

Sheep to textiles: approaches to investigating ancient wool trade

Margarita Gleba

Introduction

During the last 10,000 years of human history textiles increasingly took over as the primary material for clothing and many other, utilitarian items. The acquisition of textiles became an economic necessity and while different cultures have found different solutions to the problem, most have combined production and trade to varying degrees.¹ Whereas much of textile manufacture happened on a household level, some textile products were traded over long distances in the form of raw materials, semi-finished items (e.g. combed wool or yarn) or finished textiles. The desirability of the traded goods was often determined by their raw material and/or its quality. In this article, I will focus on one particular textile raw material, sheep wool.

Sheep wool has been and still remains one of the major fibres for textile making.² It derives from the coat of domestic sheep (Figure 1) and has properties that differ markedly from plant materials, which explains its quick popularity soon after its adoption. Its fibres have a scaly surface (Figure 2), which accounts for wool's ability to felt, resulting in water- and wind-proof fabrics. The scales and the crimp (number of bends per unit length) produce air pockets between the fibres making wool an excellent insulating material against heat and cold. Wool fibres stretch much more easily than bast fibres and hence are very elastic, making it a much more suitable fibre for weaving in twill technique, which developed during the Bronze Age and became the predominant type of weave during the Iron Age in most of Europe.³ In fact, the earliest extant wool textile finds from Shahr-i Sokhta, Iran, already include examples of twill.⁴ Unlike plant fibres, which are generally difficult to colour, wool comes in a variety of shades naturally and can be dyed easily a multitude of bright hues. All of these properties make wool one of the most useful types of fibre available, and it is not surprising that in ancient times it was one of the main textile materials, particularly for clothing.

Another reason for wool's popularity is the relative easiness with which it could be obtained compared to other fibres. Traditional animal husbandry does not require complex technology and today sheep are still a common sight throughout many rural areas even in densely populated Europe. The advantage of sheep herding over, for example, flax cultivation is that wool, as a fibre, does not require prime agricultural land; in fact, non-agricultural areas can be utilized as pastures.⁵ Wool does not require ploughing, sowing, weeding, or harvesting, and it is less affected by soil and weather conditions. Fewer herders are needed to tend the flock in order to produce a greater volume of fibre than would be generated by the same people cultivating flax. The agricultural labour, which would have been necessary for flax growing, could therefore be diverted to other tasks. The preparation of wool fibres for spinning is a technology

¹ Jenkins 2003, 4-5.

² Cf. e.g. Forbes 1956, 2-27; Ryder 1983a; Barber 1991, 20-30.

³ Bender Jørgensen 1992, 120; Rast-Eicher 2005, 128.

⁴ Costantini *et al.* 2009. The finds also include the earliest examples of looped (knitted?) wool.

⁵ See, however, Beresford 1998 on the enclosure of arable land for sheep pastures in England during Late Medieval times, which lead to depopulation of entire villages and economic crisis.

relatively less weather-dependent and time-constrained than the numerous stages of flax post-harvest processing.

Sheep husbandry also has broader significance for the small household. A few animals can provide enough wool for household consumption. Although in the past large-scale wool manufacture was controlled by the elite social strata (and it has even been argued that control over sheep flocks led to the development of complex and hierarchical social systems),⁶ small-scale production must often have been carried out for the needs of each individual household, at least in a non-urban setting.

For all these reasons, sheep wool has been the major animal textile fibre since what Andrew Sherratt has called the ‘secondary products revolution’,⁷ which involved the use of domestic animals for the exploitation of ‘renewable’ secondary products such as milk and wool, and the dates and geographical details for which are a matter of constant revision.⁸ Although sheep domestication process commenced in the Fertile Crescent approximately 10,500 calibrated radiocarbon years BP,⁹ the direct evidence for the use of wool fibre in textile production can be dated back no earlier than the 4th millennium BCE. Some of the earliest textile remains made of sheep wool come from Shahr-i Sokhta, Eastern Iran, and date to ca. 3100-1800 BCE. Irene Good analysed 43 samples made of sheep wool from the site, and categorised them into at least eight separate types of fleece.¹⁰ Recently, wool was also reported as the raw material in the textiles of Majkop Kulture found at Novosvobodnaya in the North Caucasus, dated to 3700-3200 BCE.¹¹ In the following millennia, wool became an important and, in some areas primary, textile material.

