: http://www.sammlungen.mak.at/sdb/do/start.state, link: Spätantike Textilien, no 196.

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Bibliography

Aitchison, T., Ottaway, B. and Scott, E. (1990) Statistical treatment of groups of related radiocarbon ages. In W. Mook and H. Waterbolk (eds.), *Proceedings of the second international symposium 14C and Archaeology*. *PACT* 29, 125-140.

Bronk Ramsey, C. (1995) Radiocarbon calibration and analysis of stratigraphy: the OxCal program. *Radiocarbon* 37.2, 425-430.

Cat. Berlin (2000) Fluck, C., Linscheid, P. and Merz, S., *Textilien aus Ägypten, Teil 1. (Spätantike – Frühes Christentum – Byzanz. Kunst im Ersten Jahrtausend. Reihe A: Grundlagen und Monumente, 1. Staatliche Museen zu Berlin – Preußischer Kulturbesitz. Skulpturensammlung und Museum für Byzantinische Kunst, 1.)*. Wiesbaden.

Cat. Brussels (1988) Lafontaine-Dosogne, J. and De Jonghe, D., *Textiles Coptes*. Musées Royaux d'Art et d'Histoire. Brussels.

Cat. Hamm (1996) *Ägypten – Schätze aus dem Wüstensand. Kunst und Kultur der Christen am Nil (Ausstellungskatalog Hamm 1996, Mainz 1996-1997, München 1997, Schallaburg 1998)*. Wiesbaden.

Cat. Vienna (2005) Noever, P. (ed.), *Verletzliche Beute. Spätantike und frühislamische Textilien aus Ägypten/ Egyptian Textiles of Late Antiquity and early Islam*. Vienna.

Cat. Zottegem (1993) De Moor, A. (ed.), *Koptisch Textiel. – Coptic Textiles* (Publicaties van het provinciaal archeologisch museum van Zuid-Oost-Vlaanderen, Site Velzeke, Buitengewone Reeks Nr. 1). Zottegem.

Cortopassi, R. (2008) Vêtements "Romains" au Louvre. In C. Alfaro and L. Karali(eds.), *Purpureae Vestes II. Symposium Internacional sobre textiles y tintes del Mediterráneo en el mundo antiguo*, 149-158. Valencia.

De Moor, A., Van Strydonck, M. and Verhecken-Lammens, C. (2004) Radiocarbon dating of a particular type of Coptic woollen tunics. In M. Immerzeel and J. Van der Vliet (eds.), *Coptic studies on the threshold of a new millennium II. Proceedings of the seventh international congress of Coptic studies* (Orientalia Lovaniensia Analecta 133), 1425-1442. Louvain.

De Moor, A., Verhecken-Lammens, C. and Verhecken, A. (2009) *3500 years of textile art. The collection ART in headquarters*. Tielt.

Errera, I. (1916) *Collection d'anciennes étoffes egyptiennes*. Brussels.

Forbes, R. J. (1956) *Studies in Ancient Technology*, vol. IV. Leiden.

Hofenk de Graaff, J. H. (2004) The colourful past. Origins, chemistry and identification of natural dyestuffs, Archetype publications Ltd., London.

Kendrick, A. F. (1920) *Catalogue of textiles from burying grounds in Egypt*, vol. 1. London.

Koren, Z. C. (2008) A New HPLC-PDA Method for the Analysis of Tyrian Purple Component. *Dyes in History and Archaeology* 21, 26-35.

Pausch, M. (2003) *Die römische Tunika. Ein Beitrag zur Peregrinisierung der antiken Kleidung*. Augsburg.

Pritchard, F. (2006) *Clothing Culture: Dress in Egypt in the first millennium AD. Clothing from Egypt in the collection of The Whitworth Art Gallery, The University of Manchester*. Manchester.

Stuiver, M., Reimer, P., Bard, E., Beck, J., Burr, G., Hughen, K., Kromer, B., McCormac, G., van der Plicht, J., and Spurk, M. (1998) INTCAL 98. Radiocarbon age calibration, 24000-0 cal BP. *Radiocarbon* 40.3, 1041-1083.

Van Strydonck, M., Nelson, D. E., Crombé, P., Bronk Ramsey, C., Scott, E. M., van der Plicht, J. and Hedges, R. E. M. (1999) What's in a 14C date. In J. Evin, C. Oberlin, J.-P. Daugas and J.-F. Salles (eds.), *3rd International Symposium 14C and Archaeology* (Mémoires de la Société Préhistorique Française 26). *Supplément de la Revue d'Archéométrie*, 433-448.

Van Strydonck, M. (2007) How accurate are 14C dispersion diagrams in estimating a cultural period in the 1st millennium AD? In A. De Moor and C. Fluck (eds.), *Methods of dating ancient textiles of the 1st millennium AD from Egypt and neighbouring countries. Proceedings of the 4th meeting of the study group "Textiles* *from the Nile Valley", Antwerp, 16-17 April 2005*, 112-114. Tielt.

Van Strydonck, M., Vanden Berghe, I., Boudin, M. and Quintelier, K. (forthcoming 2011) Euphemia: a multidisciplinary quest for the origin and authenticity of a mummy's clothes and accessories. In A. De Moor and C. Fluck (eds.), *Dress accessories of the 1st millennium AD from Egypt. Proceedings of the 6th conference of the international research group "Textiles from the Nile Valley", Antwerp, 2-4 October 2009*.

Walker, S. and Bierbrier, M. (1997) *Ancient faces. Mummy portraits from Roman Egypt*. London.

Wouters, J. (1985) High performance liquid chromatography of anthraquinones analysis of plant and insect extracts and dyed textiles. *Studies in Conservation* 30, 119-128.

Wouters, J. (1992) A new method for dye analysis of blue and purple dyed textiles. In *Dyes in History and Archaeology* 10, 17-21.

Wouters, J. (1993) Kleurstofanalyse van Koptisch textiel. In *Cat. Zottegem*, 53-64.

Wouters, J., Vanden Berghe, I., Richard, G., Breniaux, R., Cardon, D. (2008) Dye analysis of selected textiles from three Roman sites in the eastern desert of Egypt: a hypothesis on the dyeing technology in Roman and Coptic Egypt. *Dyes in History and Archaeology* 21, 1-16.

Wouters, J. (2009) Red and purple dyes in Roman and 'Coptic' Egypt. In A. De Moor and C. Fluck (eds.), *Clothing the house. Furnishing textiles of the 1st millennium AD from Egypt and neighbouring countries. Proceedings of the 5th conference of the research group 'Textiles from the Nile Valley', Antwerp, 6-7 October 2007*, 182-185.

