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OLD TEXTILES – NEW POSSIBILITIES

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Abstract: Textile research has become an important field of archaeology. Although the established analytical methods are often viewed as specialized, their integration with other interdisciplinary approaches allows us to deal with broader archaeological issues and provides the interpretational base for a much more comprehensive investigation of textiles in ancient times. Analyses of fibres, dyes, archaeobotanical and archaeozoological remains, as well as palaeoenvironmental and geochemical investigations, provide information about available resources, while tool studies, experimental testing, and visual grouping are approaches that explore the technology and techniques. Together, these approaches can provide new knowledge about textile production and consumption and, thereby, about people and society in ancient times.

Keywords: archaeology, dye, experimental archaeology, fibre, isotopes, textiles, textile tools

INTRODUCTION

Textiles express who we are – our gender, age, family affiliation, social status, occupation, religion, and ethnicity. Knowledge of textile history is hence a key to our understanding of a multitude of human issues. After all, what separates us from other species is that we have and make ‘things’, and for the last 10,000 years textiles have been among our most indispensable things. In fact, textiles represent one of the earliest human craft technologies, certainly older than metallurgy, and they have been a fundamental part of subsistence, economy, and exchange. Textiles have an enormous potential in archaeological research, being able to tell about social, chronological, and cultural aspects of past societies, and at the same time giving us a unique opportunity to come very close to the prehistoric individual.

In archaeology, textiles and other perishable materials belong to a rather specialized field. One of the reasons for this is that textile investigation often focuses on fibre identification and the technical description of the object, while qualitative, quantitative, and contextual interpretations of such highly technical analyses only come in a second phase (but see Barber 1991; Bender Jørgensen 1986, 1992; Frangipane et al. 2009; Walton 1989; Walton Rogers 1997, 2007; Wild 1970). As the training of textile researchers working within archaeology is heterogeneous, textile analyses naturally tend to vary in quality and approach. However, an increased dialogue between textile researchers and scholars in other fields has led to a solid integration of the knowledge gained from textile analysis into the overall interpretation of particular excavation sites or broader aspects of human activities. Consequently, discussions of the topic of textiles in general archaeological literature can now include the available resources to their full potential.

In their textbook on archaeology, Colin Renfrew and Paul Bahn state: ‘[w]here textiles are concerned, the most crucial question is how they were made, and of what’ (Renfrew and Bahn 2008:339). Indeed, the integration of established analytical methods and development of new ones allows us to know more about ‘how’ and ‘of what’, but also to know ‘when’, ‘from where’, and ‘why’. Answering these questions leads to more complex and increasingly fine-meshed interpretations of the role textiles played in ancient societies.

A textile is not simply a binary system of spun, twisted, or spliced fibres, but first and foremost a result of complex interactions between resources, technology, and society (Fig. 1). The catalysts for this interaction are the needs, desires, and choices of any society, which in turn influence the exploitation of resources and development of technology. Conversely, the availability of resources and the state of technology condition the choices of individuals and society. The totality of these interactions is expressed during textile production.

Resources for making textiles include plant and animal products used for fibres and dyes, as well as those used in various stages of textile making, such as washing or fulling. In this way, agriculture, animal husbandry, exploitation of environmental resources, and landscape use are closely linked to textile production. Technology of textile production incorporates techniques, which can be gleaned from textile structure, textile tools, and experimental archaeology. Individual and collective

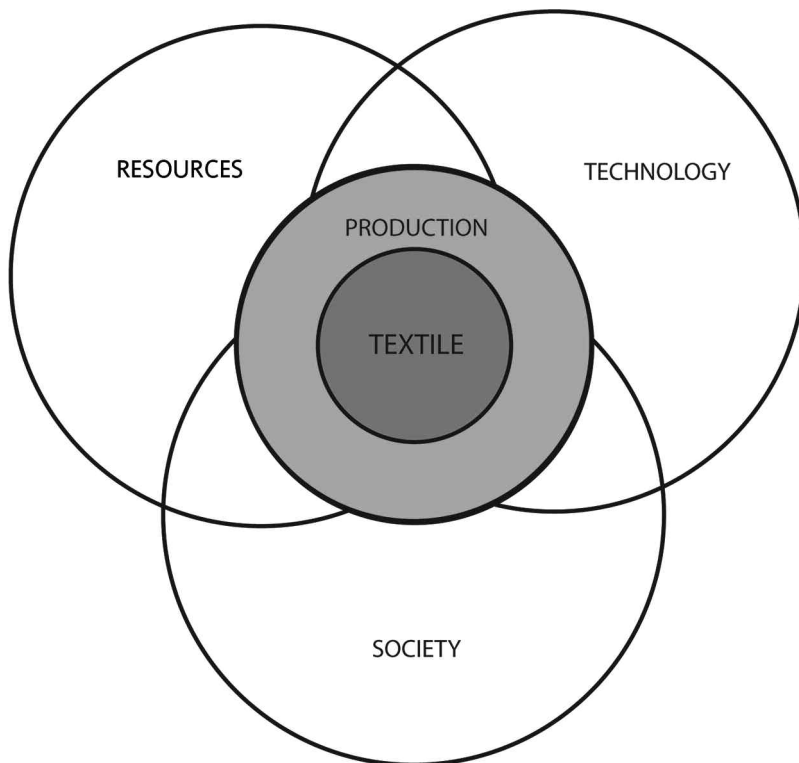


Figure 1. A model of textile and textile production as interaction between resources, technology, and society. Graphic work by Marianne Bloch Hansen.

strategies to meet the needs and desires of society are expressed in the choice of techniques, resource materials, consumption patterns, production scale, exchange of goods and know-how. The appearance of a textile is a result of negotiation of all these choices.

