

Missing link: an early wool textile from Pustopolje in Bosnia and Herzegovina

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*In 1990 the excavation of a group of tumuli in south-western Bosnia was published in the pages of *Antiquity*. The key discovery was the Bronze Age burial of an adult male (Pustopolje tumulus 16), wrapped in a large woollen textile. At the time, little attention was paid to the textile. New analyses of the fabric, however, have led to a reappraisal of this find. The textile is presented here fully for the first time, with details of the analyses that have been undertaken. These reveal that the Pustopolje textile has major significance for our understanding of the early development of weaving technology and clothing in the Bronze Age archaeological record, and in particular it underlines the presence of distinct and separate weaving traditions in Central Europe and Scandinavia.*

Keywords: Bosnia and Herzegovina, Bronze Age, textile, wool, garment

[Editor's note: for a glossary of textile terminology, see Zhao *et al.* in *Antiquity* 91 (2017): 371–73]

Introduction

In volume 64 of *Antiquity*, Alojz Benac presented a short note on a group of tumuli with exceptional organic preservation that he had excavated in 1980–1984 in the valley of Kupreško polje in south-western Bosnia (Benac 1990). One of them, Pustopolje tumulus 16, contained a burial with a wooden coffin, parts of a sledge, skin, grass and the skeletal remains of a man who had been covered with a thick woven wool textile. Benac did not attempt to describe the textile except for a drawing illustrating how it covered the entire burial. In an earlier publication, a detail of the fabric border was also shown (Benac

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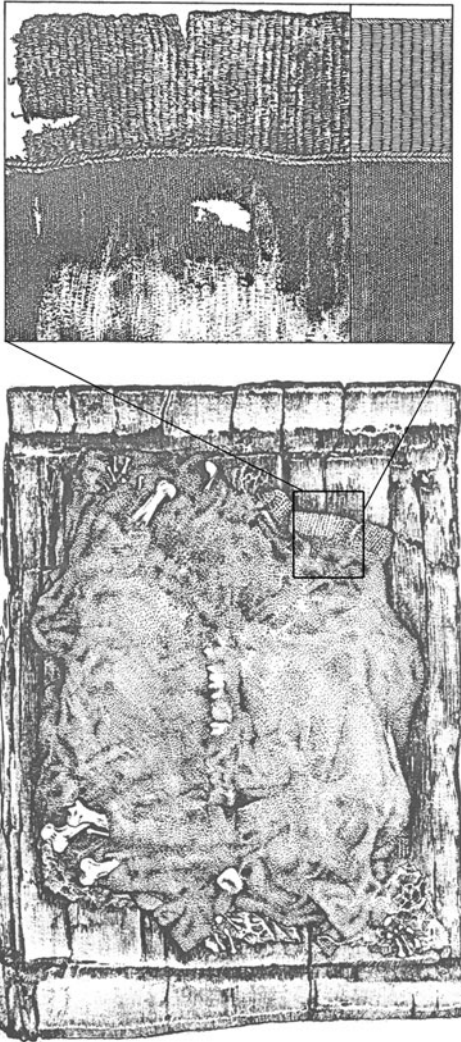


Figure 1. The Pustopolje burial and detail of the textile. (After Benac 1986.)

1986: 109) (Figure 1). The textile did not quite elude the attention of scholars (Bender Jørgensen 1992: 103; Grömer 2016: 126, 361), and as the Yugoslavian Wars (1992–1995) made communications difficult, the Pustopolje textile has not been given the attention it deserves. This has recently been remedied. It has been examined, restored and re-dated, and is now on display in the Franciscan Museum and Gallery Gorica in Livno, Bosnia and Herzegovina (Marić Baković & Car 2014). In 2011, two of the present authors visited the museum in Livno to examine the textile. Dye analysis, wool analysis and radiocarbon dating have also been carried out.

The textile from Pustopolje has been radiocarbon dated to the fifteenth century BC, which makes it the earliest large woollen textile in Europe. It is 1.7m wide and 3m long; although fragmented, almost all of the borders and selvages are preserved. This means that it is technically complete, which makes it an important source for understanding the beginnings of wool production and the use of textiles in the Bronze Age. This article is the first presentation of the Pustopolje textile (Figure 2) to supply a technical description including information on dating, fibre and colour, followed by a discussion of this magnificent item in the context of contemporaneous Bronze Age textiles, textile technology and possible use.