Julia Galliker

Research in Progress: Application of Digital Image Processing to Analysis of AD 7th-12th Century Eastern Mediterranean Silk Textiles

Overview
While comparing images of historic silks with technical data, I have often wondered how recent technological improvements might contribute to textile analysis. What other factors can be defined and objectively measured, in addition to well-established criteria such as material type, thread count, twist direction and weave structure?
Through my doctoral research, I have been exploring how computer-based digital image processing methods can provide a supplementary source of data for technical textile analysis. Image processing, also known as computer vision, is used in modern textile manufacturing for error detection and quality control. Research describing applications of image processing methods to textile production include studies by Zhang and Bresee (1995), Cybulska (1999), Behera (2004), Behera and Mishra (2006) and Drobina and Machnio (2006).
Computer-based image processing can support textile research in two complementary ways: improved pictorial information for human interpretation and automated, machine-based data processing (Gonzalez and Woods, 2008). Several researchers have applied image analysis methods to archaeological textiles including El-Homossani (1988), Cork, Cooke and Wild (1996), Bischoff and Murray (2005) and Scharff (2007). In recent years, significant imaging technology improvements in fields such as medicine and material science have enlarged the set of techniques available for application to historic textiles.
The main advantages of using image processing as a tool for documenting historic textiles are speed and non-invasive data collection. Manual documentation of fine or complex textiles can be slow and tedious. Similarly, detecting the incidence and type of faults through visual inspection over a large area can be difficult. To aid in this process, algorithms can be written to extract diffuse physical and production details from surviving textiles. In addition, measurements of important characteristics such as yarn diameter and weave density are highly variable and rely upon statistical sampling to obtain meaningful measurements. When correctly defined and validated, automated image processing can produce results that are specific, objective and reproducible.
Designing a research programme that does not involve direct intervention with textiles in institutional collections is a practical way to work within the contemporary research environment. Staffing limitations and conservation policies, while essential to protect fragile textiles, make collections access challenging, especially for the extended period of time necessary to thoroughly analyse technical attributes. Most institutions have visitation policies that limit handling and the use of probes. Alternatively, image capture can occur *in situ* according to a defined research protocol. Such an approach is appropriate for a research programme intended to compare textiles held by a number of different institutions.
From a research point of view, digital image processing should be regarded as an additional source of data, complementary to the information gained from first-hand textile artefact studies. Detailed,

piece-specific analyses prepared by experts with extensive access to historic textiles remain an essential resource to textile studies. For instance, the limitation of not being able to photograph the reverse side of a textile because of mounting conditions or fragility must be considered in designing a research plan.

Technical Analysis of Professional Silk Workshop Products

By applying image processing methods to analysis of surviving silks attributed to the Eastern Mediterranean region between 7th-12th centuries AD, my research goal is to obtain a more specific and detailed understanding of professional silk workshop production practices. During this time interval, sophisticated figured silk textiles were woven on drawlooms at various production centres. Drawlooms represented a work-saving application of technology to the problem of pattern replication. By separating the warp threads by function into binding and figure groups, patterns could be repeated by following prescribed sequences. Fortunately, a reasonably large population of drawloom woven silks attributed to Byzantine and Eastern Mediterranean workshops survive in various collections. Many fragments have been extensively studied from an art historical perspective with attention devoted to the interpretation of motifs and patterns depicted on the textiles. Scholars contributing research from this perspective include Grabar (1956), Beckwith (1974), Starensier (1982) and Muthesius (1995, 1997 and 2004).

No archaeological evidence survives to provide evidence about how, when and where these textiles were produced. Most silk textiles in institutional collections come from elite burials or were obtained through excavations with limited contextual evidence. In contrast to art historical-based research, my research focuses on textiles from a production point

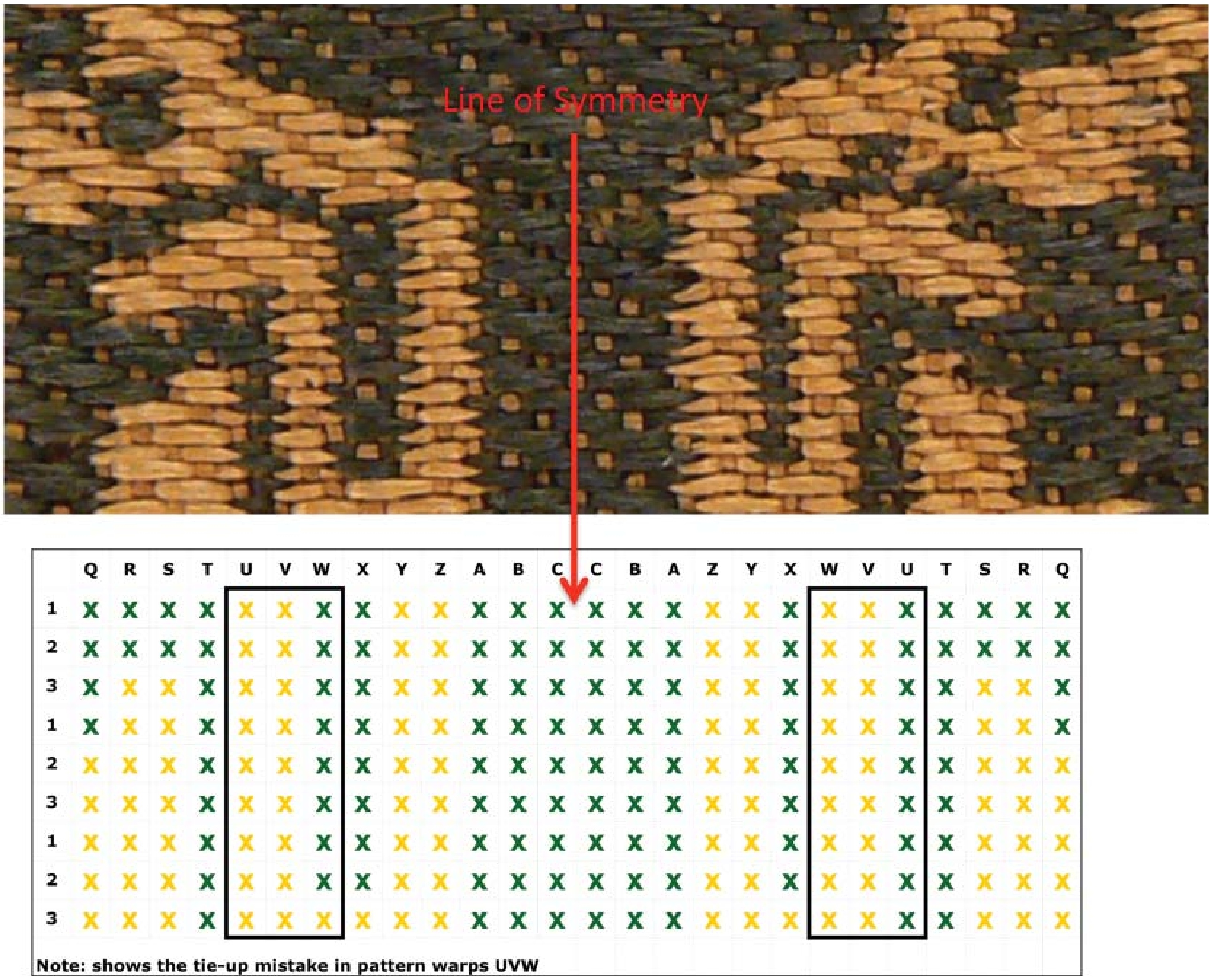

Fig. 1. Error diagram - incorrect pattern warp tie-up.

of view, resulting from a series of decisions involving materials, design and technology. My specific objectives are: to distinguish the characteristics of textiles woven in professional workshops, document the organisation and decisions involved in the production process, and use this information to discern patterns of practice for workshop attribution.

During the past five decades, institutions such as CIETA (Centre International d'Étude des Textiles Anciens) and the Abegg-Stiftung have published extensive technical analyses documenting weft-faced compound weave figured silks attributed to the Eastern Mediterranean and Central Asian regions. Many textiles have also been published in a number of museum catalogues, for example, the Musée national du Moyen Âge and the Musée historique des tissues. These mainly piece-specific analyses prepared according to the CIETA method of textile analysis provide an essential basis for technical textile research.