In this article, we outline some of the established and new methods used to investigate archaeological textiles, and suggest new approaches that allow us to deal with broader archaeological issues and provide the interpretational base for a much more comprehensive investigation of textiles in ancient times.

TEXTILES

Archaeological textiles, particularly prehistoric ones, tend to be rare finds as, like any perishable organic material, they are subject to rapid decomposition in archaeological contexts and their preservation requires special conditions to prohibit their destruction by micro-organisms. Preservation conditions affect survival of plant and animal fibre materials in different ways. Dry climates

preserved textiles by desiccation in Egypt (e.g. Schrenk 2004) and Syria (e.g. Schmidt Colinet et al. 2000). Salt has preserved fabrics in Austrian salt mines (e.g. Bichler et al. 2005) and in the Tarim desert in north-west China (e.g. Barber 1999; Wiczorek and Lind 2007). Waterlogged conditions have conserved textiles in the Alpine region (e.g. Bazzanella et al. 2003) and north-west Europe (e.g. Hald 1980; Möller-Wiering 2010; Schlabow 1976; Walton 1989). The contents of the Scythian tombs in Eurasia (Polosmak and Barkova 2005) and the Norse burials in Greenland (Østergård 2004) were frozen, leaving fabrics almost unaltered. Often, textiles are preserved through exposure to fire, which leads to the creation of carbonized samples as in Gordion, Turkey (Ellis 1982), or through mineralization, when they come into contact with metal objects (e.g. Bender Jørgensen 1986, 1992; Möller-Wiering 2010; Walton Rogers 2007).

The scarcity and poor preservation of archaeological textiles are two factors often cited for the absence of focus on textile studies. Although valid to a certain extent, such reasoning has obscured the fact that textiles are much more abundant in archaeological contexts than generally assumed and should, whenever present, be studied in the same way as any other archaeological finds. Containing both organic and inorganic components, textiles represent a find category that is able to provide the kind of information that few other materials can.

BASIC ANALYSES

Although the methods used in textile analysis vary depending on the state of preservation, often requiring a combination of analytical techniques, the basic examination of a textile can be performed by the naked eye in combination with microscopy (Walton and Eastwood 1983). Optical microscopy has been the preferred tool for a long time but it can be supplemented by technologically more advanced methods. Scanning electron microscopy is used in the identification of fibres by comparison with reference standards for the cross-section and longitude of a fibre. Animal fibres, if well preserved, can be recognized by the scales on their surface; the shape, position, and sequence of these scales present on the fibre surface can then be used to identify an animal species (Appleyard 1960). The identification of plant fibres is often more complicated since the distinction between flax, nettle, hemp, and other plant species is difficult, even in the laboratory, particularly when the fibres are degraded (Bergfjord and Holst forthcoming). With the use of a microscope it is also possible to observe the wear and damage to which individual fibres have been subjected, and which can provide information about the use and function of the textile as well as about the duration of its utilization (Wild et al. 1998). Hidden structures, especially relevant in the case of mineralized examples, can be investigated by X-ray and, more recently, computerized tomography of three-dimensional objects – CAT-scanning – has been employed for this purpose (Cybulska et al. 2010; Lynnerup 2007; Peek and Nowak-Böck 2007).

The most important descriptive features of an archaeological textile to be recorded during such analysis are as follows:

- Dimensions (overall and for specific structural elements): these indicate preservation and, in some cases, the use and function of the textile.
- Condition (whether a textile is preserved in an organic, mineralized or carbonized state, and degree of damage/preservation): this determines the amount of information and type of analyses that can be performed, as well as conservation strategies.
- Colour (natural pigmentation and/or presence of dyestuffs): this indicates the contemporary resources and technologies which were available to obtain, apply and combine colour for aesthetic and/or functional purposes.
- Textile structure (weave type, thread count, types of edges): this characterizes the weaving technique and the choices made to produce a specific textile for a specific purpose.
- Yarn structure (spin or twist direction and angle, thickness): this characterizes spinning technique and the choices made to produce a specific yarn.
- Fibre (plant/animal, morphology): this provides information about the local availability of resources or their exchange, the selection and preparation of the raw material, and indicates the properties of this material as well as the possible use.
- Decoration (woven pattern, embroidery, appliqués): this expresses the function and/or meaning of the textile.
- Irregularities and faults: these tell us about the people who produced the textile, their skill or the number of weavers that worked on the piece, but also about the technology, and provide important evidence for determining the warp and the weft and thus the construction technique, and possibly the type of loom used to produce the textile.
- Wear through use (holes, creases) and repair (mends, darns, patches): these indicate the degree and duration of use, reuse, and the value of the textile.
- Construction (tailoring, combination of materials): this indicates the use of the textile in costume, the user's gender/age (male, female, child), and, sometimes, the user's role in society.