The Pustopolje textile in the Yugoslavian Wars

After excavation and initial restoration, the textile was briefly on display in Kupres, and was then transferred to the Hasan Brkić Museum in Livno. With the outbreak of war in April 1992, the finds had to be evacuated from the museum. Pieces of the coffin were stored in a wooden military chest and sheltered at the Orlovac Hydropower Plant in Podgradina near Livno; the textile and the remains of the deceased were placed in the basement of the Franciscan monastery in Livno. At the end of the war, the collections of the Hasan Brkić

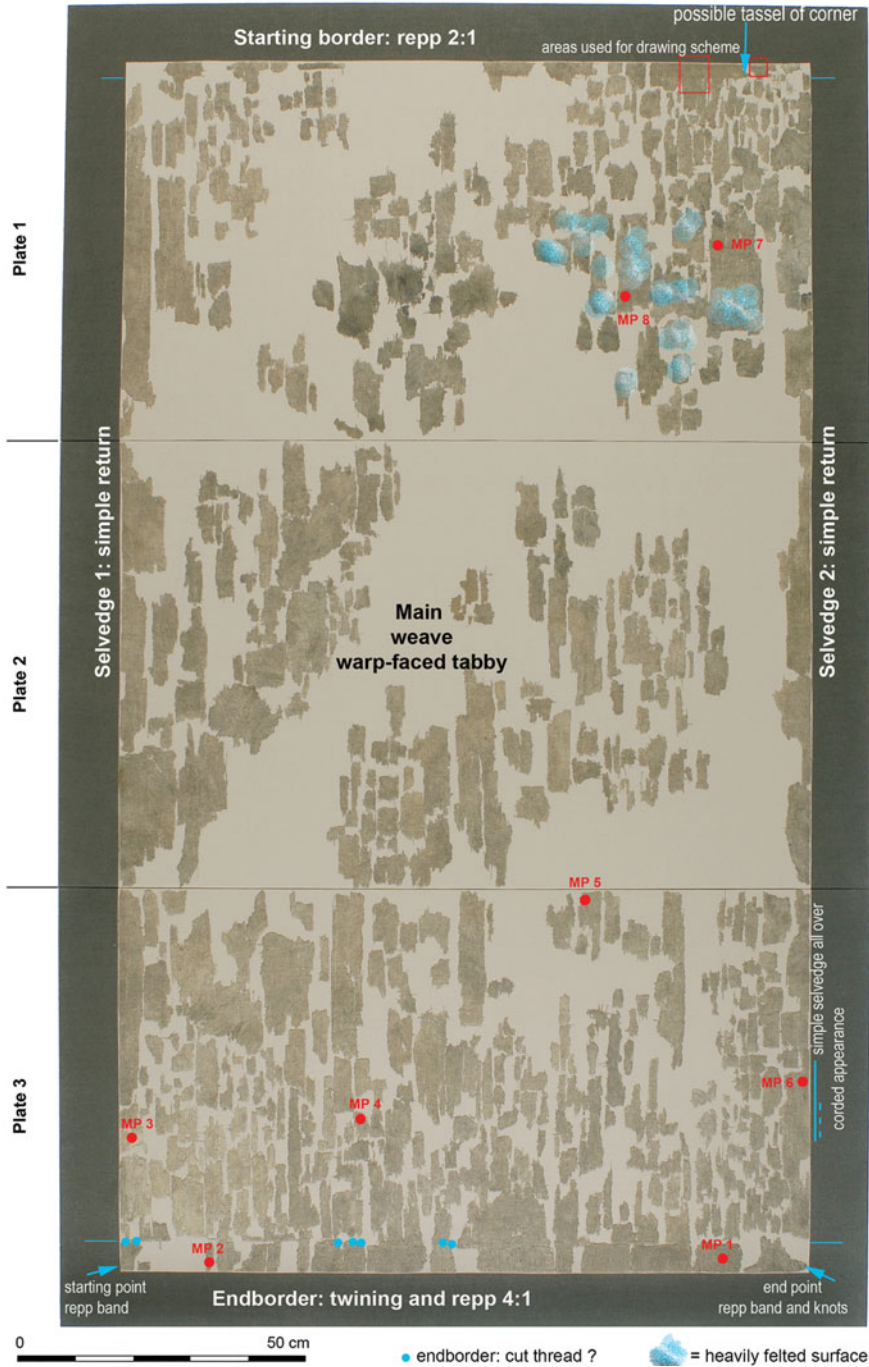


Figure 2. Overview of the Pustopolje textile. Points of examination (MP/measure points) are marked in red, with felting shown in blue. Important constructional features are marked with arrows. (Photograph by Hrvatski Restauratorski Zavod.)