Complementary to the CIETA approach (CIETA, 1979, 1987), computer image processing combined with the cross-sectional analytical capabilities of a relational database provide a means to capture and analyse low level details using established statistical methods. In effect, the proposed methodology is a sort of "industrial inspection" for historic textile analysis. The idea is to apply relevant tools from textile material science to characterise various textile attributes. To date, I have defined twenty technical "tests" grouped into the following categories:

- **Material characterisation** evaluates the qualities of the fibre and yarn as the products of industrial processes in their own right. I am looking at three different attributes: yarn diameter, helix angle and if possible, fibre diameter. The basic idea is that professional workshops used professionally prepared inputs with less variation than would be found in home or cottage settings.
- **Textile characteristics** refer to the function and qualities of historic silks as cloth. This set of characteristics applies relevant concepts from material science such as fabric weight, density, performance and appropriate use assessment.
- **Design analysis** looks at the particular methods used to accomplish a given pattern. This concept is complementary to an art historical, motif-based approach by focusing on how a design was rendered from a technical weaving perspective.
- **Quality** as applied to weft-faced compound weave textiles is measurable in terms of mistakes. There are various types of faults in weaving including design, material, loom preparation (Fig. 1) and execution errors (Fig. 2). These have been noted in the literature, but not systematically measured and subjected to statistical analysis.
- **Management characteristics** refer to production planning evidence found in textile remains. Examples include pattern design for production
- efficiency and alternate weft sequencing to save work. As above, these attributes have been noted in the literature, but not statistically measured among a large set of textiles.

Collectively, these data also provide evidence for loom characteristics including: binding and pattern harness capacity, loom physical dimensions, reed/warp spacing, beater characteristics, tensioning devices for binding and pattern warps, and physical relationships. In all likelihood, we will never know how the looms looked, but there is greater scope to evaluate how they functioned through technical analysis.

In order to develop my specifications, I needed to obtain a large population of textile images. I had the good fortune to be able to spend a week at Dumbarton Oaks in Washington, D.C. photographing the portion of the collection relevant to my research (Fig. 3). This collection has never been published, so seeing the textiles first-hand was a treat. At this stage, the collection was ideal for my purposes; it is extensive enough to represent a solid cross-section of relevant textiles in various survival states without being overwhelming. I was able to obtain about 80 gigabytes of digital images taken at different macro and microscopic scales (Figs. 4-5).

The experience was also extremely valuable in helping me to define a formal protocol for photographing textiles *in situ*. Unexpectedly, my most significant problem relates to reflection and glare from the textile fibres rather than glass or mounting materials. When photographing collections in the future, I will use a polarising filter to diminish the light distortions that affect my measurements.

During the summer of 2010, I worked with a Master's level computer engineering student at the University of Birmingham to develop the technical basis for my project. In a convergence of learning opportunities, my software development served as my colleague's M.S. research project. We have made significant foundation progress, but several technical challenges remain. Although image analysis is widely used in modern industrial textile production, historic textiles have some different characteristics that make automated detection more difficult, including variables such as: fragmentary conditions, deterioration, lighting and mounting differences. Since my colleague has now graduated, I am looking for another student to complete the digital image characterisation

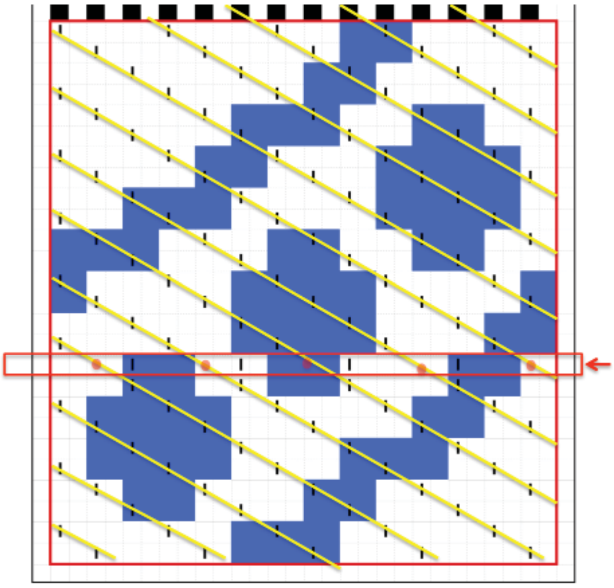

Fig. 2. Error diagram - incorrect binding shed sequence.

Fig. 3. Microscope set-up at Dumbarton Oaks storage and study room. © Julia Galliker.

Fig. 4. Macro scale image of Dumbarton Oaks BZ.1953.2.126 - Large roundel with candelabra tree. © Julia Galliker.

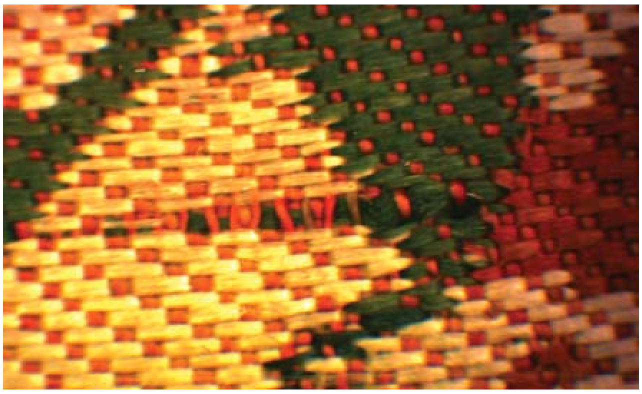

Fig. 5. Micro scale image (0.7x magnification) of Dumbarton Oaks BZ.1934.1 - Sampson and Lion. © Julia Galliker.

software application.
My next steps include software testing and preliminary analysis of results. If all goes according to plan, I hope to proceed with larger scale data collection during the summer of 2011. I am interested in hearing from others working on similar or complementary approaches.

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Bibliography

Beckwith, J. G. (1974) Byzantine Tissues. In Stănescu, M. B. A. E. (ed.) *Actes due XIVe Congrès international des études byzantines (6-12 September, 1971).* 344-353. Bucarest.

Behera, B. K. (2004) *Image-processing in Textiles: A Critical Appreciation of Recent Developments.* Manchester, UK.

Behera, B. K. and Mishra, R. (2006) Objective Measurement of Fabric Appearance using Digital Image Processing. *Journal of the Textile Institute* 97, 147-153.

Bischoff, J. J. and Murray, A. (2005) Digital Microscopy and Application of Digital Image Analysis for the Study of Textile Fibres. In Janaway, R. & Wyeth, P. (eds.) *Scientific Analysis of Ancient and Historical Textiles: AHRC Research Centre for Textile Conservation and Textile Studies. First Annual Conference 13-15 July 2004.* 95-101. London.

CIETA (1979) *Tracés Techniques.* Lyon.

CIETA (1987) *Notes on Hand-Weaving Techniques in Plain and Figured Textiles (English).* Lyon.

Cork, C. R., Cooke, W. D. and Wild, J. P. (1996) The Use of Image Analysis to Determine Yarn Twist Level in Archaeological Textiles. *Archaeometry* 38, 337-345.

