9-2014

Textile Materials and Techniques in Central Europe in the 2nd and 1st Millennia BC

Karina Grömer
karina.groemer@nhm-wien.ac.at

14th Biennial Symposium ~ Los Angeles
September 10 - 14, 2014
NEW DIRECTIONS: Examining the Past, Creating the Future.

Textile Materials and Techniques in Central Europe in the 2nd and 1st Millennia BC

Karina Grömer

Introduction

The 2nd and 1st millennia BC (roughly the Bronze and Iron Ages)[1] represent a period, when many textile inventions can be recognized and developments in textile craft can be studied in Central Europe. Bronze Age in Central Europe starts ca. 2200 BCE and is characterized by a new material, bronze, an alloy of nine parts of copper and one part tin. The discovery and the spread of knowledge related to metal processing resulted in a technological revolution that eventually transformed the economy and society as a whole. Bronze (and later iron) enabled the production of better tools and weapons, because both materials are very stable and malleable. Trade and exchange also flourished during this time. All of this led to an increased division of labour and other political and social differentiation. During the 9th and 8th centuries BC again, it was the use of another innovative raw material, iron, that gave rise to the name of an era (Iron Age is dated between 800 and 15 BC). While the Etruscan culture became dominant on the Apennine Peninsula, Greece extended its sphere of influence through the establishment of colonies on the north-western Mediterranean coast. In the Early Iron Age (Hallstatt Period, ca. 800-400 BC), the influence of these Mediterranean urban cultures expanded into the zone north of the Alps. There is strong evidence for trade with Greek colonies in southern France dating to the 6th century BC. Wine, spices, bronze vessels and luxury goods were the objects of desire, which were valued by the Central European Iron Age elites. A strive for such representational objects characterizes the behaviour of the higher strata of society during this time.

One of our key sites to explore innovations in textile technology is the salt mine of Hallstatt[2]. Here, during prehistory salt was exploited and textiles as well as other organic finds were left behind in the mine after their use. Salt provides excellent preservation conditions, with plant material surviving as well as animal fibres, leather and skins. About 300 textile units (more than 700 single fragments) from Bronze and Iron Ages are known from the prehistoric salt mines, ranging in date from 1500-300 BC. They display a large variety of textile techniques and provide insight into different aspects of textile craft. Over the recent years, the Natural History Museum has collaborated in different research projects[3], which allowed us to perform systematic fibre and dyestuff analyses of this material. Important steps of the *chaîne opératoire*[4] (Fig. 1) can be studied by means of the Hallstatt textiles, beginning with fibre preparation and spinning, covering various weaving and patterning techniques, as well as the finishing like dyeing or sewing. These aspects of textile production will be discussed in the following with a special focus on fibres.

---

[1] Cunliffe 1996; Kristiansen 2000.
[2] Kern et al. 2009.
[3] CinBA- Creativity and Craft Production in Bronze Age Europe (www.cinba.net), DressID Clothing and Identitiy - New Perspectives on Roman Textiles (www.dressid.com) (access: July 2014).
[4] See Belanová-Stolcová and Grömer 2010, Fig. 3.1

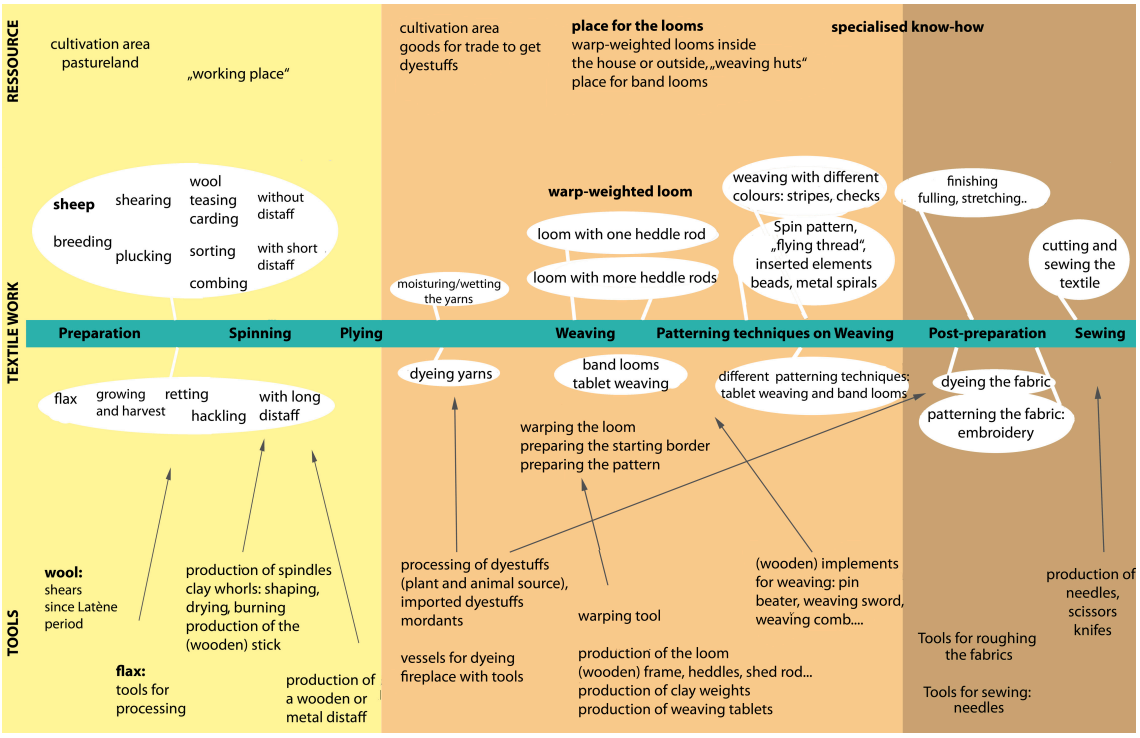


Figure 1: Chaîne opératoire of textile production (© K. Grömer).