All of these features individually are important parameters that, together with contextual data, can be used as social, cultural, economic, geographical, and/or chronological indicators. Thus, synthetic analyses of large numbers of textiles from burials have permitted an overview of textile types in European prehistory, which leads to new insights into the development and spread of technologies (e.g. Bender Jørgensen 1986, 1992). Urban excavations in northern Europe have yielded rich data about textile consumption in Oslo (Kjellberg and Hoffmann 1991), Turku (Kirjavainen 2002), Dublin (Wincott Hockett 2003), and York (Walton 1989). Basic and comprehensive textile analysis of mineralized fabric remains on metal objects in Iron Age weapon deposits has shed light on warriors' clothing (Möller-Wiering 2010). Such synthetic approaches are necessary in order to make the material accessible and useful to non-textiles researchers and to gain a more integrated view of textile technology and production, and thereby of their role, in ancient societies.

SPECIALIZED METHODS AND APPROACHES

Whilst basic analysis constitutes standard operating procedure in textile research, within recent decades textile archaeology (and archaeology in general) has been enriched by many approaches that come from other research fields. Analytical methods within natural sciences have been adopted and used to extract new types of information from archaeological material. Examples include isotopic tracing to determine geographical provenance, radiocarbon dating, High Performance Liquid Chromatography (HPLC) for dye analysis, Scanning Electron Microscopy (SEM) for fibre identification, X-ray spectroscopy for mineralized textiles, DNA analysis for identification of animal species, and X-ray micro-diffraction for fibre identification.

Many of these more specialized methods and approaches are catalysts that can widen a microscopic view of a textile as an object or type of material leading towards a macroscopic vision of its function, meaning, and role in society. The following examples represent some of the areas that we anticipate having an important impact in textile studies in particular and archaeological research in general.

Fibre analysis

One of the important fields of textile archaeology is fibre research. Textile quality and appearance are dependent on the material of which the textile has been made, that is fibre. The main fibres used in antiquity were derived from plants (cellulose based) and animals (protein based). The biological source of fibres may be identified by microscopy on well-preserved textiles. However, very degraded samples require chemical tests, such as solubility measurements, which can distinguish cellulose fibres from protein-based ones, although they will not help to identify a specific species (Lambert 1997:143). The new methods of amino acid composition (Good 1999:87–88) and DNA (Gilbert et al. 2004) analyses are being developed for protein-based fibres. Hemp and flax differentiation of modern fibres is possible under a polarized light microscope through the difference in micro-fibrillar orientation, hemp being z-oriented and flax and nettle being s-oriented. Recent research has also produced a new means of differentiating between flax on the one hand, and hemp and nettle on the other, on the basis of the presence of calcium oxalate cluster crystals in nettle and hemp, but not in flax (Bergfjord and Holst forthcoming). In degraded textiles, alternative methods of differentiation have been further developed. Physicists at the University of Kiel have used synchrotron radiation micro-beam diffraction and micro-fluorescence and successfully identified ramie by this method (Müller et al. 2006).

Fibre investigation, however, is more than just identification of material source. By studying fibre on a microscopic level we can come closer to understanding issues of selective breeding /cultivation, selection, and processing of fibres, and their wear. These issues are essential to the understanding of agriculture, animal husbandry, domestication, and technology.

In archaeology, analyses of wool fibre fineness are used to determine the fleece type of prehistoric sheep, enabling comparisons with fleeces from modern sheep,

particularly the so-called primitive sheep breeds, and leading to conclusions about ancient breeds. Assessment of fibre quality is based on the diameter measurement of 100 fibres and statistical analyses resulting in a distribution diagram. Michael Ryder (1969, 1974, 1983, 1992) established an evolutionary scheme for wool development based on fibre diameter measurements. Wool contains three parts differing in structure and size: kemp, hair, and the wool itself. Early varieties of sheep had coats containing more hair and kemp than wool. Ryder (1969) demonstrated that, over the course of time, selective breeding has produced increasingly finer and more uniform wool. According to Ryder (1983), ancient fine wool should be regarded biologically as generalized medium wool; these generalized medium fleeces, which evolved from more primitive hairy types, appear in the archaeological record around 1500 BC and the modern fine and true medium types evolved from them.

Ryder's model provides an invaluable foundation for fibre studies and demonstrates a strong link between fibre and textile. Biological variations of fibre composition and the transformations that take place between raw wool and finished textile must be taken into account (as also argued by Good 1999; Rast-Eicher 2008). A fleece of a primitive sheep may contain several qualities of wool. The composition of a fleece also varies between different animals of the same breed/variety and further depends on the sex, age, and physical state of the animal. Fibre in a textile, moreover, is a product of numerous processes: breeding, selection, processing, and finishing. Fibre analysis (Christiansen 2004; Rast-Eicher 2008; Østergård 2004:79–92) shows that the situation is even more complex since many different qualities of wool can be differentiated within the defined fleece type. The fleece composition particular to a breed and raw material preparation can therefore be considered the two main factors influencing composition of fibre in yarn. Fibre exploitation has had a great impact on subsistence strategies of past societies, which were transformed when plant fibre was largely replaced by animal fibre, as demonstrated by McCorrison (1997) and Rast-Eicher (2005).

Dye analysis

Although archaeological textiles often survive as brown or colourless rags, it does not always follow that they looked this way when made. Addition of colour has been an integral part of textile making (Cardon 2007). Dye and mordant identification usually requires sophisticated chemical analyses. Absorption spectrophotometry supplemented by chromatography and chemical tests was used to detect dyes in the Roman Iron Age of northern Europe (Bender Jørgensen and Walton 1986; Walton 1988). Another method for natural organic dye analysis is high performance liquid chromatography (HPLC), which has recently given surprising results for textiles from the Pre-Roman Iron Age (Vanden Berghe et al. 2009, 2010). Both techniques allow the identification of the active ingredients but do not always enable determination of the source or the specific hue of the textile, making the analyst's experience very important. Since the sources for dyestuffs are numerous throughout the world, it is important to take into account the archaeobotanical data from the area where the dyed textile has been found.