Cybulska, M. (1999) Assessing Yarn Structure with Image Analysis Methods. *Textile Research Journal* 69, 369-373.

Desrosiers, S. (2004) *Soieries at autres textiles de l'Antiquité [Catalogue du Musée National du Moyen Age - Thermes de Cluny].* Paris.

Drobina, R. and Machnio, M. S. (2006) Application of the Image Analysis Technique for Textile Identification. *Autex Research Journal* 6, 40-48.

El-Homossani, M. M. (1988) Creating a Protocol for Reconstructing Weaving Technologies: Early Compound Non-Silk Fabrics Found in Egypt. In Vollmer, J. E. (ed.) *1988 Proceedings: Textiles as Primary Sources,* 26-39. Washington, D.C.

Gonzalez, R. C. and Woods, R. E. (2008) *Digital Image Processing.* Upper Saddle River, N.J.

Grabar, A. (1956) La soie byzantine de l'évêque Gunther à la Cathédrale de Bamberg. *Münchner Jahrbuch der bildenden Kunst* 3, 7-26.

Martiniani-Reber, M. (1986) *Lyon, musée historique des tissus: Soieries sassanides, coptes et byzantines: Ve-XIe siècles* Paris.

Muthesius, A. (1995) *Studies in Byzantine and Islamic Silk Weaving.* London.

Muthesius, A. (1997) *Byzantine Silk Weaving AD 400 to AD 1200.* Vienna.

Muthesius, A. (2004) *Studies in Silk in Byzantium.* London.

Russ, J. C. (2007) *The Image Processing Handbook.* Boca Raton, FL.

Scharff, A. B. (2007) Use of a Digital Camera for Documentation of Textiles. In C. Gillis and M.-L. Nosch (eds.), *Ancient Textiles: Production, Craft and Society: Proceedings of the First International Conference on Ancient Textiles, held at Lund, Sweden, and Copenhagen, Denmark, on March 19-23, 2003,* 254-257. Oxford.

Starensier, A. L. B. (1982) *An Art Historical Study of the Byzantine Silk Industry.* Ph.D. dissertation, Columbia University.

Zhang, Y. F. and Bresee, R. R. (1995) Fabric Defect Detection and Classification Using Image Analysis. *Textile Research Journal* 65, 1-9.

Queries

Nancy Spies has these questions to the ATN readers:
Anna Contadini, in her book, “Fatimid Art at the Victoria and Albert Museum” (p. 49), says that “On receiving the threads, the weaver had first to use a pumice stone to clear off their blackish crust ...”. The footnote takes me to S.D. Goitein's “Mediterranean Society” (vol. IV, p. 408, note 205) which, in turn refers me to the 11th-century “Ma'alim al-Qurba” by Ibn al-Ukhuwwa of Egypt. In this, I read, in Chapter XXX, that “... the thread [must be] of good quality and freed of black crust by means of rough black stone.” There is, however, no further mention of this black crust in either al-Ukhuwwa, Goitein, or Contadini. What is this black crust? What was the process that caused the black crust to form on the linen thread? Is there any primary documentation, other than al-Ukhuwwa?
Al-Shayzari, in his “Book of the Islamic Market Inspector” written in 12th-century Cairo, says that cotton carders “... must not mix new cotton with old nor red cotton with white.” Was this red cotton a naturally-occuring cotton color? If not, did the Egyptians dye the cotton before spinning it? By “red”, could al-Shayzari possibly mean some form of brown or orange?
We know from Maureen Fennell Mazzaoui, “Italian Cotton Industry in the later Middle Ages, 1100-1600.”, that “cotton from certain regions of Anatolia was red in color, a condition caused by excessive humidity or insect damage.” (p. 173, footnote 69). Did the same occur in Egypt or did Egypt perhaps import this red cotton?

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Nancy Ukai Russell

Wrapping and Unwrapping the Body: Archaeological and Anthropological Perspectives

20-21 May 2010, Institute of Archaeology, University College London, UK

A conference at University College London on "Wrapping and Unwrapping the Body", organized by Susanna Harris (Institute of Archaeology, UCL) and Laurence Douny (Department of Anthropology, UCL), brought 14 archaeologists and anthropologists together to explore processes of wrapping the body, different types of wrapping materials and the meaning of wrapping practices across time and space. Subjects ranged from the wrapping of ancient Egyptian mummies, presented by John H. Taylor of the British Museum, to description of the cloth-wrapped carts and other burial objects at the Eberdingen-Hochdorf princely Celtic burial site in Germany, by Johanna Banck-Burgess of Regierungsprasidium Stuttgart.

For archaeologists, a discussion of wrappings and the body tends to focus on excavation findings, wrapped corpses and the technical analysis of fibers. The inclusion of anthropologists in the conference created opportunities for cross-disciplinary discussions on the act of wrapping as a transformational process, the meaning and usage of different materials, and the place of cloth as a covering that protects, conceals, transports and heralds new beginnings.

The presentations were divided into three sessions: "Wrapping as Transformation," "Wrapping the Dead," and "Wrapping the Living." Of particular interest to ATN readers would be the papers on archaeological textiles. Taylor discussed how the wrapping of the corpse in ancient Egypt was a crucial element of the formal disposal of the body, providing the "cocoon" in which the renewal of life-force took place. This temporary state was marked by inertia and restraint before the transition to new life after death.

Banck-Burgess showed intriguing artist's renditions of the interior of the princely grave at Eberdingen-Hochdorf (late Hallstatt - early La Tène period) in which archaeologists found that all of the objects buried with the deceased prince were wrapped in textiles, "hiding" the optical value of the objects. Barbara Wills, a senior conservator of the British Museum, discussed the fragility of linen bandages and woolen shrouds of ancient mummies from Egypt and the Sudan, and the process of using fine netting, in one case, to stabilise the mummy wrappings, while Vicky Gashe of University of Manchester highlighted the noteworthy variation of materials used for corpse wrappings between the locations of nearly 1,500 predynastic-Old Kingdom period graves in the Badari region of Upper Egypt. Matting, reeds and linen were the most common wrapping materials. Beyond textiles, wrappings made of plant materials and animal skins were also discussed, providing stimulating ways to think about cloth in a wider context. Santiago Riera of University of Barcelona painted a sensory portrait of how plants were used as dyes, fragrances, resins and flower offerings in preparing corpses for burial, in conjunction with animal skin and plant material wrappings, according to findings dating from the Late Bronze Age in the Balearic Islands. Harris expanded the landscape for thinking about animal skins as a human covering in her lucid examination of examples from 14th century BC across Europe.

Conceptual approaches to wrapping the body, space and landscapes were raised in other presentations: talismanic Islamic motifs on woolen weavings from Niger Bend, Mali (Claude Ardouin); the process of producing raw silk "tun-tun" indigo textiles in Mali and Burkina Faso, which are then made into objects of prestige worn as signs of identity (Laurence Douny); flags and costly textiles as signs of political and diplomatic power in 19th century West Africa (Fiona Sheales); and the "wrapping" of the spatial environment on Easter Island (Karina Croucher).

The problem of textiles and how human bodies are wrapped was also discussed from the perspective of art history, fashion and conservation: an art historical tour of cloth in paintings and prints (Liz Rideal); lace production and the body (Nicolette Makovicky); and the conservation process of an English court mantua at the V&A (Titika Malkogeorgou). How babies are wrapped at the beginning of life (Nancy Ukai Russell) brought full circle the discussion of textiles used to wrap the human body, which had begun with an examination of the wrappings of the dead.