Museum were merged with those of the Franciscan monastery to create the Franciscan Museum and Gallery Gorica Livno.

Conservation, reassessment and restoration

Before being put on display, the Pustopolje textile was restored in the Hrvatski Restauratorski Zavod in Zagreb by textile conservator Gordana Car and her colleagues (Marić Baković & Car 2014). The textile had been stored between glass layers, in the form of two plates, each measuring $1.43 \times 1.07\text{m}$. The 596 fragments that now constitute the textile were cleaned, analysed and rearranged. This led to a surprise. Benac (1986) had assessed the size of the textile as $1.7 \times 2\text{m}$; the conservators were able to confirm Benac's assessment of the width of the fabric as 1.68m using the two transverse borders that were preserved, but they found that the fabric must have been at least 3m long, as fragments of the two selvages total no less than 5.7m. After conservation, the fragments were laid out within the four woven borders according to nuances of colour, width and spots. They were then placed on boards of acid-free cardboard and covered with fine monofilament netting that was sewn with silk thread onto the beige cotton fabric chosen as background. During the restoration process, Stana Kovačević from the University of Zagreb, Faculty of Textile Technology, investigated the textile before it was shielded with a protective cover in the form of a monofilament netting (described in Marić Baković & Car 2014). The textile was then catalogued as FMGG 6974.

Radiocarbon dating

The original dating of the Pustopolje burial (3660 ± 120 cal BP) was limited to samples of the timber structure (Benac 1990: 331). Since then, it has become possible to date the textiles themselves by radiocarbon. A sample of the Pustopolje textile was dated by Mark Van Strydonck of the KIK/IRPA in Brussels (Lab-Code: KIA-47815; Van Strydonck 2012) to 3195 ± 30 cal BP, i.e. between 1495 and 1435 BC at 68.2% probability, and between 1520 and 1510 BC at 95.4% probability (Figure 3). It was pre-treated with chloroform twice by immersing it for 15 minutes in an ultrasonic bath to eliminate the polyvinylacetate. Afterwards, the sample was pre-treated with the solvents hexaneacetone-ethanol and Milli-Q water in the ultrasonic bath. Infrared spectroscopy did not detect any PVA after pre-treatment (Van Strydonck 2012). The dating makes the Pustopolje textile approximately a century older than the famous well-preserved garments and textiles found in oak-log coffins in Denmark (Broholm & Hald 1940; Christensen 2006; Randsborg 2011: 139) (Table 1).

Wool

Wool analysis and measurements have been carried out by Antoinette Rast-Eicher of ArcheoTex on four samples from the Pustopolje textile (Rast-Eicher & Bender Jørgensen 2013). All showed the same type of wool, where very fine fibres were combined with very coarse ones (Figure 4). This kind of wool is typical of the Bronze Age, although most other finds show evidence of wool sorting (Rast-Eicher & Bender Jørgensen 2013). The coarse fibres (kemp) range around (or over) $100\mu\text{m}$ in diameter. The scales of the kemp fibres are

Table 1. Dates of Bronze Age graves with large textiles, based on Christensen (2006) for Danish finds.

Site	Grave	Date	Dating method	Dated item
Pustopolje, Bosnia and Herzegovina	male burial	1495–1435 cal BC (at 68.2% probability)	radiocarbon	textile
Borum Eshøj, Denmark	grave A, old male	1358–1330 BC	dendrochronology	coffin
Borum Eshøj, Denmark	grave B, young male	1353–1326 BC	dendrochronology	coffin
Egtved, Denmark	female burial	c. 1370 BC	dendrochronology	coffin
Muldbjerg, Denmark	male burial	1377–1345 BC	dendrochronology	coffin
Trindhøj, Denmark	male burial	1364–1337 BC	dendrochronology	coffin
Skrydstrup, Denmark	female burial	1220–970 cal BC (at 65.3% probability)	radiocarbon	coffin