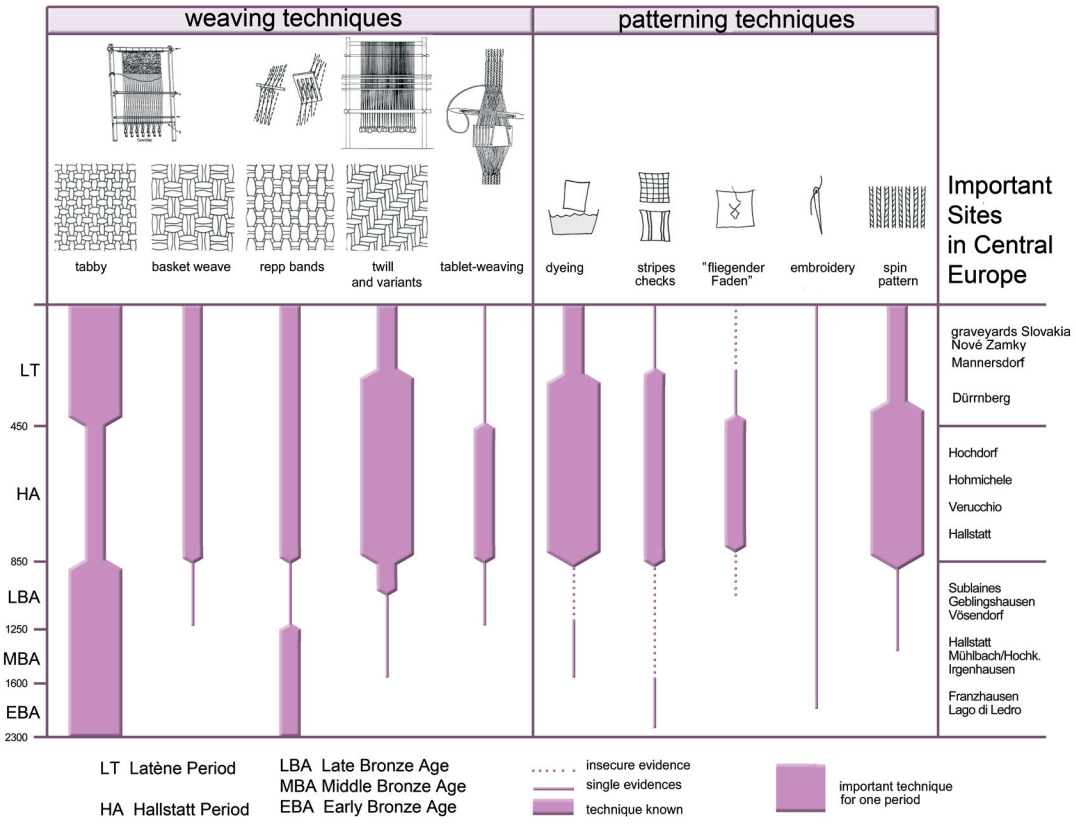


Figure 2: Development of textile techniques in Central Europe (© K. Grömer).

The basic concept here is that of development, inventions and innovations in textile technologies in Central Europe (Fig. 2).[5] Within the last decades increasing theoretical attention is being given to understand the process of technological innovation. In our case, the theories of Barbara Ottaway[6] are helpful: she distinguishes between invention, innovation and general use. She defines invention as the discovery of a new technical process, while innovation includes the adoption of the new technique and their products. Whereas invention demands creativity and experimentation, often based upon existing technologies, it does not become innovation unless it is integrated into the various domains of society.

Fibres and Their Preparation

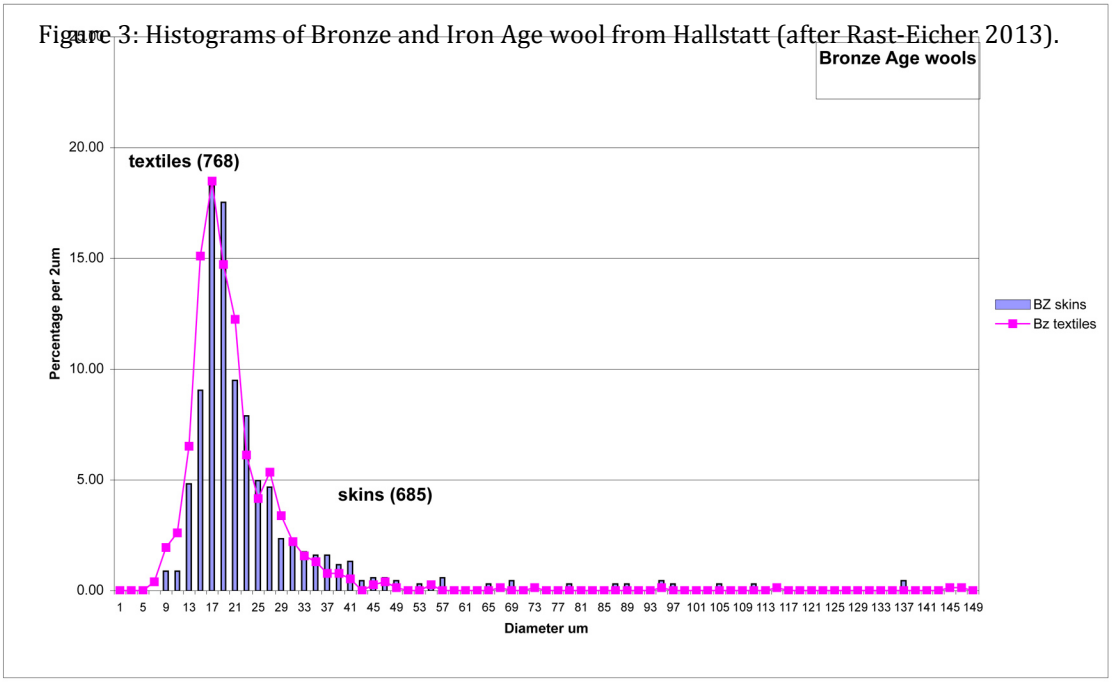
Textile production in prehistoric Europe as well as in other parts of the world was dependant on the raw material – in this case animal and plant fibres. Textile technology in the Neolithic Europe was based on plant fibres[7]. Along it we find a high standard of basketry and twining techniques[8]. It is also the period when the basic spinning and weaving techniques were developed.