The conference organizers intend to publish an edited volume of selected papers from this conference and the "Wrapping Objects" session organized in December 2009 (see review in *ATN* 50).

Margarita Gleba and Susanna Harris

European Archaeologists Association: Threads to the Past

1-5 September 2010, The Hague, The Netherlands

The aim of the interdisciplinary session "Threads to the past: novel methods for investigation of archaeological textiles and other organic materials", organised by Margarita Gleba and Susanna Harris (Institute of Archaeology, University College London, UK) was to discuss new methods that can be applied to the investigation of archaeological textiles and demonstrate their potential for the investigation of ancient economy, technology and agriculture. The papers demonstrated how scientific methods that have been or are being developed within archaeology (such as ancient DNA studies, isotopic tracing, laboratory excavation, experimental archaeology) can be incorporated into this field.

Susanna Harris in her paper "Investigating the material properties of archaeological textiles" demonstrated quantitative and qualitative methods used in textile engineering and industrial textile design to investigate the material properties of archaeological textiles through examples from the Neolithic to Bronze Age textiles in Western Europe.

Eva Andersson Strand presented experimental tests and discussed the limitations and possibilities of a new method of textile tool data analysis in her paper

"Loom weights and weaving, textiles and production in the ancient Mediterranean". These results can help us to visualise textiles in situations where none have been preserved and furthermore allow a discussion of textile production, its complexity and impact on society.

Margarita Gleba and Tom Gilbert discussing "Textiles, wool, DNA and sheep domestication", gave an overview of the possibilities of DNA analysis for the studies of sheep domestication and presented the results of a pilot project which aims at developing the methodology for wool textile use in ancient DNA sequencing by analysing modern sheep wool of different types (variation in pigmentation, fibre size, presence of dyes *etc*.), which subsequently can be applied to the archaeological material.

In her paper "Weaving invisible' - looking for earliest traces of plant fibre use and weaving through phytoliths analysis", Liliana Janik suggested an innovative science based approach of using the phytolith extraction and sample analysis for identifying potential presence of plant material.

Karin Margarita Frei presented the method based on the strontium isotopic system, which has been developed in order to address questions regarding the provenance of ancient textiles. Presently, this method is being applied to Danish Iron Age garments, which represent one of the best preserved textile collections from European prehistory.

Bodil Holst and Christian Bergfjord in their paper "Identifying archaeological textile fibres using modern analysis techniques" presented a novel method for identifying nettle fibres based on polarisation microscopy using x-ray microdiffraction. The method relies on measuring very slight species-dependent differences in the cell wall structure and can be applied both to animal and plant fibres. It often works well even on damaged fibres with degraded surface features which may obscure the results of light and electron microscopy.

Finally, Tereza Štolcová's presentation "Latest results of the laboratory research of in situ blocks with organic materials from the Early Migration Period chieftain's grave in Poprad-Matejovce, Slovakia" demonstrated that successful laboratory and experimental methods are highly dependent on good excavation and documentation practice.

These papers demonstrate not only that the field holds great potential in elucidating many aspects of past cultures, such as economy, technology, trade, fashion and religion, but also that at the moment there is a developing energy and expertise in this research. Such advances are only possible by building on the solid foundation of several decades of high quality, dedicated scholarship that have developed standard recording, identification and classification practices.

The session was standing room only and attracted EAA attendees from a variety of fields, who provided pertinent and searching questions following each paper. Some of the exchanges became quite heated, as scholars debated to clarify their methods, results and positions. The atmosphere of the session is best summarised by the comments of a session attendee who said they "felt genuinely excited" at several points in the session due to the accumulation of new ideas, new data and debate.

Britt Nowak-Böck and Timm Weski

European Archaeologists Association: Golden Glittering Garments. Investigation – Systematic Study – Experimental Reconstruction – Handling

1-5 September 2010, The Hague, The Netherlands

The 16th meeting of the European Association of Archaeologists (EAA) in The Hague, The Netherlands from 1-5 September 2010 offered the opportunity to organise a session about "Golden Glittering Garments: Investigation – Systematic Study – Experimental Reconstruction – Handling". In this session garments which were decorated with golden metal threads, mainly from the Hellenistic, Roman and Early Medieval periods were presented. The debate centred on different themes: How were the gold threads produced and applied to the cloth? Which parts of the garments were decorated? Are there chronological or spatial differences? Which gold textiles were gifts or imports for example from the Mediterranean area and which ones were produced locally? Are there uniform rules how to document and catalogue gold threads? Are there new methods to analyse gold threads? How can the gold decoration be reconstructed experimentally? How to handle these textiles from the excavation to their display or long-term storage? In particular how to keep the original arrangement of the gold threads as found in the grave and how to handle the decomposed organic components of the garments? The session was not only aiming at archaeologists, but also at restorers, experimental archaeologists or natural scientists.

Britt Nowak-Böck (Germany) set the theme in the first paper and asked questions concerning handling, preservation, investigation and publication of gold textiles in general. Several aspects of technological analyses of gold threads were mentioned including first experiments with the technology of 3D tomography. The main focus was on the identification of patterns of gold bands and first results of precise reconstructions of Bavarian braids were discussed.

Ina Meißner (Germany) presented the results of her diploma thesis (Technical University Munich). She focused on her investigations on 42 Merovingian gold textiles from Bavaria in Southern Germany, Hessen and from Northern Italy. For comparing the different types of gold threads an accurate and comprehensive documentation was necessary. With the help of a scanning electron microscope, and a confocal microscope as well as a light microscope the production methods and tool marks were analysed and could be compared to modern gold foil stripes. She performed structural examinations to determine whether annealed flexible or tensioned gold foils were converted to threads and whether the treatment of gold foil differs between spun and un-spun gold stripes. The X-ray fluorescence spectroscopy and SEM equipped for energy-dispersive X-ray spectroscopy were used for the determination of the chemical composition of the gold. Inclusions observed in micrographs were analysed in the hope of gaining important information on manufacturing technologies and the origin of the gold. With her paper "Gold thread from Near Eastern rulers to Roman Emperors: evidence and problems" Margarita Gleba (United Kingdom) gave an insight into her study about gold textiles. She presented a wide range of examples from different regions dating mainly to the Hellenistic and Roman period. It is still difficult to localise the production centres of these precious textiles exactly. This was followed by Carina Stiefel's (Germany) summary of her MA thesis (University Freiburg) about Merovingian gold textiles from South and Western Germany. She analysed burial sites, tomb types, dimensions of the grave, gender and age of the deceased and finally classified the grave goods according to the "Qualitätsstufen" by Rainer Christlein. Her results showed that garments decorated with gold threads were not limited to the highest social rank. Further it was not possible to detect any limitations concerning the age and gender for the use of gold textiles. Christoph Eger (Germany) gave an overview of the graves with golden decorated garments (with gold threads, appliqué plates and golden tubes) of the Late Roman and Vandal time from North Africa. Beside the well known two rich Vandal time graves near Carthage there are more references of gold textiles from Late Antiquity from early excavations in Tunisia and Algeria. Obviously, in Vandal times wearing gold decorated garments was often connected to the immigration of foreign people. Most likely the bearers of the clothes originated from South Eastern Europe. Niklot Krohn (Germany) spoke about two important graves of the late Merovingian period, dated about AD 700 from South Western Germany Dürbheim, "Häuslesrain" (Tuttlingen) and Lahr-Burgheim, St. Peter (Ortenaukreis). According to Krohn the gold threads from Dürbheim are the remains of a decoration braid from the cloak of the buried man. In the female grave from Lahr-Burgheim very unusual, square formed applications made of gold threads, most likely originating from a frontlet known as *vitta* were discovered. Though unfortunately some other speakers with interesting papers could not come to the meeting, it was an interesting session with vivid discussions. The main problem for the comprehensive studies about archaeological gold textiles is the insufficient state of publication. Only few graves with gold garments have been published yet. The gold threads are usually just briefly mentioned, the illustrations are mostly not very usefull and the technical descriptions are often confusing which is caused by using nonspecific terms. Furthermore, it appeared that different approaches of analysing this group of objects are necessary in order to gain more reliable results. In conclusion, the opportunities and the limits in the research of gold threads depend essentially on the international and interdisciplinary cooperation of archaeologists, restorers, site technicians, natural scientists and craftspeople. The summaries of the papers of the EAA session "Golden Glittering Garments" together with Ina Meißner´s diploma thesis will be published soon in the "Berichte der Bayerischen Bodendenkmalpflege".