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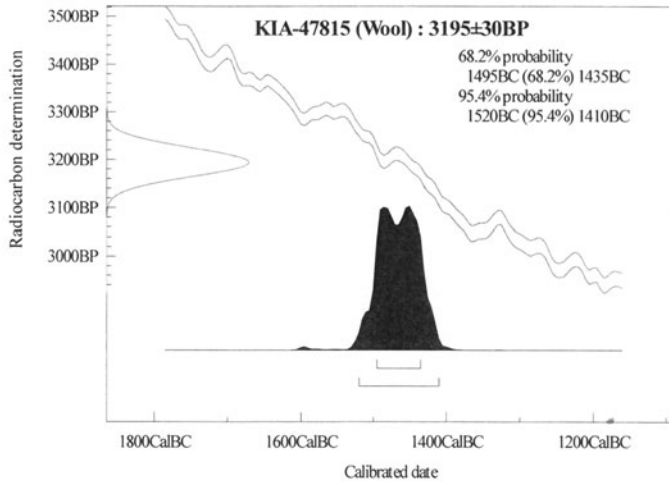


Figure 3. Radiocarbon dating of the Pustopolje textile (Bronk Ramsey 2005; Reimer et al. 2009).

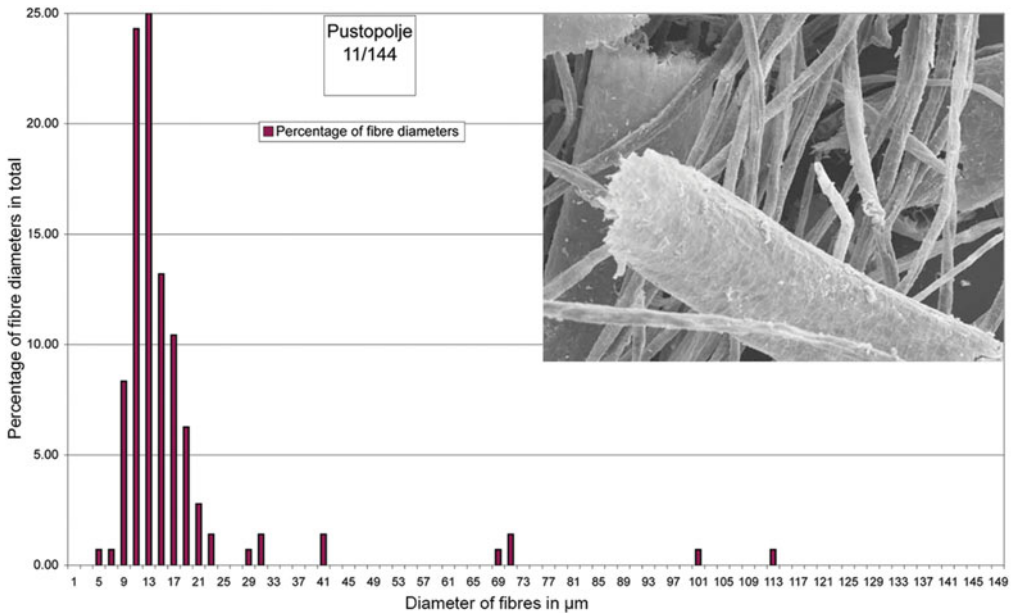


Figure 4. Wool from the Pustopolje textile. Top: Pustopolje sample 11/147. Large fibres with net-like or horizontal-scale pattern (photograph by Antoinette Rast-Eicher). Bottom: Pustopolje sample 11/144. Histogram of wool measurements. Inset: detail of the textile's surface, showing coarse kemp fibres. (Photograph by Hrvatski Restauratorski Zavod.)

either polygonal-net-like or horizontal lines; longitudinal pleats and breaks indicate some shrinkage (Figure 4). The Pustopolje wools belong to category D as defined by Rast-Eicher (2008: 155). The fine fibres were probably slightly pigmented; the kemp appears light with a large dark medulla.

The best comparison to the Pustopolje wool comes from mouflon fibres from Sardinia (Rast-Eicher & Bender Jørgensen 2013). The European mouflon (*Ovis ammon musimon*) is a wild remnant of early domesticated sheep (Rezaei *et al.* 2010). A sample of mouflon fibres shows the same type of large fibres, some with net-like scales, others with fine horizontal lines. The wool of a textile from Lenk-Schnidejoch, dated to 1891–1634 cal BC, resembles the Pustopolje wool (Rast-Eicher 2015). Further parallels may be found in the wools from Hochkönig-Mitterberg, dated to 1600–1500 BC (Rast-Eicher & Bender Jørgensen 2013), and Castione dei Marchesi in Italy, dated to 1600–1200 BC (Gleba 2012: 3645). All of these show indications of wool sorting, as most of the coarse fibres have been removed.