Different animal fibres were used for textile production in Central Europe during prehistory, especially known from the Iron Age: horse hair was employed as weft for tablet woven and band woven ribbons from Hallstatt and Dürrnberg salt mines[9]; analysis textiles found at the Vedretta di Ries glacier in Northern Italy identified some of as made from goat hair[10].
The most important fibre is sheep wool for Central European prehistory. It is assumed that primitive sheep with longer hair that could be used for spinning, appeared some time in Late Neolithic/Early Bronze Age. Textile technology and inventions in Bronze Age Europe depended on the developments in sheep breeding. Early Bronze Age textiles are usually of plied yarn and tabby, sometimes decorated with sewn-on beads, fringes or floating threads. The copper and salt mines at Mitterberg and Hallstatt in Austria[11], both dated between 1600 and 1200 BC, offer a fully developed wool textile culture. The wool tabbies there are made of single yarn and are coarser than the Early Bronze Age linens.

Fibre analysis was out by Antoinette Rast-Eicher[12] on the Bronze Age wool textiles such as Castione dei Marchesi, Mitterberg or Hallstatt. Wool measurements consist of determining quality through measuring the diameters of the fibres. For this, a statistically sufficient number of fibres (min. 100) is measured. The quality category is ascertained and finally the measurements are presented in the form of a histogram. For the site of Hallstatt we had the

[5] See Grömer 2012, Fig. 1.27.
[6] See Ottaway 2001.
[7] See Harris, in this volume; and Rast-Eicher 2005.
[8] E.g. Medard 2012.
[9] Grömer et al. 2013, catalogue; HallTex 20, 123, 136; Grömer and Stöllner 2009, Fig. 6; Ræder Knudsen and Grömer 2012.
[10] Bazzanella et al. 2005.
[11] Grömer 2012, 30-36.
[12] Rast-Eicher and Bender Jørgensen 2013; Rast-Eicher 2008; 2013.

possibility not only to investigate textiles but also skins found there in order to compare them with the textiles and with still existing primitive sheep types. The wool detected in Bronze Age textiles from Central Europe is of a primitive fleece type. In general, Bronze Age sheep skins and the coarser tabby textiles display the same fleece type (Fig. 3, above) – which is more or less a type like the modern Soay sheep. However, Bronze Age textiles which reflect an innovative step according to weave type or patterning, have a different wool type (compared to the coarser tabbies). Interestingly, the Bronze Age special wools are of a similar type to the advanced Hallstatt period fleece from the skins[13].