Wool Trade

Being a lightweight material and coming in a variety of colours and qualities, it is hardly surprising that wool has been a short and long-distance trade item *par excellence* throughout its history. Even to this day, the seat of the Lord Speaker in the House of Lords of the Parliament of the United Kingdom is a large square bag of wool called the ‘woolsack’, a reminder of the principal source of English wealth in the Medieval period, when wool trade was one of the most important economic sectors.¹² As trade material, however, wool is invisible archaeologically, not only because of its perishable nature, but also since, like other raw materials, it was subsequently worked into finished products. Our evidence for ancient wool trade is hence fragmentary and often indirect. The sources of information include written texts and archaeological textiles made of wool.¹³ Scientific

⁶ McCorriston 1997; also cf. Arbuckle 2012, with an overview of earlier literature.

⁷ Sherratt 1981; 1983.

⁸ For an overview, see Greenfield 2010.

⁹ Peters et al. 2005.

¹⁰ Good 1999. A recent preliminary report on 51 textile fragments from later excavations by Costantini et al. (2009) mentions that over 1,000 additional textile fragments have been excavated at the site between 1999 and 2006.

¹¹ Shishlina et al. 2003. The context of this material, however, is not entirely clear.

¹² <http://www.parliament.uk/site-information/glossary/woolsack/> Accessed 7 August 2013.

¹³ Another source, iconography, will not be discussed here since examples are few and the identification of wool trade in these depictions is, for the most part, a matter of interpretation rather than definite knowledge. One frequently cited example from Roman times is the depiction of large bales of supposedly wool being moved over land and water on the so-called Igel Column near Trier, Germany; cf. Drinkwater 1982. It is, however, more likely that wool textiles rather than raw wool are intended.

analyses of the latter, including fibre quality analysis as well as strontium and stable isotope tracing, may provide direct evidence of the movement of wool over long distances, although we cannot always be certain whether it circulated in the form of raw fibre, spun yarn or woven textiles.

Written sources

A variety of the extant written sources from the ancient Near East demonstrate that wool was traded extensively there at least since the Early Bronze Age.¹⁴ The information on wool trade is particularly detailed in the archives documenting the Old Assyrian trade in the Anatolian city of Kaneš (modern Kültepe in Turkey). Here, the data concerning the quantities and types of wool traded are recorded, as well as their prices, places of provenance, and organisation of trade.¹⁵ In some cases, substantial quantities of wool (500 talents=15 metric tons) were traded.¹⁶ Notably, different qualities of wool are mentioned in the Bronze Age texts, some of which were associated with specific geographical locations or colour, but mostly referred to by qualifiers such as ‘good’, ‘soft’, ‘long’, ‘new’ or ‘inferior quality’.¹⁷ It is, however, unclear if different varieties of sheep with different fleece qualities existed that would approximate modern breeds.

Fast-forwarding to the 1st millennium BCE, there is some written information about wool traded in the Mediterranean area. The case at hand is that of the Milesian wool, famous throughout the ancient Greek world.¹⁸ Thus, the inhabitants of Sybaris, a Greek city in southern Italy, were reputed for wearing garments of Milesian wool.¹⁹ On the other hand, another south Italian Greek city, Locri, passed a law prohibiting men from wearing garments made of Milesian wool, regarded as excessively luxurious.²⁰ Occasionally, the quantities of wool traded are mentioned as well. For example, *Syracusia*, an enormous ship designed by Archimedes and built around 240 BCE, reportedly carried, among other things, 20,000 talents (=520 metric tons) of wool on its maiden voyage from Syracuse in Sicily to Alexandria in Egypt.²¹

By the beginning of the Common Era, different qualities of wool were available to Roman consumers.²² The 1st century CE Roman writer Columella, in his agricultural opus *De Re Rustica*, rated northern, Gallic races of sheep, especially that of Altino (near modern Venice), as superior to those of Calabria, Apulia, Tarentum in southern Italy and

¹⁴ Cf. e.g. summary by Algaze 2008 for the Uruk period; Biga 2010 on wool in the archives of Ebla; Waetzholtz 1972 on wool in the Ur III. It is peculiar that wool trade is not mentioned in Linear B texts, apart from one possible (and contentious) reference to Cypriote wool; see Rougemont in press. However, trade activities in general are not well documented in Linear B archives, which appear to be mostly concerned with internal administration of goods and their production; cf. Olivier 1996-1997.

¹⁵ Cf. Veenhof 1972; Michel and Veenhof 2010; and especially Lassen 2010.

¹⁶ Lassen 2010, 176.

¹⁷ Cf. e.g. Waetzholtz 1972 for wool qualities in the Ur III texts; Veenhof 1972 and Lassen 2010 on wool qualities in the Old Assyrian trade archives; Del Freo et al. 2010 and Rougemont in press on wool qualities mentioned in the Aegean Linear B texts.