Dissertations

Sanna Lipkin, Oulu University, Finland, has been awarded a PhD for her thesis: *Textile-making in central Tyrrhenian Italy from the final Bronze Age to the Republican Period.*

Karin Margarita Frei, The Saxo Institute, University of Copenhagen, Denmark, has been awarded a PhD for her thesis: *Provenance of Pre-Roman Iron Age textiles - methods development and application.*

Recent publications

The true and exact dresses and fashion: archaeological clothing remains and their social contexts **by Dóra Mérai (Archaeopress 2010, Oxford).**
The author's main aim in this study is to look at how and within what framework the elements of costume from Ottoman period burials in Hungary have been treated by previous research, and to suggest some new directions of interpretation. The information on the ethnic and geographical origins of the population interred in sixteenth- and seventeenth-century cemeteries in Hungary, as provided by historical sources, has determined the questions formulated within previous archaeological scholarship: the analysis of burial customs and finds, mostly remains of clothing, has focused on an ethnic interpretation. This study has two main aims. First, to look for factors other than ethnicity which could contribute to the formation of clothing and of the way it appears in the archaeological record, taking a closer look at the archaeological and various aspects of the social and cultural context of certain objects. Second, to see how historical archaeology can modify our understanding of clothing in the past: the way it was treated by contemporary peoples, and the social and cultural structures that produced it.
ISBN 9781407305554
Price £ 46.00
http://www.archaeopress.com/searchBar.asp?title=Sub+Series&id=52&Sub+SeriesID=52

Dress and cultural identity in the Rhine-Moselle Region of the Roman Empire **by Ursula Rothe (Archaeopress 2009, Oxford).**
While the present inquiry charts new territory in Roman cultural research, there are in fact two academic disciplines that have long recognised the relationship between clothing and identity and have established useful theoretical frameworks in which to examine this relationship: anthropology and sociology. Following the introduction, chapter 2 begins with a discussion of the symbolic meanings of dress as identified by sociologists and anthropologists based on their research in more modern contexts. The next two sections set out the chronological and geographical scope of the study by explaining the time period chosen and the boundaries and histories of the study's three areas. This investigation is primarily focussed on depictions on grave monuments. The reasons for this, as well as a discussion of the nature of the sources and their unique potential to inform us about identity, are the subject of chapter 3. More technical aspects of the use of Roman gravestones are included in Appendix III. In order to be able to gauge the effect integration into the Roman Empire had on the dress behaviour of the Rhine-Moselle population, it is important first to establish what was worn in the region before Roman conquest. This is closely linked to the question of the origins of the garments found in the Roman period. The first part of chapter 4 puts forward a number of new theories regarding pre-Roman dress in the region and the origins of garments. As a result, and also due to a certain amount of confusion in terminology in previous studies, the second part of chapter 4 presents a typology of garments including brief descriptions. Each garment is given a code number to facilitate identification in the catalogue which includes all civilian funerary monuments depicting identifiable clothing from the Rhine-Moselle region. Chapter 5 discusses the results from analysing dress behaviour on the stones in the catalogue which is presented, primarily in graphical form, in Appendix II. The penultimate section of chapter 5 investigates the meaning of headwear in general and the possible significance of the various bonnets that appear to have played such a central role in native dress in the Rhine-Moselle region. The final section looks at the phenomenon of mixing garments of different origin within the same outfit as a solution to the 'problem of what to wear' in a complicated cultural environment. A general summary and comparison of these results is undertaken in the conclusion (chapter 6) in order to link the findings back to the current state of Roman cultural studies and to assess how these findings contribute to our understanding of the social processes at work in the provinces of the Roman Empire.
ISBN 9781407306155
Price £ 41.00
http://www.archaeopress.com/searchBar.asp?QuickSearch=rothe

L'art du tissage au néolithique. IVe-IIIe millénaires avant J-C en Suisse **by Fabienne Médard (CNRS Editions 2010)**
Consacré à l'artisanat textile sur les sites néolithiques du Plateau suisse, cet ouvrage fait suite à une publication dédiée aux activités de filage fondée sur les données issues des mêmes gisements (Médard, 2006, CRA 28). Aboutissement d'un travail de

recherche soutenu par le Fond National Suisse de la Recherche Scientifique (Bern), il permet d'apprécier l'ensemble de la chaîne opératoire de production textile en menant la réflexion à son terme. Les nombreux poids de tisserand, les restes de tissus remarquablement préservés et la connaissance des fibres textiles utilisées forment un ensemble de données suffisamment riche et complet pour dresser le bilan des activités de tissage sur les sites néolithiques littoraux.
L'examen diachronique des poids de tisserand met en évidence une évolution entre le Néolithique moyen et le Néolithique final. Changements morphologiques, allégement et qualité de cuisson attestent de modifications liées à l'apparition de nouveaux besoins, de nouveaux modes de fabrication et à l'exploitation de matières textiles jusqu'alors inusités.
L'analyse des tissus révèle l'existence de deux catégories de vestiges obtenus à l'aide de techniques différentes : les techniques cordée et tissée. La distinction va au-delà des choix de fabrication : les étoffes cordées néolithiques se signalent comme des biens ordinaires destinés à des usages variés ; inversement, les textiles tissés apparaissent comme des biens d'exception achevés une fois détachés du métier. La contrainte technique n'est pas à l'origine de ces différences, car la particularité des réalisations en armure tissée tient essentiellement à la nature des fibres employées. La qualité du matériau résulte incontestablement de choix effectués en fonction de besoins et de projets déterminés à l'avance ; une dichotomie très nette existe entre les tissus confectionnés à partir de fibres de tige et ceux réalisés à partir de fibres d'écorce. Le lin est presque exclusivement réservé aux textiles en armures tissées. Confectionnés à l'aide d'une fibre choisie, ils pouvaient être destinés à des occasions particulières (rassemblements, unions, deuils, fêtes, rites, etc.) à l'échange ou au don (troc, dots, offrandes, etc.).
La valeur matérielle et sociale de ces ouvrages est manifeste, mais les observations effectuées montrent qu'il ne s'agissait pas nécessairement de vêtements ; tout au plus s'agissait-il d'accessoires vestimentaires. Les changements du Néolithique final pourraient en revanche signaler de profonds changements marqués par l'essor du tissage, cette fois peut-être destiné au vêtement.
L'exploitation de l'ensemble de ces données vient compléter et renouveler d'une manière inédite et originale notre connaissance des sociétés néolithiques.
ISBN 978-2-271-06802-6
Price € 38.00
http://www.cnrseditions.fr/ArcheologiePrehistoire/6287-l-art-du-tissage-au-neolithique-tome-30-fabienne-medard.html