Dyestuffs

Dyestuff analyses have been performed by Maarten van Bommel and Ineke Joosten of the Cultural Heritage Agency of the Netherlands, and Regina Hoffmann-de Keizer of the University of Applied Arts in Vienna (Hofmann-de Keijzer 2016: fig. 84; and an unpublished report by Van Bommel *et al.* 2012). The fibres of the textile fragments were examined by optical light microscopy (OLM) and scanning electron microscopy coupled to energy-dispersive spectroscopy (SEM-EDS). The fibres are very clean, and the typical scales are still visible. They show many tears and fractures indicating mechanical stress. Their surfaces contain holes that might have been caused by microbes.

High performance liquid chromatographic analysis indicated the presence of unknown yellow and red components in two samples. The yellow components belong to the flavonoid dye classes that are also found in weld, saw-wort, dandelion and camomile, but an exact identification was not possible. The red components found could not be linked to any known plant species. They could be products of degradation products, or they could indicate the presence of an unknown (possibly local) plant. It cannot be excluded, however, that the colouring components originate from the archaeological environment. The composition of the two samples was very similar, yet in sample 5, an unknown orange component was found that is probably not a dye but could be a marker of peat bog or body fluids (Van Bommel *et al.* 2012).

The construction of the textile

The Pustopolje textile is woven in tabby. It is made with a repp starting border, a main web with simple selvedges and an elaborate finishing border (Figure 5 & Table 2).

The starting border is approximately 35mm wide, and was constructed as a 1/2 repp band. The paired weft of the band turns into the warp of the main web (Figure 6; cf. Hoffmann 1964: fig. 26, Grömer 2016: figs 66–67). Both yarn systems of the starting border are s-twisted. A fragment of the starting border, currently misplaced, displays the felted remains of a knot or tassel, and may represent one of the corners of the fabric (Figure 6). A further piece of the starting border, missing on the mounted fabric, is in the exhibition showcase with the remains of the deceased (Gordana Car, Hrvatski Restauratorski Zavod, *pers. comm.*; see also Marić Baković & Car 2014). No transitional features between the starting border

Table 2. Technical data of the Pustopolje textile. Note that the warp of the main web is the weft of the starting border, and that the weft of the finishing border is the warp of the main web.

Part of the web	Thread system	Threads	Twist	Yarn diameter	Twist angle	Thread count
Starting border						
1/2 repp band	warp	single yarn	s	0.9–1.1mm	30–40°	10 threads/cm
	weft	paired yarn	ss	0.7–0.8mm	35–40°	4–5 × 2 threads/cm
Main web						
tabby	warp*	single yarn	s	0.7–0.9mm	35–40°	10 threads/cm
	weft	single yarn	z	0.9–1.3mm	30°	5 threads/cm
Twining		paired yarn	s	0.8–0.9mm	20°	passes over 2 warp threads
Finishing border						
4/1 repp border	warp	single yarn	z	0.9–1.1mm	20–30°	8 threads/cm
	weft**	quadruple yarn	ssss	0.6–0.9mm	30–40°	3 × 4 thread