¹⁸ One of the earliest references is Aristophanes’ *Frogs* 543, although it was likely traded in much earlier times; cf. Gleba and Cutler 2012.

¹⁹ Athenaeus, *Deipnosophistae* 12.519.

²⁰ First Greek written code of laws attributed to Zaleucus; cf. Dalby 2002, 113.

²¹ The description of the ship and some of its cargo by Moschion survives in Athenaeus, *Deipnosophistae* 5.40; see Turfa and Steinmeier 1999.

²² Cf. e.g. Frayn 1984; Jongman 2000; Vicari 2001; Busana and Basso 2012.

Miletos in Asia Minor.²³ Martial²⁴ and Tertullian²⁵ also refer to the high quality of wool from Altino.²⁶ Lead tesserae from Iulia Concordia and Altinum in northern Italy mention wool (*vellera*), although it is uncertain whether it was a trade item in itself, or served as the packing material for other goods.²⁷

Columella's contemporary, encyclopaedian Pliny the Elder also gave a very detailed description of various wools traded in his time,²⁸ although according to him, the most valued wool came from Apulia.²⁹ Tarentine and Canosine wools in particular were regarded as some of the best and were exported raw.³⁰ The second best was the wool of a Greek breed, confusingly also called Italian, and the third place was held by the Milesian sheep from Asia Minor.

It is clear from these descriptions that specific varieties (breeds?) of sheep, differing in the colour, length and thickness of their fleece, were established in different areas of Italy and the Mediterranean by the 1st century CE. The question arises whether these different sheep and fleeces and their movement can be distinguished in the archaeological material.

Archaeological Material

Archaeologically, sheep have been studied primarily through animal bone assemblages.³¹ As early as the beginning of the 6th millennium BCE, when the first evidence for farming in Europe appears, sheep are among the most important domestic animals and by the 4th-3rd millennia BCE, the mortality data of faunal samples indicate the increasing importance of animal secondary products, such as wool.³² By 1000 BCE, generalised stock-keeping had been replaced by a more intensive fibre acquisition system, with a distinct emphasis on wool production as seen in the slaughter of adult animals.³³ At present, however, animal bones often do not provide sufficient data even to distinguish unambiguously between sheep and goat, much less between the different types of sheep, although important advances based on non-morphological methods have recently been made.³⁴ Sheep bones also do not help us with understanding sheep wool³⁵ – for that we need to look at archaeological textiles made of wool.

Textile Analysis

Creation of a textile involves transformation of raw material through a series of

²³ *De Re Rustica* VII.2.

²⁴ *Epigrams* XIV.155.

²⁵ *De pallio* 3.6.

²⁶ On wool production in Altino and Venetia, cf. Bonetto *et al.* 2004; Bonetto and Ghiotto 2004, 52-53.

²⁷ Cresci Marrone and Pectenò 2009-2010.

²⁸ *Naturalis Historia* 8, 187-199.

²⁹ On differences between various authors' rating of the wool qualities, see Grelle and Silvestrini 2001, 96.

³⁰ Pliny *Naturalis Historia* 8, 190-191. On Tarentine wool production cf. Morel 1978. On Canosine and Apulian wool production in general, cf. Acri 1983 and Grelle and Silvestrini 2001.

³¹ Cf. Greenfield 2010 for an overview.

³² E.g. Arbuckle 2012.

³³ E.g. De Grossi Mazzorin 2004, 39.

³⁴ Buckley *et al.* 2010.

³⁵ A possibility of extracting ancient DNA (aDNA) from archaeological wool textiles (cf. Brandt *et al.* 2011) may open a new avenue of investigation in the future, however, whereby aDNA from relatively rare archaeological wool may be compared to the aDNA extracted from the much more abundant sheep bones.

processes. Each stage of this transformation leaves information in the final product, which can be recovered through textile analysis. Textile analysis involves assessment of the textile's dimensions, condition, colour, fibres, fibre preparation, twist direction, thread count, weave type, edges, applied decoration, faults and use wear.³⁶ Many of these features are important parameters in themselves, but in combination and, together with contextual data, they can be used as social, cultural, chronological and/or geographical indicators. Researchers often identify as imports textiles with technical features that are not typical for a specific area.³⁷ A non-local textile is, however, not necessarily the same as non-local raw material and vice versa.³⁸