Ancient Nets and Fishing Gear: Proceedings of the International Workshop on "Nets and Fishing Gear in Classical Antiquity: A First **Approach", Cádiz, November 15-17, 2007 by T. Bekker-Nielsen and D. Bernal Casasola (eds) (Aarhus University Press 2010)**
ISBN 978 84 9828 302 0
Price € 66.95
http://www.unipress.dk/en-gb/Item.aspx?sku=2432

Prähistorische Textilkunst in Mitteleuropa. Geschichte des Handwerkes und der Kleidung vor den Römern **by Karina Grömer with contributions by Regina Hofmann-de Keijzer & Helga Rösel-Mautendorfer (Naturhistorisches Museum in Wienna 2010)**
Spinnen, Weben, und Nähen – das alles ist uralte überlieferte Handwerkskunst. Textiles Handwerk begleitet den Menschen schon seit der Steinzeit. Bis vor wenigen hundert Jahren nahm es – neben dem Nahrungserwerb – einen großen Teil seiner Arbeitszeit in Anspruch. Das Textilhandwerk, insbesondere die Weberei, hat viel zur allgemeinen Technikentwicklung beigetragen. Webstühle, in der Jungsteinzeit entwickelt, stellen die ersten „Maschinen" der Menschheitsgeschichte dar; sogar die Automatisierung mittels Lochkarten wurde für dei Weberei entwickelt. Mit diesem Handwerk wurden aber nicht nur wesentliche Güter des täglichen Bedarfs – allen voran Kleidung – hergestellt, sondern auch Gebrauchswaren sowie repräsentative Objekte bis hin zu Luxusartikeln. Textilien waren wertvoll, dies drückt sich auch im Recycling von Stoffen aus. In der Urgeschichte wurden ausgediente Kleidungsstücke als Binde-, Verpackungs- und sogar als Verbandsmaterial verwendet. Bereits in der Urgeschichte dienten Kleidung und Schmuck nicht bloß als Schutz vor klimatischen Einflüssen. Textilien sind eben mehr als nur simples Gewand, sie stellen ein wesentliches Merkmal jeder Kultur dar. Damals wie heute ist Kleidung ein wichtiges nonverbales Kommunikationsmittel und sagt viel über ihren Träger, dessen sozialen Status, Alter und Geschlecht sowie Gruppenzugehörigkeiten aus.
ISBN 978-3-902421-50-0
Price € 35 (excl. postage)
verlag@nhm-wien.ac.at

Benguerel S. et al. 2010. ***Gesponnen geflochten gewoben: Archaeologische Textilien zwischen Bodensee und Zuerichsee*****. Frauenfeld: Amt fuer Archaeologie des Kantons Thurgau.**
Die Sonderausstellung «gesponnen, geflochten,

gewoben – Archäologische Textilien zwischen Bodensee und Zürichsee» zeigt schwerpunktmässig die aussergewöhnlich gut erhaltenen Textilien aus den jungsteinzeitlichen Feuchtbodensiedlungen der heutigen Ostschweiz und Süddeutschlands. In den Kantonen Thurgau und Zürich sowie im Archäologischen Landesmuseum Baden-Württemberg in Konstanz lagern über tausend Gewebe und Geflechte aus Bast und Lein aus der Zeit zwischen 4200 und 800 v.Chr. Basthüte, Sandalen, Körbe, Netze, Taschen, vernähte Rindenschachteln, Kleiderfragmente dokumentieren die grosse Vielfalt an textilen Fundstücken, die in den wassergesättigten Schichten der sogenannten Pfahlbausiedlungen die Jahrtausende überlebt haben. Neben den «Fertigprodukten» werden aber auch zahlreiche Funde der Textilherstellung vorgestellt: Erntemesser, Flachsschäben, Hechelkämme, Spindeln, Spinnwirtel sowie Garnknäuel und Fadenspulen belegen verschiedene Abläufe bei der Fadenproduktion.
Zur Sonderausstellung erscheint ein reich bebildeter **Katalog**. Er kann an der Museumskasse für Fr. 20.- erworben werden.

ARACHNE (Occasional Publication for the History of Costume and Textiles in the Aegean and Eastern Mediterranean) *3, 2009*, I. Tzachili / T. Bolonti (eds.).

Annette Paetz gen. Schieck and Michael Tellenbach

Three Years of DressID – Interim Report

Three years of successful and fruitful research collaboration lie behind us. Further two years of inspiring meetings, great collaborations, and fascinating results about "Clothing and Identities – New Perspectives on Textiles in the Roman Empire" are ahead of us. Thanks to the financial support of the European Commission's Culture Programme 2007–2013 (www.DressID.eu), DressID begun on October 1st 2007 and will last until the end of September 2012. Seven research institutions, universities, and museums participate in the programme, providing interdisciplinary approaches and a multinational pool of participants. The project is being coordinated by the Curt-Engelhorn-Stiftung für die Reiss-Engelhorn-Museen in Mannheim. Partners are the Danish National Research Foundation's Centre for Textile Research at the University of Copenhagen, the KIK-IRPA in Brussels, the archaeological and historical institutes of the universities of Sheffield, Valencia and Rethymnon, as well as the Naturhistorisches Museum in Vienna. Starting off with 35 researchers from European countries, the number of colleagues attracted by DressID constantly increases due to its infrastructure, network, and the inspiring platform it provides for this particular field of archaeological research. Today, DressID encompasses more than 90 researchers from Europe and beyond.
The programme focuses on sociological aspects of Roman antiquity, illustrated by dress as the most important vehicle of human beings to express their identity within society. It is the individual choice of garments, the combination of its elements and accessories, the cut, shape and colour, as well as the quality of cloth that non-verbally transmits information on a person's cultural and social identity, status, profession, ethnicity, and age. Dress and textiles provide great insights into cultural processes of acceptance or rejection or even creativity in transferring foreign impacts into new fashion.
In this respect, the Roman Empire is of great interest. Its growth was based on military conquests followed by the establishment of civil administrations. The extent to which Roman political power and its symbols were accepted or not is not easy to discern.

Roman influence has long been determined by certain markers of identity such as baths or theatres, or tools, as for instance, the grinding bowl, or even foodstuff such as olives, wine and olive oil. Garments as markers of identity are being investigated by DressID and when combining the research results of our colleagues, it becomes evident that those subjected to Roman rule, found highly individual ways of assimilating to certain Roman parameters, accepting some symbolic accessories in certain contexts or rejecting others, or even emphasising traditional elements or inventing new garments and traditions triggered by the foreign impact. On the other hand, foreign influences, types of garments and materials were adopted by the Romans. The most obvious types of garments that illustrate this mutual exchange are the toga and the trousers, being respectively ultimate symbols of Roman citizenship or Barbarian identity.