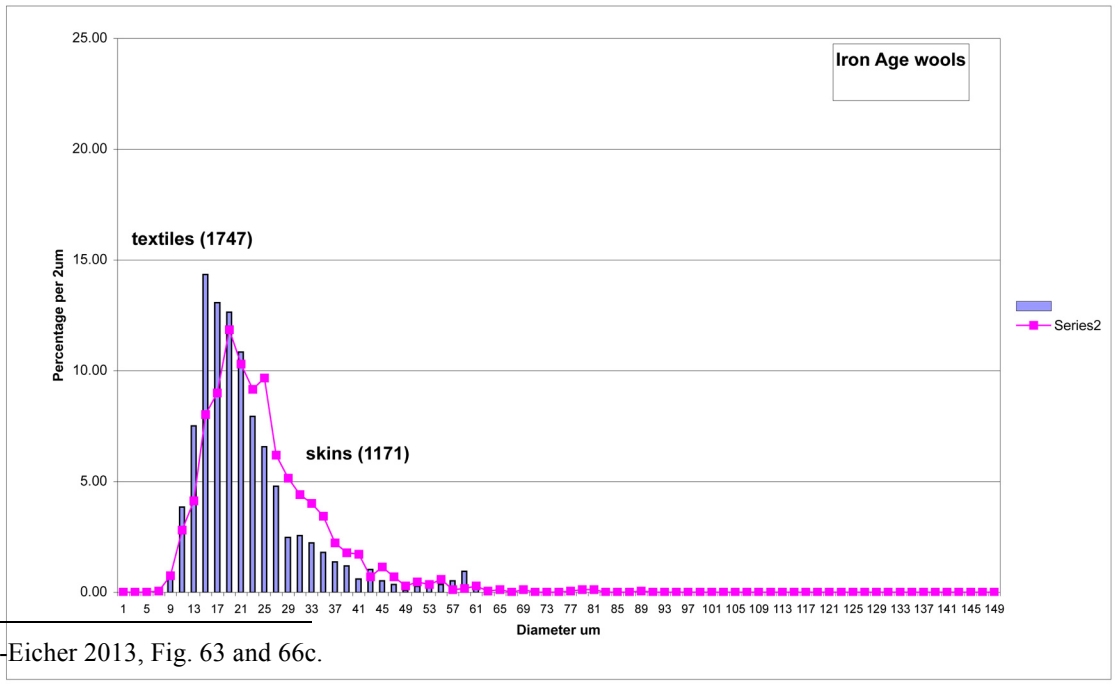


Figure 3: Histograms of Bronze and Iron Age wool from Hallstatt (after Rast-Eicher 2013).

[13] Rast-Eicher 2013, Fig. 63 and 66c.

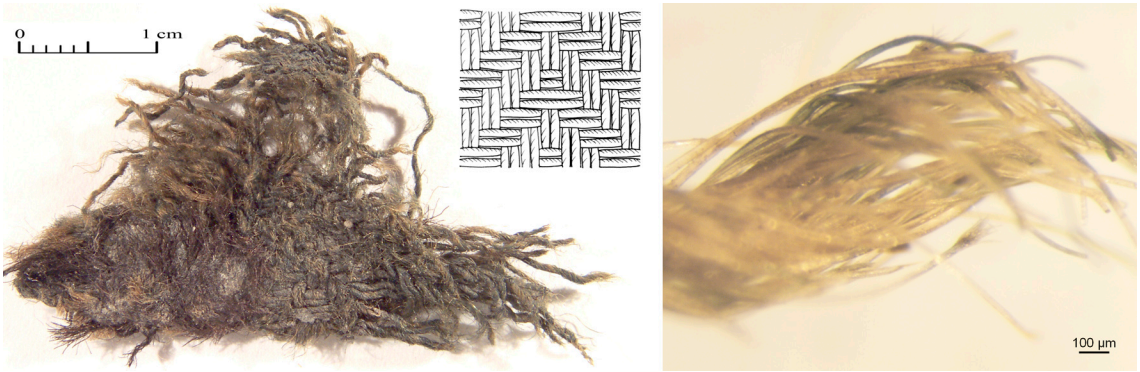
In Iron Age, the wool measurements of skins from Hallstatt demonstrate that the wool is of a type comparable to the primitive Vrin sheep breed in Switzerland[14]. There is, however a bigger difference between contemporary skins and textiles (Fig. 3, below). The fibres in the textiles are finer and have a narrower peak than those of the skins. This may be a result of a more intensive preparation process of the fleece for use in textiles[15] compared to the Bronze Age when wool was used as it came from the sheep and only in a few cases we can detect a sorting process. In Iron Age Hallstatt we even have evidence for the combing of wool[16].

This is important for our understanding of the creative impact of what the people decided to do with the raw material. Again, it is of note, that textiles which represent an innovative step, are usually made of wool type different to the „common" textiles of the same site and period.

Colour

Early sheep had brown wool but there is also evidence for breeding of sheep for light wool in the Bronze Age Hallstatt[17]. The preference for sheep with light wool can also be detected in the Early Iron Age Hallstatt.

Light wool allows dyeing and therefore colour. Investigations of dyestuffs in textiles from Hallstatt[18] proved that dyeing with woad dates back to the Middle Bronze Age (Fig. 4). This means that development in sheep breeding goes hand in hand with aesthetic decisions of the people. Blue-dyed textiles might have served as a perfect background and contrast to the attached shiny metal ornaments, used during this period. As a case study, this was shown on the dress accessories of a rich woman living in the Danube area around 1500 BC[19].



[14] Rast-Eicher 2013, Fig. 66d.
[15] See also Rast-Eicher 2013; For the preparation process and tools to be used see Grömer 2015.
[16] Rast-Eicher 2013, Fig. 60b.
[17] Grömer et al. 2013, see catalogue, *e.g.* HallTex 24; 45, sewing thread; 238; 242. Rast-Eicher and Bender Jørgensen 2013, 1231-1232.
[18] Hofmann-de Keijzer et al. 2013, 142.
[19] Found in Winklarn, Austria, stored at the Natural History Museum Vienna. See Grömer, Rösel-Mautendorfer and Bender Jørgensen 2013.

Figure 4: Hallstatt, Bronze Age twill weave with blue dye, HallTex 211 (©NHM Vienna and University of Applied Arts).

Some of the Bronze Age textiles from Hallstatt, Radfeld and Mitterberg also bear evidence of red and yellow dyestuffs[20]. Beside light wool, pigmented wool still was valued. So we have to re-evaluate our picture of Bronze Age textiles from dull coloured to natural shades accentuated with bright colours.

The Early Iron Age shows evidence of a wide creativity with colours[21]. We know that the fleece, the yarn and sometimes the woven fabric were dyed, creating charming patterns in various weaving techniques. Plant dyes like chamomile, weld, woad, madder and others were employed to obtain bright coloured textiles. The Hallstatt period also saw the use of imported dyestuffs such as insect dyes[22]. *Kermes vermilio* was identified at the princely grave Hochdorf, while textile dyed with a red component similar to carminic acid was found at Hallstatt salt mine. Possible sources for the latter are the Polish cochineal (*Porphyrophora polonica* L.) living in northeastern Europe and the Armenian cochineal (*Porphyrophora hameli* Brandt*)* native to western Asia in the region of Mount Ararat.