The identification of active ingredients and their combination is a key to the understanding of dye technology, exchange, aesthetics, value, and meaning. For example, the dye analyses of Early Iron Age textiles from Verucchio in Italy demonstrate that several different dyes were used to add colour to the textiles, showing an understanding of a complex, multiple-stage dyeing process (Vanden Berghe 2002:220). The identification of true purple in some fourth-century BC textiles found at the inland Siberian site of Pazyryk indicates a long-distance trade in textiles coloured with this dye (Polosmak and Barkova 2005), since true purple is derived from marine molluscs and its production is generally associated with the Mediterranean region.

Analysis of large series of samples from the same area can even change the accepted stereotypes about the appearance of people's costumes in the past. Thus, Early Iron Age people of Scandinavia were believed to have worn textiles of natural fibre colours, but the recent tests of over 50 textiles from Danish and Norwegian bogs have shown that the vast majority of them were dyed in bright colours (Mannering and Gleba forthcoming; Vanden Berghe et al. 2009, 2010).

Strontium isotopic tracing

Identifying provenance of archaeological artefacts in absolute terms is often difficult if not impossible. This is especially true of archaeological textiles, which, made with widespread materials and long-lasting techniques, may defy typological classification and lack of visible reference to their origin. Strontium (Sr) isotope ratios have recently been shown to be a unique indicator for wool fibre provenance (Frei et al. 2009). This newly developed methodology can either be used independently or as a control for typological and/or technical analysis.

Strontium isotopic signatures are transmitted from eroding geological materials through soils and the food chain into the human and animal tissues, where Sr substitutes for calcium (Ca). In archaeology, strontium isotope analysis has been widely applied, mainly for the purpose of reconstructing human and animal migration routes in antiquity (e.g. Beard and Johnson 2000; Bentley 2003; Bentley et al. 2002; Grupe et al. 1997; Knudson et al. 2005; Price et al. 1994, 2000, 2002, 2004; Schweissing and Grupe 2003). Since the path of the strontium isotopic ratios through the food chain is unfractionated, it is possible to apply the method also to animals and plants and hence to their products, in this case fibre and consequently textiles (Benson et al. 2006; Frei et al. 2009; Von Carnap-Bornheim et al. 2007). Recent research has demonstrated that the Early Iron Age tubular garment found in a Danish bog at Huldremose (Fig. 2) was created from wool of both local and non-local origin (Frei et al. 2009; Mannering et al. 2010), while the contemporary Gerum mantle from Sweden was made of non-local wool (Frei 2009).

Strontium and oxygen isotope ratios can also be used to determine the provenance of plants, as in the case of species used to manufacture prehistoric basketry and matting from archaeological sites in the western Great Basin of the USA (Benson et al. 2006). The strontium isotope data indicated that the willow and tule used to produce the textiles were harvested from different sources, suggesting the use of both local and non-local raw materials (Benson et al. 2006).



Figure 2. *The tubular garment from Huldremose, Denmark, 350–30 BC. Photo by the National Museum of Denmark.*

The results of isotopic tracing analyses must be compared to the local geological environment and the bio-available strontium composition in order to ascertain if the textile was made of local fibre. Thus this tracing technique relies on the local and regional geological differences of the rock and soil properties. Although it provides a potential method for distinguishing between local and non-local origin, it is more difficult to delineate precisely the exact geographical provenance.

Molecular analysis

DNA analysis is a rapidly developing research field with great potential in archaeology, and new genetic research aims at decoding ancient fibres in archaeological textiles. Genetic data from archaeological specimens provide an important new source of information for addressing questions in prehistory. Mitochondrial DNA (mtDNA) has been widely used to explore origins of domestic sheep, and according to phylogenetic trees constructed by mtDNA,

there are at present four maternal lineages of ancient sheep, indicating at least three geographically independent sheep domestication events. This work, however, has been done primarily on material extracted from sheep bones recovered from archaeological contexts. Techniques and methods are getting more refined, allowing extraction of minute amounts of DNA, such as are present in hair shafts, which can then be replicated. Thus, small mtDNA fragments have been extracted from bison dating back longer than 65,000 years and a horse dating back 2000 years (Gilbert et al. 2004), as well as bighorn sheep dating back 10,000 years (Bonnichsen et al. 2001). Ancient DNA can also shed light on gene function, for example hair colour as evidenced in a study on Neanderthals (Lalueza-Fox et al. 2007).

Hence, in the near future we should be able to use wool textiles to extract and analyse ancient DNA allowing us to approach the questions dealing with ancient sheep breeds and sheep domestication. Technology from modern wool proteomics can further be used to analyse the proteome and changing properties of ancient wools (Plowman et al. 2000). DNA of textile plants is also currently being investigated, in particular with the aim to explore ancient flax genetics to identify the specific markers and properties of fibre flax and oil flax respectively (Allaby et al. 2005).