DressID participants come from various fields of research such as archaeology, papyrology, ancient history, textile research and restoration, chemistry, physics, and many other disciplines, grouped into eleven study groups with two focuses: basic research and contextual research. Multidisciplinary approaches, the combination of methods, the joint discussion and interpretation of the results mark the progressive way of dealing with ancient textiles and lift textile research to a new and higher level.

Three years of DressID mark a great moment especially when looking back at the tremendous output of the participants, their achievements, and the amazing speed of advancement within this field of archaeological research. The project's productivity and records are impressive. Five General Meetings have been held so far, starting off in Valencia with published conference papers (Alfaro Giner, Tellenbach and Ferrero 2009), followed by Copenhagen, Rethymnon, Hallstatt, and Sheffield. Countless meetings and workshops such as the textile production workshop in August 2010 at The Land of Legends, Lejre, Denmark, have been conducted by the study groups. Study Group A (Self and Society) held a conference in Sheffield in May 2009 (Carroll and Rothe 2010); Study Group E held a conference on certain aspects of "Production and Trade" in Hallstatt in June 2009; Study Group D (Dress and Religion) had a conference in Bonn in October 2009; and Study Group B met in November 2010 on the topic "Rome and the Provinces" in Valencia. Furthermore, two international conferences related to the project have been organised by the Danish co-organiser in Copenhagen, May 2008, focusing on "Military and Textiles", and by the British co-organiser in Sheffield, June 2010, on "Dressing the Dead". All of these conference papers have either been published or are currently being prepared for publication. So far, our DressID colleagues have published four monographs, and 130 articles in conference proceedings, scientific journals, and catalogues. Beside the above mentioned conferences and meetings, DressID members have also participated in numerous other conferences bringing the attention to the often overlooked aspects of textiles and costumes in the archaeological record.

While the already started research activities will continue, the project is now entering a new phase: the launching of the DressID exhibition which will be the first to present large numbers of original textiles and garments, reconstructions of costumes and tools, combined and illustrated by sculptures, paintings and reliefs from Roman times. It will confront central Roman material with textiles from the borders of the Empire such as Scandinavian or Syrian textiles, as well as Pre-Roman Hallstatt, Hochdorf and Etruscan textiles. It will demonstrate technical traditions and changes through Roman impact, as well as individual ways of dealing with Roman influence in the various regions of the Empire. The exhibition will open on December 16th, 2011, at the Reiss-Engelhorn-Museum in Mannheim. In June 2012, it will be transferred to the Naturhistorisches Museum in Vienna, and then to the Museum Principe Felipe in Valencia.

We expect the coming two years to be just as challenging and successful as the past three years and we look forward to further great insights into antiquity, and great collaborations among our highly motivated colleagues.

Bibliography

Alfaro Giner, C. Tellenbach, M. and Ferrero, R., eds. (2009) *Textiles y Museología. Aspectos sobre el estudio, Análysis y Exposición de los Textiles antiguos y de los instrumenta textilia. - Clothing and Identities. New Perspectives on Textiles in the Roman Empire, DressID, Actas del I Meeting General Valencia-Ontinyent, 3-5 diciembre de 2007*. Valencia.

Carroll, M. and Rothe, U. (2010) Tagung der Arbeitsgruppe „Self and Society" im Rahmen des EU-ProjektesDressID, veranstaltet von Maureen Carroll und Ursula Rothe am 27. und 28. Februar 2009 am „Department of Archaeology" an der Universität Sheffield. *Mannheimer Geschichtsblätter* 19, 2010, 41 – 146.

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Why leather?

8 September 2011

Institute of Archaeology, UCL, London, UK. The common occurrence of animal skin products, whether leather, furs or rawhide throughout history, prehistory and into the present day attest to their enduring utility and desirability. But why did and do people choose to use these materials? This apparently simple question raises a number of issues.

Animal skins have a range of chemical and physical properties. Processing methods such as rawhide and *cuir bouille* emphasise the stiff and solid properties of skins, while tanning or oil dressing may bring out their soft and supple nature. There is also the distinctive visual appearance of leather and furs. The desirability or otherwise of leather may be attached as much to the qualities of the finished product as to the status of skin acquisition and origins. Skins may be a welcome by-products of animals slaughtered for their meat, or may be the sole reason for breeding and killing animals. Fake fur and imitation leather are known in the past and present. As resources, leather and furs are readily interchangeable with other materials. This leads to a cross over in materials; shoes are known in leather, textiles and basketry versions, body armour may be made with leather, sheet metal or stuffed textiles.

So why leather? The aim of this session is to consider the role of animal skin products by questioning the nature of the material itself and the values attached to it in specific contexts of time and place. We welcome papers addressing these issues through examples from archaeology, history, anthropology and the present day.

This one-day event is organised by the Archaeological Leather Group (ALG) http://www.archleathgrp.org.uk/. Please send abstracts of approximately 250 words to Diana Friendship-Taylor (Meetings Co-Ordinator) at piddington.museum@tiscali.co.uk and Barbara Wills (Chair) at nickandbarbara@ntlworld.com. The deadline for abstracts is 7th January 2011. The papers will be made available in electronic format on the ALG website.

Textile Calendar 2011

25 June 2010-19 June 2011: Exhibition Die Textilsammlung Georg Schweinfurths, Bode-Museum, Museumsinsel Berlin, Germany
http://www.smb.museum/smb/kalender/details.php?lang=en&objID=24881&typeId=10

20-21 January: Sprechende Bilder, Textilwerkstätten und Erinnerungskultur in staufischer Zeit, Anna-Reiss-Saal, Reiss-Engelhorn-Museen D 5, Mannheim, Germany. www.re.fh-koeln.de

4 February-1 May: Exhibition *Gesponnen geflochten gewoben: Archaeologische Textilien zwischen Bodensee und Zuerichsee*, Konstanz, Germany.

8 February-22 May: Exhibition *Basketry: Making Human Nature*, the Sainsbury Centre for Visual Arts and the University of East Anglia, Norwich, UK
http://www.scva.org.uk/exhibitions/press/?exhibition=115

24-30 April: ISEND 2010 - International Symposium & Exhibition on Natural Dyes, La Rochelle, France
http://www.isend2011.com

26-29 April: 11th Nordic TAG, session *Textile and Theory*, Kalmar, Sweden
http://lnu.se/om-lnu/konferenser/nordic-tag-2011-/textile-and-theory

5-7 May: Conference *Basketry and Beyond: Constructing Cultures*, University of East Anglia, Norwich, UK
http://www.uea.ac.uk/art/events-news/events/basketryandbeyond

9-13 May: 11th NESAT, Esslingen, Germany
http://www.nesat.org

16-19 June: 12th International Conference on Oriental carpets (ICOC), Stockholm, Sweden
http://www.icoc-orientalrugs.org/index.shtml

8 September: The Archaeological Leather Group, Why leather?, Institute of Archaeology, UCL, London, UK. http://www.archleathgrp.org.uk/

14-18 September: 17th Annual Meeting of the European Association of Archaeologists, Oslo, Norway
http://www.eaa2011.no

7-9 October: Textiles from the Nile Valley, Antwerp, Belgium
http://www.dressid.eu/calendar/conference-textiles-nile-valley-antwerp

General Information

Guidelines to Authors

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

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

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

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

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

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

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

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

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

Please submit contributions by post to:

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Or by electronic mail to the corresponding editor:

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