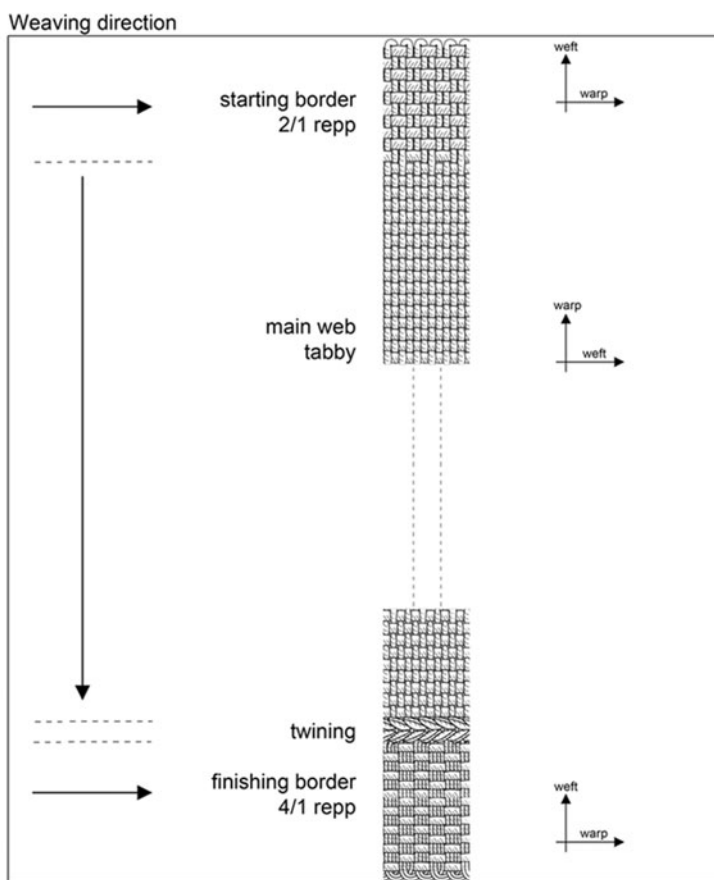


Figure 5. The overall construction of the Pustopolje textile. Arrows indicate the direction of weaving in each of the three stages of production: the starting border, the main web and the finishing border. The weft of the starting border becomes the warp of the main web and turns into the weft of the finishing border. (Drawing by Karina Grömer.)

and the main fabric could be observed, such as *croisage* (crossing of the threads) or cut-off threads.

The *main web* is a warp-faced tabby, made from s-twisted warp yarns and z-twisted weft yarns. The fabric appears to be very even and competently woven. The selvages are simple, i.e. each weft turns around and continues in the next shed without further ado. Occasionally, the turning threads interplay with the outermost warp thread, resulting in a corded appearance (Figure 6).

The *finishing border* is approximately 90mm wide, and begins with two opposed rows of twining made with paired yarns, concluding the main web, followed by a wide repp 4/1 border (Figure 7). The twining divides the end of the s-twisted warp threads of the main web into pairs that become the weft of the finishing border in two steps. Each pair of those threads was inserted into a shed of the finishing border, turned back into the next shed along with a fresh pair of warp ends and cut just below the twining. Remains of felted,

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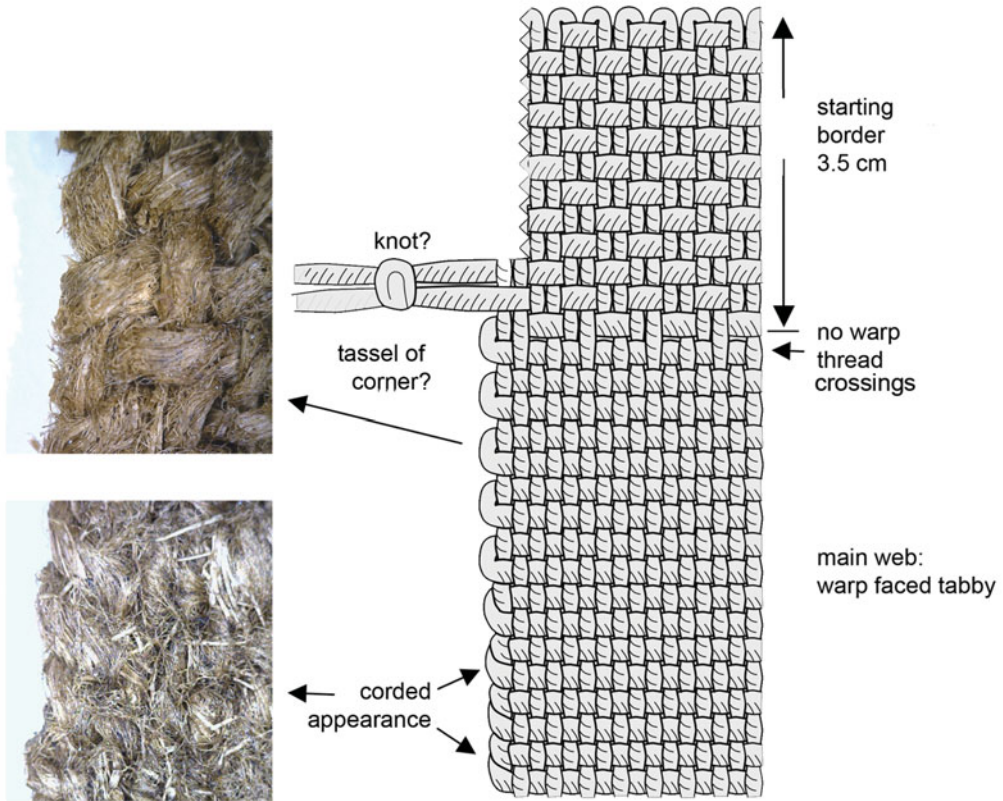