Inventions and Innovations in Weaving

During the 2nd millennium BC some inventions have been made concerning weaving and patterning techniques. Again, those inventions go hand in hand with more developed sheep types and preparation methods. Especially the textile finds from Hallstatt provide a clue for our understanding of textile craft in Central Europe, but also finds from other sites broaden our picture.

Bronze Age textiles are generally simple, tabby being the main weave type (Fig. 5). However, in Central Europe, we see the first innovative power in Middle Bronze Age, around 1600 BC. Remarkable are the early woollen twills[23], which would have required a development of a warp-weighted loom equipped with more than one shaft. These special weaves also display special wool. The wool measurements point to an advanced fleece type and/or careful preparation of the fleece[24]. These early twill textiles are single finds among hundreds of Bronze Age tabbies. Twill, however becomes the main weave type in Hallstatt Period (800-400 BC)[25].

[20] Hofmann-de Keijzer et al. 2013, Fig. 55.
[21] Hofmann-de Keijzer et al. 2013 and Hofmann-de Keijzer 2015.
[22] Hochdorf: Walton Rogers, in Banck-Burgess 1999, 244; Dürrnberg: Stöllner 2005; Hallstatt: Hofmann-de Keijzer et al. 2013, 150.
[23] Grömer et al. 2013, 60-62; Grömer 2015, chapter B.
[24] Rast-Eicher 2013. See also discussion in Rast-Eicher and Bender Jørgensen 2013, 1233-1238.
[25] Compare Banck-Burgess 1999; Gleba 2008; Gleba and Mannring 2012 (see in various articles); Grömer et al. 2013, 60-62.

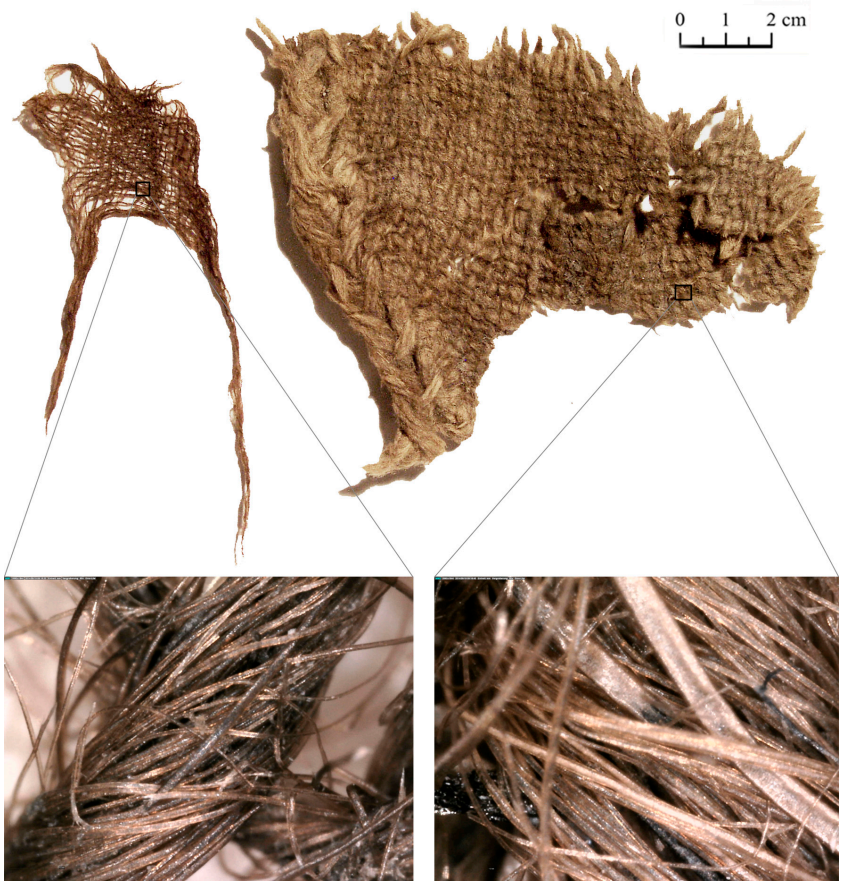


Figure 5: Bronze Age tabby textiles from Hallstatt salt mine, fine and coarse with fibre details, DinoLite Microscope 100x (©NHM Vienna).

A recent find indicates that tablet weaving also dates back to Middle Bronze Age with a date ca. 1400-1250 BC[26]. Annemarie Farke identified a starting border from Schwarza as tablet-woven[27] – but from Hallstatt there is the earliest evidence for a tablet-woven band with colour pattern, in this case stripes.

[26] Grömer et al. 2013, catalogue, HallTex 288.
[27] Farke, 1993, 111: Fabric Nr. 13c from Tumulus C1.

Figure 6: Iron Age textiles from Hallstatt salt mine (©NHM Vienna).

After the innovative period during the Bronze Age, during which the main textile culture was still based on simple tabbies, there is a „boom“ in the Hallstatt Period (Fig. 6). It is the Early Iron Age, where we can recognize a fully developed textile art with a wide variety

colours, patterns and textile qualities[28]. This can be found not only in princely graves like Hochdorf, which is a very specialized context, but also in other graves and the saltmine at Hallstatt. Between 800-400 BC variants of twill weaving – along with other weave structures are a common feature. This was done in very high qualities with up to 40 threads per cm and 0.1 mm thread diameters.