Fibre analysis

A method that has been used to identify textile provenance is based on fibre quality assessment, which involves measuring the diameter of 100 fibres per thread, and statistical analysis resulting in a distribution diagram (Figure 3). In archaeology, analyses of wool fibre quality 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. Sheep fleece contains three parts differing in structure and size: kemp (over 100 microns), hair (over 60 microns), and the wool itself (Figure 2). Michael Ryder established an evolutionary scheme for wool development based on fibre diameter measurements.³⁹ Early varieties of sheep had coats containing more hair and kemp than wool. Ryder hypothesised that, over the course of time, selective breeding has produced increasingly finer and more uniform wool by replacing kemp with hair and narrowing the hair diameter. Woolly sheep are believed to have developed by the middle of the 4th millennium BCE. Where and when they developed is still an open question but the above-mentioned wool textiles found at Shahr-i Sokhta include examples made of woolly fleeces.⁴⁰ Furthermore, selective breeding resulted in the appearance of white fleece permitting dyeing, and the loss of natural shedding ability.⁴¹

Ryder's model provides an invaluable foundation for fibre studies and demonstrates a strong link between fibre and textile. However, biological variations of fibre composition and the transformations that take place between raw wool and finished textile must be taken into account.⁴² A fleece of a primitive sheep may contain several qualities of wool. The composition of a fleece also varies between different animals of

³⁶ Cf. e.g. Walton and Eastwood 1983; Gillis and Nosch 2007.

³⁷ This is particularly relevant in periods when more standardised, "brand" textiles appear; cf. e.g. discussion of the Verring type twills in Bender Jørgensen 1992, 133-136. Note, however, that in such discussions the actual production places or areas are unknown.

³⁸ Cf. discussion in von Holstein 2012, Chapter 5.

³⁹ Ryder 1964; 1969; 1983; 1992; 2005.

⁴⁰ Good 1999.

⁴¹ Most modern sheep breeds must be shorn yearly. When a few years ago in New Zealand a Merino wether named Shrek evaded muster for six years, he produced over 27 kg of wool:

[http://en.wikipedia.org/wiki/Shrek_\(sheep\)](http://en.wikipedia.org/wiki/Shrek_(sheep)) accessed 8 August 2013. The usual average yearly yield of Merino is 4.4 kg; cf. Australian Wool Compendium data for 1967-68 to 2001-02, cited on page 6 of 2002 Australian Wool Production Survey: http://www.agric.wa.gov.au/objtwr/imported_assets/content/aap/sl/wool/bull4544.pdf retrieved 8 August 2013.

⁴² Cf. Christansen 2004; Rast-Eicher 2008.

the same breed 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. Hence, Antoinette Rast-Eicher proposed a different fleece classification system, based on the investigation of rare breed fleeces and archaeological material in Switzerland.⁴³ Rast-Eicher's system is ultimately derived from the one used in wool industry and assigns single or multiple letters to fleeces with different percentages of fibres of different diameter.

Irrespective of the fleece classification system used, certain distribution patterns are discernible, particularly when large sets of textiles are analysed, permitting to identify fleeces that do not fit the general pattern and may therefore be identified as of non-local origin. Thus, a recent publication of the Bronze and Iron Age wools from Hallstatt, Austria noted some unusual Bronze Age fleeces with dyed, naturally nearly white wool and fibre diameter measurements that did not correspond to the typical Bronze Age fleeces found in the salt mines.⁴⁴ The authors suggested that these wools either were some of the very few white Bronze Age wools available locally, or that they had been imported to Hallstatt.⁴⁵ This could be the first evidence for wool trade in Bronze Age Europe.

Another, later example is the wool from the fragment found in a 4th century BCE burial at Cogion-Coste di Manone in Italy. It is composed of much finer fibres than what is typical for Italy at this time (Figure 3).⁴⁶ The closest comparison to this find is represented by the three samples of wool textiles from a 5th century BCE burial at the ancient Greek city of Nymphaeum in Crimea, Ukraine, which have been hypothesised to be Milesian imports.⁴⁷ As noted above, the ancient Greek city of Miletos on the west coast of Turkey is known from the written sources to have been the originating place of sheep with particularly fine fleeces. However, it remains to be ascertained (possibly using the strontium isotope analysis described above) whether the wool from Cogion (or those of Nymphaeum) was local or not.

Wool quality analysis was also used to suggest non-local provenance for textiles from various medieval contexts as well. A knitted wear fragment found in the Castle Ditch at Newcastle upon Tyne and dated to the 15th century was identified as a likely import from Italy, Spain or France, based on the fact that the fleece composition was fine and it was furthermore dyed with an exotic dye, kermes.⁴⁸ Among the over 400 textile fragments recovered from the 13-15th century Elbing in Poland, many were identified as English or Spanish (merino) imports, based on the comparison between their wool quality histograms and the distribution of fibre in modern samples from the Shropshire and Merino breeds.⁴⁹

Isotopic tracing

⁴³ Rast-Eicher 2008.