Radiocarbon analysis

When textiles are sufficiently well preserved, they can be dated in relative terms on stylistic/typological grounds, although usually within very wide chronological brackets. More often, however, textiles are dated by context or association with other archaeological objects. The method of radiocarbon dating was not applied to textiles until recently as it was expensive, required prohibitively large samples, and results were often imprecise. The Accelerator Mass Spectrometry (AMS) method, developed in the last 20 years, requires samples of only 10–20 mg and is proving an important dating tool (Pollard and Bray 2007:248–250). Textiles are especially suitable for ^{14}C dating since they have a short life and may even give more precise dates than other material (van der Plicht et al. 2004:488). Recently, Scandinavian textiles ranging in date from the Bronze Age and Early Iron Age (Mannering et al. 2010) up to post-medieval times (Nockert and Possnert 2002) were dated and re-dated by radiocarbon. The ^{14}C method was also used to date several late antique tunics from Egypt, which had been separated from their context and could not be dated by other means (Pritchard 2006:13–25; Schrenk 2004:476–478). Furthermore, even if the absolute dates are imprecise, they can make it possible to demonstrate the contemporary existence of what were thought previously to be chronologically differentiated styles.

Whilst challenges include the presence of conservation agents and other general problems associated with ^{14}C dating, the future may allow chronological differentiation between different materials from the same context, for example different garments and the body in the same burial. This may lead to new insights into the lifetimes of different objects and their contextual associations.

Visual grouping

Textiles with the same technical data, such as thread count, thread diameter and twist, may look and feel completely different, while textiles with differing technical parameters may have a very similar appearance. Technical information does not take into account the two- and three-dimensional relationship between threads, or surface treatment, such as fulling. Therefore, a textile is more complex than its recorded technical information, and even if it were possible to collect more measurable data than is usually done for archaeological finds, all the factors that create the final textile appearance cannot be quantified or qualified. This demands an alternative way to describe and define textiles – a difficult task, complicated by vagaries of vocabulary, which however permits investigation of regional and chronological trends in textile appearance. Thus, textiles of the Iron Age differ from the medieval ones in their appearance. Scandinavian Roman Iron Age fabrics have a very different look from contemporary Roman products from Egypt, much as Roman *terra sigillata* pottery products from different production centres differ in their appearance.

Because textiles are recognized and experienced through sight and tactile sense, it is useful to describe and group them on the basis of their final visual appearance. Visual grouping can be used as a complement to technical analyses. It builds on a description of how a textile looks and what impression it gives, textiles with a similar description forming a visual group.

The visual description is based on the factors that give a textile its surface texture, and these factors must be identified and described. The description can for instance include a characterization of the yarn evenness, woolliness or hairiness, lustre, thread movement, how clearly the threads are seen, the weave, how regular or irregular the surface looks, perceived thickness and density of the textile, and the degree of felting.

Although visual sorting of bulk finds, such as pottery sherds or lithic artefacts, is often standard procedure for archaeological post-excavation projects, the method has only recently been applied to textiles, since textile finds are often not numerous enough to warrant such an approach. The visual grouping method was developed on the basis of the large number of textile finds from the Roman quarry at Mons Claudianus in Egypt (Hammarlund 2005). The quantity of textile fragments and the short recording season necessitated the division of textiles into distinctive groups based on their appearance. The work was further developed on Nordic medieval textiles (Hammarlund and Vestergård Pedersen 2007; Hammarlund et al. 2008). Since every corpus of material is unique, the method needs to be adapted to the particular data being studied, in order to take into account the specific factors determining visual appearance and impression.

The method enables us to break down and discuss large textile collections from one place, to compare visually grouped textiles geographically and/or chronologically, to examine and explain the technological processes behind different visual groups, and to assess different fabric appearances and impressions in relation to changes in taste. As such, it allows the investigation of textiles on a more cognitive level – how they may have been seen, perceived, and felt – thus providing an insight into prehistoric tastes and preferences.

BEYOND TEXTILES

Textile research also includes the investigation of other types of evidence such as written and iconographic sources but also the remains of animals and plants yielding fibres and dyes, as well as tools used to produce textiles. Textile tool studies in particular have had a great influence on our understanding of textile production and the processes involved. Another methodological impact on textile research comes from the study of craftsmanship and experimental archaeology, often the combination of the two. The results from experiments and tool studies form an important basis for the interpretation of the function of different tools and for the evaluation of which textiles could be produced on any given site.

Archaeobotany and archaeozoology

Plants represent one of the most important and oldest resources in textile production, providing fibre, for example: flax (*Linum usitatissimum*), nettle (*Urtica dioica*), hemp (*Cannabis sativa*), or cotton (*Gossypium* sp.); dyestuffs, for example: woad (*Isatis tinctoria* L.), weld (*Reseda luteola* L.), madder (*Rubia tinctorum* L.), safflower (*Carthamus tinctoria* L.), saffron (*Crocus sativus* L), and bedstraw (*Galium verum* L.); mordants, for example: clubmoss (*Diphasium complanatum*); and washing agents such as soapwort (*Saponaria officinalis*). The plant remains most commonly retrievable archaeologically include seeds and/or pollen. Unfortunately, our understanding of the role of plants in agriculture, economy, and textile production may be biased by the absence of palaeobotanical data analysis from excavations of the archaeological sites where material survives. Furthermore, when the data are present, the focus is usually on cultivated, and in particular edible, species; thus linseeds are often interpreted as a source of nourishment although probably they were used for fibre cultivation as well (Willerding 1973:235). The presence of plants such as bedstraw and elder may indicate exploitation for dyes (Kroll 1982:478, 481). Uneven preservation of plant remains must be kept in mind; the sampling of modern flax fields has demonstrated that poor preservation of flax pollen has led to erroneous conclusions about the absence of flax cultivation in Ireland (Gennard 1985). Even single grains of flax pollen may be sufficient to indicate the cultivation of the crop.