In the following La Tène Period we see a more simple textile culture – again there are more tabbies. We can detect fewer patterns, and there are standardised qualities in thread count and thread diameter. Maybe here lies the beginning of early mass production[29].

Pattern and Design

During the 2nd millennium BC some inventions were also made in weaving and patterning techniques. Stripes break up the monochrome surface of a textile, they define edges and channel the viewer's attention in specific directions. Stripes can be made very easily in weaving. Bundles of warp threads of different colour are threaded onto the loom, or threads of different shades were are as weft on monochrome warp. The earliest striped textile in Central Europe derives from a rich woman's grave at Franzhausen in Austria[30], and dates back to 2000 BC (Early Bronze Age). It is a flax weft-faced tabby with dark stripes.

The early striped fabrics highlight the generally monochrome textile world of the Bronze Age. From 800 BC onwards, textiles in Central Europe display more and more decorative patterns[31]. Prehistoric textiles in Central Europe are usually not decorated with motifs in a kind known from pottery or bronze artefacts – it is a different design principle. We usually do not find curved lines or naturalistic motifs like birds or horses. The reason may be the way textiles are made, with warp and weft forming a very strict underlying geometric system. Tapestry techniques have not been common in prehistoric Europe.

Not only the warp-weighted loom was used to produce textiles, but also smaller looms, like diverse band weaving implements[32]. Patterning is very easy with such tools: Using warp threads of different shades, you can make stripes or checked designs in numerous variations. More difficult is the handling of tablet weaving. As mentioned, this technique is known from the Middle Bronze Age onward and maybe is a patterning technique, which was developed in Central Europe itself. The tablets are threaded with warp threads of different colour. The pattern is created by turning the tablets. Three-dimensional understanding is required to be able to make such patterns – Iron Age tablet braids can be highly complicated with triangles, swastica and meanders. They serve as decorative ribbons on clothes, as belts and – in the case of Hochdorf – as decoration for wall hangings in a grave[33].

---

[28] Banck-Burgess 1999; Gleba and Mannring 2012 (see in various articles); Grömer 2015, chapter B.
[29] See Grömer 2015, chapter C1.
[30] Grömer 2012, Fig. 1.1.
[31] Banck-Burgess 1999, 52-64; Grömer et al. 2013, 80-89.
[32] Comprehensive see Grömer 2015, chapter B.
[33] Banck-Burgess 1999.

The tablet woven band from Hallstatt[34] may serve as an example for the high standard of sheep breeding and preparation (Fig. 7): Light wool was used to obtain well dyed threads. Especially for tablet weaving it is necessary to work with well prepared raw material. The appearance of the threads reflects well combed wool with fibres lying parallel, spun into even threads. The threads have to be highly twisted and plied so they do not get damaged during tablet weaving . The results of all this preparatory work are shiny and even threads with a flat surface to give lustre – a quality product from Iron Age.