⁴⁴ Rast-Eicher and Bender Jørgensen 2013, 1231.

⁴⁵ Rast-Eicher and Bender Jørgensen 2013, 1234.

⁴⁶ Gleba 2012. It should be noted, however, that very few archaeological wools from Italy have been analysed to date and statistically more significant sample may change these conclusions in the future.

⁴⁷ Ryder and Hedges, 1973; Ryder, 1974, 103. All other wools of comparable fineness are dated to the Roman period or later (Ryder 1974, 102; 1987, 123).

⁴⁸ Walton 1981, 191, 200. See also Walton Rogers 1995.

⁴⁹ Maik 1988, 219.

Currently, new scientific analytical methods are being developed for identifying the provenance of wool in archaeological samples, based on strontium⁵⁰ and stable isotope tracing.⁵¹ Analysing distribution of these isotopes allows distinguishing between possibly local and non-local materials.

Thus, strontium isotopic tracing investigation of a large pre-Roman Iron Age textile found in a bog at Huldremose, Denmark, demonstrated that it was made of a combination of wools derived from at least three distinct geographical locations, two of them non-local.⁵² Since wools with different strontium signatures occur in the same textile, it is clear that raw material was traded rather than textile. Based on the homogeneity of the yarn and weave it has been previously assumed that the textile was made locally of locally available material, so the results of the strontium analysis force us to rethink our assumptions about the organization of wool textile production in Iron Age Scandinavia.

Comparable results were reached by Isabella von Holstein who used carbon ($\delta^{13}\text{C}$), nitrogen ($\delta^{15}\text{N}$), un-exchangeable hydrogen ($\delta^2\text{H}$), and oxygen ($\delta^{18}\text{O}$) to analyse medieval wool textile finds from sites around the North Sea, including Iceland, the British Isles, Sweden and north Germany: some of the samples regarded as typical for the site were demonstrated to have been produced of non-local wool.⁵³ Converse also turned out to be the case in this study, whereby textiles considered atypical turned out to be made of wool with local isotope signature. These results indicate that evaluating the origin of textiles based on traditional analytical methods may underestimate the extent of movement of wool and wool textiles over long distances.

Conclusion

Comparison of the results obtained through fibre investigation with Sr, DNA and palaeoproteomic⁵⁴ analysis as well as with the information available from the written and iconographic sources may provide a much clearer and elaborate picture of ancient wool trade and its profound impact on technology, agriculture, animal husbandry and economy from prehistory through the Roman period and later. Furthermore, large-scale projects which are investigating textiles from Hallstatt in Austria, Switzerland, Scandinavia, Italy and other areas are starting to provide important data for comparison. More regional studies will allow defining fleece types of a large geographical area, resulting in a better understanding of wool and textile trade patterns in the past.

Biography

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⁵⁰ Frei et al. 2009a and in this volume.

⁵¹ von Holstein 2012 and in press.

⁵² Frei et al. 2009b.

⁵³ von Holstein 2012.

⁵⁴ The new technique of analysing proteins surviving in the archaeological artefacts such as textiles may be more informative than DNA analysis in cases of highly degraded material since proteins are more stable than DNA molecules; cf. Heaton *et al.* 2009.

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Captions (5-8 images)

Figure 1. Icelandic sheep, one of the oldest North European sheep breeds (Photo: courtesy of Stark Hollow Farm).

Figure 2. Scanning Electron Microscope image of Iron Age wool fibres (Image: M. Gleba).

Figure 3. Histogram of wool quality measurements, Cogion-Coste di Manone, Italy, 4th century BCE.

Biography

Margarita Gleba is currently European Research Council Principal Research Associate at the Institute of Archaeology, University College London, UK. She has previously worked as a research project manager at the Centre for Textile Research, University of Copenhagen (2005-2009), and as Marie Curie Fellow at UCL (2009-2011). Her PhD (Bryn Mawr College, 2004) dealt with textile production in pre-Roman Italy and she continues to explore the development and social and economic role of ancient textile production and consumption in her present work. She is the author of *Textile Production in Pre-Roman Italy* (Oxbow 2008), and editor of *Textiles and Textile Production in Europe from Prehistory to AD 400* (Oxbow, 2012) and several other books.