Archaeozoological evidence in the form of sheep bones permits analysis of slaughter patterns, which may indicate whether animals were kept for wool or meat. Predominance in the flock of adult animals, in particular castrated males, generally indicates wool production. For example, in the Mediterranean area, by the Early Iron Age, generalized stock-keeping had been replaced by a more intensive husbandry system, with stocks consisting mostly of sheep and goats, and with a distinct emphasis on wool production (De Grossi Mazzorin 2004:39). Sheep husbandry in various locations began to be specialized: in central Italy, Cerveteri seems to have been a centre for producing wool, while at Populonia sheep were kept to supply the town with meat (Barker and Rasmussen 1998:186). Smaller sites and farms, on the other hand, probably practised a less specialized sheep husbandry producing all the requisite subsistence products of meat, milk, and wool.

The study of bone assemblages, landscape, and transhumance patterns can give valuable information on the development of society's strategies in wool production and identify sites and regions with specialized production.

Another archaeozoological material important for textile and dye studies consists of muricid shells found on Mediterranean sites, where large accumulations of them testify to the production of one of the most celebrated dyes of antiquity, true or Royal or Tyrian purple (Alfaro and Karali 2008; Alfaro et al. 2004; Haubrichs 2005; Reese 2005).

A more integrated study of archaeobotanical and archaeozoological assemblages, as well as geological and palaeoenvironmental data, can help in locating and mapping the areas of exploitation in time and space, thereby advancing our knowledge of not only textile production but also of agriculture, husbandry, and ecology. Such comprehensive and interdisciplinary studies provide new perspectives for the entire field (Karg forthcoming; Kenward and Hall 1995; Walton Rogers 1997).

Tool studies

Textile tools are ubiquitous at archaeological sites and several important textile tool studies form an important contemporary scholarship on the topic (Andersson 2003; Gleba 2008; Mårtensson et al. 2009; Médard 2000; Walton Rogers 1997).

Textile implements often constitute the single most important and plentiful type of evidence for assessment of the scale of textile production and technology at a given site. These implements include tools associated with various stages of textile manufacture: preparation of the fibres, spinning of the yarn (Fig. 3), weaving of the fabric, and secondary processes such as sewing and embroidery. Not all of these stages leave clear physical traces in the archaeological record, since many tools, especially those used in the preparation of fibres, could be made of perishable materials such as wood or bone, and have not survived time and the elements. Extant implements are frequently made of fired clay; these include spindle whorls, loom weights, and spools. Metal tools, such as needles and shears, are also among the documented finds. Occasionally bone implements such as combs, distaffs, and weft beaters also survive.

Through ethnographic studies we often have knowledge about tool function and different processes such as fibre preparation, weaving techniques, and/or tools made of perishable materials (Hoffmann 1964). A study of number, distribution, and morphology of tools, based on statistical analyses of their physical parameters of preservation, size, weight, and use wear, can provide valuable information about technology, scale of production, and the importance of textile manufacture for a particular site, as well as about the raw materials and the final products (e.g. Andersson 2007; Walton Rogers 1997).

Tools, as indicators of production, although ubiquitous, are not always recovered *in situ*. Nevertheless, our identification of the function of textile implements is often determined by the context in which they have been found. The main archaeological contexts for textile implements are: settlements, burials, and votive or

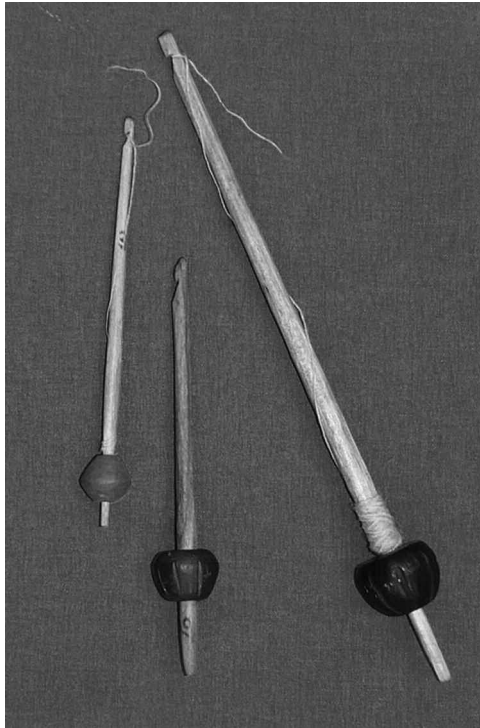


Figure 3. Spindle shafts and spindle whorls. Photo by Linda Olofsson.

sacred deposits. Each provides information about the role of tools and of textile production in society. Thus, while the primary function of tools can be inferred from settlement contexts, burials and votive deposits can tell about the symbolic value of tools and the social implications of textile production (Gleba 2008).

Functional typologies of tools, combined with analysis of the contexts in which they were found and their distribution patterns, allow inferences about changes and development of textile production in and between different sites and regions. If it is recorded where the specific tools were found it is possible to suggest how textile production was organized and carried out (workshops or household contexts). Different types of installations (dyeing and fulling vats, flax soaking pits) can also provide important information about the organization of production (Borgard and Puybaret 2004).