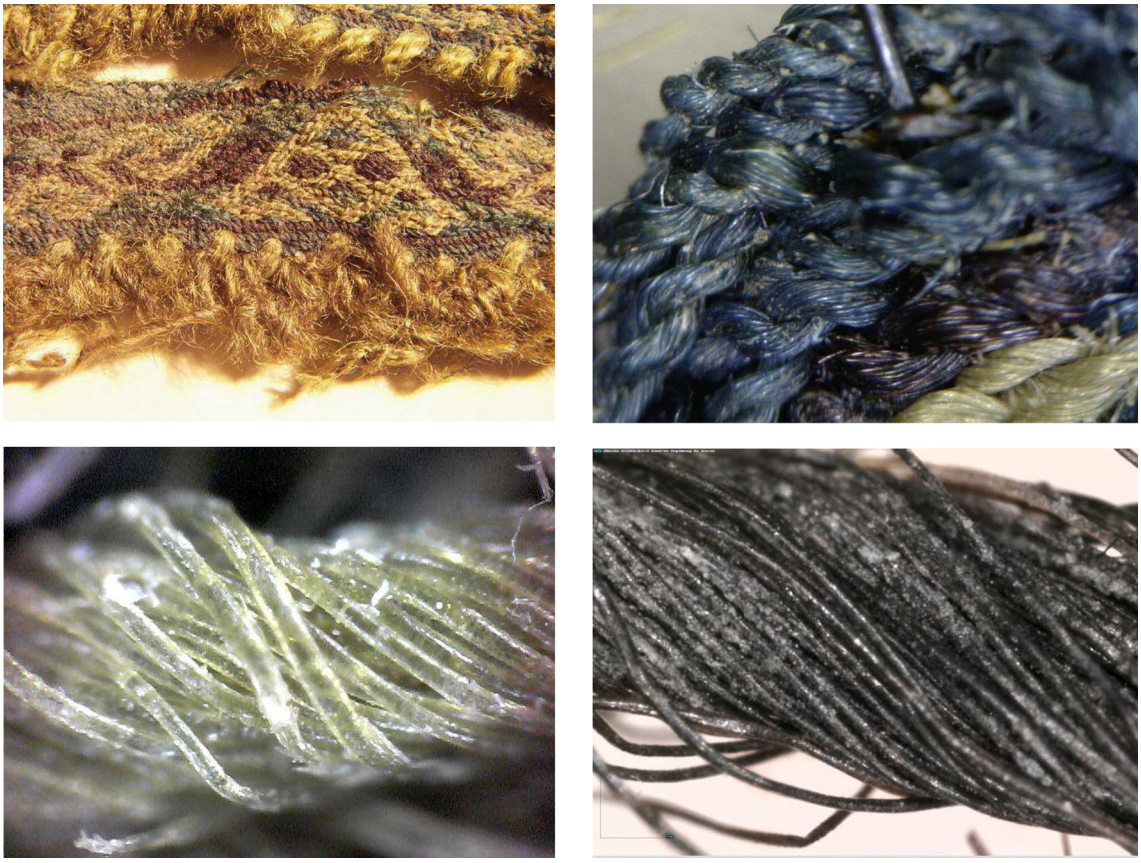


Figure 7: Hallstatt Tablet woven band 123: Band und details Fasern wie in Powerpoint! (©NHM Vienna, Microphotos: K. Grömer and A. Rast-Eicher).

For a spin or shadow pattern[35], the difference of spinning direction was exploited to provide decoration. S- and z-twisted threads placed side by side catch the light differently and give a subtle tonal pattern. We can see stripes or bands created by alternating groups of s- and z-twisted threads. This is a very common pattern type in Central European Hallstatt Culture, but also in Italic and Etruscan cultures, as we know from the finds of Verucchio[36]. High quality wool without coarse guard hair and this special treatment of the

[34] Grömer et al. 2013, catalogue, HallTex 123.
[35] Banck-Burgess 1999, 53-55; Grömer 2015, chapter B6.1.
[36] Stauffer 2012, also Gleba 2008, 48-49.

fibres enabled the Iron Age craftspeople to obtain spin pattern. Well prepared wool is necessary reflected by the wool types with a narrow peak without kemp.

However, even spin pattern – typical for the Hallstatt Period between 800-400 BC, was invented before that. The earliest evidence for spin pattern comes from the Mitterberg near Hochkönig[37] – from a copper mine dated between 1600-1500 BC. It is a band with groups of s- and z-plied yarn used to create a pattern effect. As in the case of the Bronze Age twill-woven and tablet-woven items from Hallstatt, here we are able to detect the same phenomenon: The wool of this item differs from the other coarser contemporary textiles from the same site[38], which are of a more primitive sheep type.

Conclusion

My main argument is that a lot of inventions and innovations made in textile techniques during the Bronze and Iron Ages in Central Europe go hand in hand with the development of sheep types during the 2nd and 1st millennia BC. Textile quality, appearance and performance depend on the raw material.

Bronze Age textile art clearly represents an invention phase, according to the theories of Barbara Ottaway, to give the textiles an attractive appearance. Based on wool measurements, outstanding Bronze Age textiles from Hallstatt (1500-1200 BC) also have specialized wool, e.g. a fragment of a chevron twill of fine quality and some dyed textiles. If these textiles are imports or made of local sheep breeds may in the future be determined by isotopic tracing. The development of dyeing in the 2nd millennium BC gave wool an greater importance because wool and other animal fibres take dye much more readily than plant fibres.

In the Iron Age, we discern a fully developed textile art with advanced methods of wool preparation, artfully used dyes, diverse patterning techniques (innovation phase and use after Ottaway). Within the social context of Central European prehistory, a value of skill and creative design begins to be important not only in metal and ceramic crafts, but also in textile production. The breeding of sheep with light and then white wool made dyeing and varied patterns possible. Diversification of sheep and wool types during the Iron Age is a harbinger of modern sheep breeds.

All of this is a representative concept of this time – a social expression. The material, technical transformations cause an aesthetical and conceptual shift. Tradition and functionality play a great role in producing textiles. But sometimes we get a glimpse on creative decisions to make special effects in a textile - both visual and haptic. Textiles with structures, patterns and applied decoration represent the idea of creative work with textile material, according to the knowledge, the skill and rules of the society.

[37] Grömer 2012, Fig. 1.2; Grömer 2015, chapter B.
[38] See Rast-Eicher and Bender Jørgensen 2013.

The production of textiles has reached a high level of technical and aesthetic achievement during the Iron Age. Textile craft even influenced the social organisation, ideology and economy, especially of the representation culture of the higher strata of Hallstatt Period and Early La Tène Period society[39].

Bibliography

J. Banck-Burgess 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 1999, Theiss Verlag.

J. Banck-Burgess 2012: *Instruments of Power. Celtic Textiles. - Mittel der Macht. Textilien bei den Kelten*. Stuttgart, Theiss Verlag, 2012.

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

M. Bazzanella et al. 2005: Iron Age Textile Artefacts from Riesenferner/Vedretta di Ries (Bolzano/Bozen – Italy). In: In: P. Bichler, K. Grömer et al. 2005 (Hrsg): "*Hallstatt Textiles" Technical Analysis, Scientific Investigation and Experiment on Iron Age Textiles*. British Archaeological Reports Int. Series 1351, 2005, 151-160.

M. Bazzanella 2012: Italy: Bronze Age. In: M. Gleba und U. Mannering, *Textiles and Textile Production in Europe from Prehistory to AD 400*. Ancient Textiles Series Vol. 11, Oxford 2012, Oxbow Books, 203-214.