By applying all this information to archaeological material we gain a more complete picture of textile production and its importance. Studies of textile tools from different contexts can give an overall picture of the textile production at a site and/or a region, thereby making it possible to address issues such as the spread and use of technology, the mobility of craft workers, communication patterns, and chronological changes in production.

Experimental tool testing

Tool studies can become even more informative when used in combination with experimental archaeology (e.g. Schierer 2005). An important part of experimental archaeology is the testing of function and efficiency of textile tools and equipment (Peacock 2001). As such, experimental archaeology forms a link between textiles and textile tools and contributes to a better understanding of textile production and its complexity. The results from experiments form an important basis for the interpretation of the function of different tools and for the evaluation of what textiles have been produced at different sites and regions. These results can help us to visualize textiles in situations where none have been preserved.

Experimental tool testing combined with knowledge of fibres and tools of the period under investigation can help to understand how and for what purpose specific textile tools may have been used. It is essential that the tests are performed by several skilled craft workers, otherwise it will be impossible to evaluate whether or not the end-product is affected by the tool or by the craft worker (Andersson et al. 2008; Mårtensson 2007; Nosch forthcoming).

Whatever the primary parameter to be investigated, it is essential to control and evaluate thoroughly every step of an experiment. Thus, the raw materials should be selected according to our knowledge of the given period and area, and the tools tested should be reconstructed as precise copies of archaeological artefacts.

By testing textile tools, it is possible to understand tool function, their qualities and limits, and the lengths of time consumed in the various production stages. For example, systematic spinning experiments with suspended spindles have demonstrated that it is primarily the fibre quality, and the weight and the diameter of the spindle whorl, which affect the finished product (i.e. the spun yarn; Fig. 4). The tests also showed that variations within a specific tool type and their combinations determine variations in the final textile product (Andersson 2003; Andersson Strand and Nosch forthcoming; Mårtensson 2007), and the variation in time consumption connected to the use of the tools (Andersson et al. 2008). Recently, further experiments have demonstrated that not only the weight but also the thickness of a loom weight plays an important role in weaving, and hence that the choice of loom weights influences the fabric (Mårtensson et al. 2009). By recording weight and maximum thickness of loom weights and combining these data with the results of experimental weaving, it is possible to hypothesize the kind of textiles that could have been produced with a given yarn type. In an archaeological context where textiles do not survive, the range of tool parameters may be used to infer the range of cloth and/or thread that could have been produced with these tools.

Combining the results from experimental testing with contextual analyses helps to answer questions that are difficult to address by studying the tools alone. Experimental tool testing can be used to investigate whether the tools and their combinations at a site could have been used to produce yarn and/or fabrics corresponding to the surviving textiles; it also provides an insight into the variation in the production of yarns and fabrics at a given site, and allows for economic and social interpretations of whether the same kinds of textiles were produced in households and in workshops, thus approaching the concepts of skill and specialization.

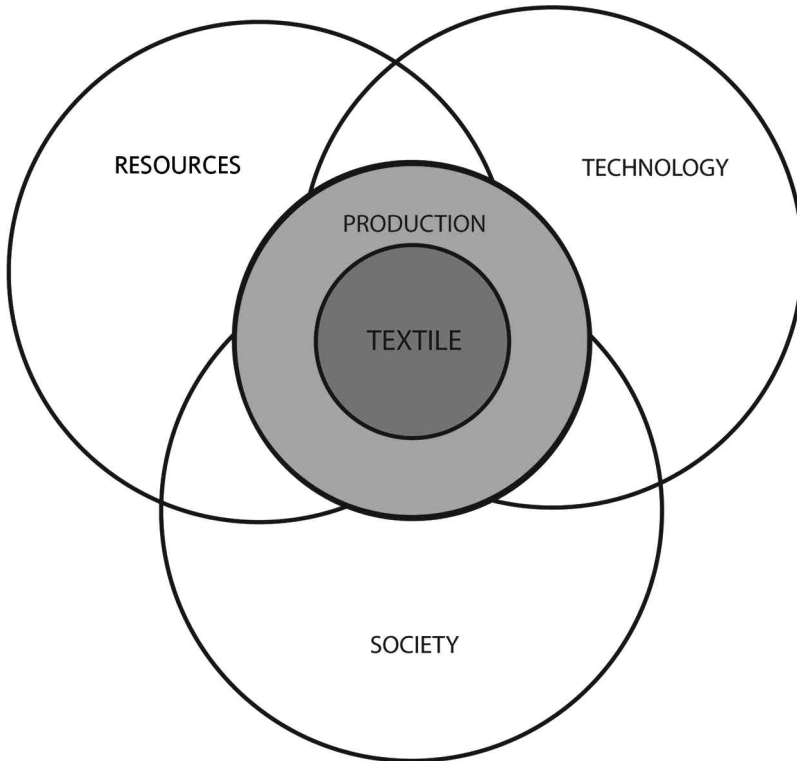


Figure 4. Calculation of metre of yarn per 100 g spun wool, 4 g, 8 g, and 18 g whorls.

CONCLUSIONS

This article aims to demonstrate some of the possibilities in the wide range of methods and approaches available to an archaeologist that can provide information and valuable insights into textiles and textile production in the past. We believe that, in order to pose more concrete questions, to widen interpretations, and to explore the full potential of a given material, it is necessary to know more about different methods and their limitations. This is a challenge not only for textile research but for the archaeological field in general and 'archaeologists must aim to become intelligent consumers' (Pollard and Bray 2007:254) of the available methods in order to get results that will allow answering questions posed and the further development of research.

Over the last 20 years, the field of textile archaeology has been enriched by a series of new scientific methods (isotopic tracing, radiocarbon dating, HPLC, SEM, X-ray spectroscopy, CAT-scanning, DNA analysis). The available methods, however, are not an end in themselves; rather, they are tools to be used in order to answer broader questions and are useful only when adapted to the aims of archaeology: to trace provenance, to understand chronology, to decode

the craft, and ultimately to understand past societies. Textile research has expanded and accumulated so many specialist methods that today it is most informative when carried out as an interdisciplinary collaboration.

Likewise, we see the need for a basic understanding of the complexity and different processes of textile production among researchers in general. Making a textile is complex and the producer needs ability and skills, as well as access to raw materials and tools. The traditions of textile making can be very strong in any given culture or society and differ from region to region and through time. A textile worker must plan carefully what she or he is going to produce (whether a skirt or a sail), which will determine the choice of the raw material and its processing, as well as the type and the amount of yarn to be spun. For example, it has been calculated that in order to produce two Viking Age costumes, 23,400 to 42,600 metres of yarn were needed, depending on the thickness of yarn (Andersson 2003:48). Subsequently, decisions must be taken as to the type of loom to be used, its set-up, and the weaving technique, as well as the finishing process.

Whatever the scale of society under investigation, the production of raw material for textiles requires long-term planning and the knowledge of animal husbandry, cultivation technology, and extensive exploitation and management of available natural resources. Analyses of fibres, dyes, archaeobotanical and archaeozoological remains, as well as palaeoenvironmental and geochemical investigations, provide information about available resources and how humans used them and manipulated them by deliberate selection based on different needs. Moreover, in more complex societies, textile production was well organized, with specialized craft workers involved in the different stages of production. Tool studies, experimental testing and visual grouping are approaches that explore the technology and techniques, thus making reference to craft and craftsmanship.

Together, these approaches can provide new knowledge about textile production, consumption and, thereby, society (e.g. Andersson 2003; Barber 1991; Gleba 2008; McCorrison 1997). Furthermore, by combining different results and, for example, ¹⁴C dating and context analysis, one can gain knowledge about changes and developments over time and space, which can be compared with and complement other archaeological information about human behaviour and society.

Within archaeology, there is a strong need for a closer integration of the various specialist fields into the overall interpretation of a site, region, or period (Pollard and Bray 2007). Scholars in the twenty-first century must integrate both knowledge about textile production and these new methods in their research, but more importantly, they must integrate the results of the methods into the archaeological and historical interpretations of past societies. Since textiles are so strongly connected to individuals, to cultures and to their technologies and economies, it is essential to embed textile research in the wider interpretations of human societies and their history. Textiles express who we are and, therefore, allow us to get very close to an individual: they express the tastes and affiliations of their wearers. A textile, however, is also a result of choices taken at every stage of its production by its maker(s), of available resources, and the level of technology achieved. In this respect, textile research is much more than the study of textiles.

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ABSTRACTS

Anciens textiles – nouvelles possibilités

Eva Andersson Strand, Karin Margarita Frei, Margarita Gleba, Ulla Mannering, Marie-Louise Nosch et Irene Skals

La recherche textile est devenue un domaine important de l'archéologie. Bien que les méthodes analytiques en vigueur soient souvent considérées comme spécialisées, leur combinaison à d'autres approches interdisciplinaires nous permet de traiter des questions archéologiques plus générales et apporte une base à interprétation pour étudier beaucoup plus en détail les textiles provenant des temps anciens. Des analyses de fibres, de teintures et de résidus archéobotaniques et archéozoologiques ainsi que des enquêtes paléoenvironnementales et géochimiques fournissent des informations sur les ressources disponibles, tandis que des études d'outils, des tests expérimentaux et le groupement visuel explorent technologie et techniques. La combinaison de ces deux approches peut apporter de nouvelles connaissances sur la production et la consommation de textiles, et de ce fait, sur les hommes et la société d'autrefois.

Mots clés: archéologie, teinture, archéologie expérimentale, fibre, isotopes, textiles, outils textiles

(translation by Isabelle Kayser-Gerges)

Alte Textilien – Neue Möglichkeiten

Eva Andersson Strand, Karin Margarita Frei, Margarita Gleba, Ulla Mannering, Marie-Louise Nosch und Irene Skals

Textilforschung ist zu einem bedeutenden Feld der Archäologie geworden. Obwohl die angewendeten analytischen Methoden oftmals als spezialisiert angesehen werden, erlaubt uns ihre Integration in andere interdisziplinäre Ansätze, weiterführende archäologische Fragestellungen zu behandeln und bietet die Deutungsbasis für eine wesentlich umfassendere Erforschung antiker Textilien. Analysen von Fasern, Farben, archäobotanischen und archäozoologischen Resten wie auch umweltgeschichtliche und geochemische Untersuchungen erbringen Informationen über zugängliche Ressourcen, während Werkzeugstudien, experimentelle Arbeiten und visuelle Gruppierungen Ansätze sind, die Technologien und Techniken erforschen. Gemeinsam können diese Methoden neue Erkenntnisse über die Textilproduktion und -nutzung – und dabei über die Menschen und die Gesellschaft in früheren Zeiten – liefern.

Schlüsselbegriffe: Archäologie; Farbe; Experimentelle Archäologie; Faser; Isotope; Textilien; Textilwerkzeuge

(translation by Heiner Schwarzberg)