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

B. Cunliffe (Eds.) 1996*: Illustrierte Vor- und Frühgeschichte Europas*. Frankfurt/New York 1996.

H. Farke 1993: Textile Reste von Dietzhausen und Schwarza. In: R. Feustel, Zur bronzezeitlichen Hügelgräberkultur in Südthüringen. *Alt-Thüringen* 27 (1993), 53-123. (Farke: 109-112).

M. Gleba 2008: *Textile Production in Pre-Roman Italy*. Oxbow Books. Ancient textiles Series Vol. 4, Oxford 2008.

M. Gleba und U. Mannering 2012, *Textiles and Textile Production in Europe from Prehistory to AD 400*. Ancient Textiles Series Vol. 11, Oxford 2012, Oxbow Books.

K. Grömer 2012: Austria: Bronze and Iron Ages. In: M. Gleba und U. Mannering, *Textiles and Textile Production in Europe from Prehistory to AD 400*. Ancient Textiles Series Vol. 11, Oxford 2012, Oxbow Books, 27-64.

K. Grömer and Th. Stöllner 2009: Ein abgerissener Ärmel aus dem Salzbergwerk Dürrnberg. Neue Erkenntnisse zur Brettchenwebtechnik in der Eisenzeit in Mitteleuropa (with contributions by Lise Raeder Knudsen und Helga Rösel-Mautendorfer). *Jahrbuch Römisch-Germanisches Zentralmuseum* 56 (2009): 105-157. Mainz, Verlag RGZM.

K. Grömer, A. Kern, H. Reschreiter und H. Rösel-Mautendorfer (Hrsg.): *Textiles from Hallstatt. Weaving Culture in Bronze and Iron Age Salt Mines*. Textilien aus Hallstatt.

[39] Compare Banck-Burgess 2012.

Gewebte Kultur aus dem bronze- und eisenzeitlichen Salzbergwerk. Archaeolingua 29, Budapest 2013.

K. Grömer, H. Rösel-Mautendorfer und L. Bender Jørgensen 2013: Visions of Dress. Recreating Bronze Age Clothing from the Danube Region. In: *Textile Journal of Cloth and Culture* Vol. 11/3, 218-241. DOI: 10.2752/175183513x1379321037403.

K. Grömer 2015 (in press): *The Prehistoric Art of Textile Making – The development of craft traditions and clothing in Central Europe*. Veröffentlichungen der Prähistorischen Abteilung, Naturhistorisches Museum Wien 2015.

R. Hofmann-de Keijzer, M.R. van Bommel, I. Joosten, A. Hartl, A.N. Proaño Gaibor, A.G. Heiss, R. Kralofsky, R. Erlach, S. de Groot 2013: Die Farben und Färbetechniken der prähistorischen Textilien aus dem Salzbergbau Hallstatt / The colours and dyeing techniques of prehistoric textiles from the salt mines of Hallstatt. In: K. Grömer, A. Kern, H. Reschreiter and H. Rösel-Mautendorfer (eds.): *Textiles from Hallstatt. Woven culture from Bronze and Iron Age salt mines / Textilien aus Hallstatt. Gewebte Kultur aus dem bronze- und eisenzeitlichen Salzbergwerk.* Archaeolingua 29, Budapest 2013, 135–162.

R. Hofmann-de Keijzer 2015: Dyeing. In: K. Grömer 2015 (in press): *The Prehistoric Art of Textile Making – The development of craft traditions and clothing in Central Europe*. Veröffentlichungen der Prähistorischen Abteilung, Naturhistorisches Museum Wien 2015.

K. Kristiansen 2000: *Europe before History*. Cambridge University Press, Cambridge, 2000.

A. Kern, K. Kowarik, A. Rausch und H. Reschreiter 2009: Kingdom of Salt. Veröffentlichungen der Prähistorischen Abteilung 3, Wien 2009.

L. Ræder-Knudsen and K. Grömer 2012: Discovery of a New Tablet Weaving Technique from the Iron Age. In: *Archaeological textiles Review* 54, 92-97.Rast-Eicher 2005

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

A. Rast-Eicher 2013: Die Faserqualität von Fellen und textilien aus dem Salzbergwerk von Hallstatt. The fibre quality of skins and textiles from the Hallstatt salt mines. In: K. Grömer, A. Kern, H. Reschreiter und H. Rösel-Mautendorfer (Hrsg.): *Textiles from Hallstatt. Weaving Culture in Bronze and Iron Age Salt Mines. Textilien aus Hallstatt. Gewebte Kultur aus dem bronze- und eisenzeitlichen Salzbergwerk*. Archaeolingua 29, Budapest 2013, 135-162.

A. Rast-Eicher and L. Bender Jørgensen 2013: Sheep wool in Bronze and Iron Age Europe. *Journal of Archaeological Science* 40 (2013): 1224–1241.

B. Ottaway 2001: Innovation, Production and Specialisation in Early Prehistoric Metallurgy. *European Journal of Archaeology* 4,1, 2001, 87-112.

A. Stauffer 2012: Case Study: The Textiles from Verucchio, Italy. In: M. Gleba und U. Mannering, *Textiles and Textile Production in Europe from Prehistory to AD 400*. Ancient Textiles Series Vol. 11, Oxford 2012, Oxbow Books, 242-253.

Th. Stöllner 2005: More than Old Rags – Textiles from the Iron Age Salt-mine at the Dürrnberg. In: P. Bichler, K. Grömer et al. (Hrsg.), *Hallstatt Textiles – Technical Analysis, Scientific Investigation and Experiments on Iron Age Textiles*. British Archaeological Reports S1351, Oxford 2005, 161-174.