Figure 6. The starting border and selvages of the Pustopolje textile. (Graphics by Karina Grömer, and photographs by Hrvatski Restauratorski Zavod.)

cut warp threads appear regularly just below the twining. The warp yarns of the finishing border are z-twisted.

Stitching

A few stitches have been observed at various points of the textile, although without any discernible pattern. The sewing thread is S2z-plyed, and is made from darker fibres than the yarns of the fabric (Figure 8).

Dimensions

Large wool textiles, including complete items of clothing from the Bronze Age, have been found in a number of oak-log coffins from Denmark (Broholm & Hald 1940). A series of blankets and wraps/long skirts can be compared with the Pustopolje textile in terms of their dimensions and construction (Figure 9). A blanket from a male burial from Muldbjerg is the widest, at 2.11m across, although as it has been cut at both ends, we have no way of

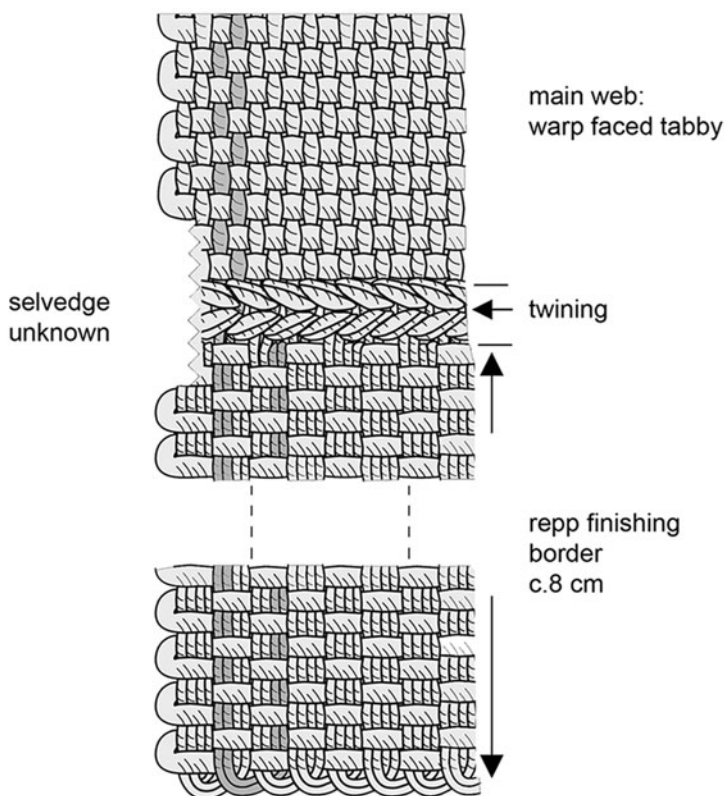


Figure 7. The finishing border of the Pustopolje textile. (Graphics by Karina Grömer.)



Figure 8. Stitch made of dark plied yarn in the Pustopolje textile. (Photograph by Hrvatski Restauratorski Zavod.)

knowing how long it originally was. The longest are two wraps from the female burials of Skrydstrup and Borum Eshøj C. The Skrydstrup wrap is 3.9m long and 1.45m wide; the Borum Eshøj wrap is 3.3m long and 1.22m wide. The Egtved blanket measures 2.59m at length and has a maximum width of 1.92m. Only one piece, a blanket from Trindhøj, is complete with all four edges preserved. It is 1.33m wide and 1.84m long (Broholm & Hald 1940). The dates of these finds are given in Table 1. The dimensions of the Pustopolje textile fit well into the overall pattern established by the Danish material. What makes it stand out is the finishing border, which has no known parallels and also appears to be more evenly woven than the Danish fabrics as the number of warp and weft threads per centimetre measured at various parts of the textile seem almost identical.

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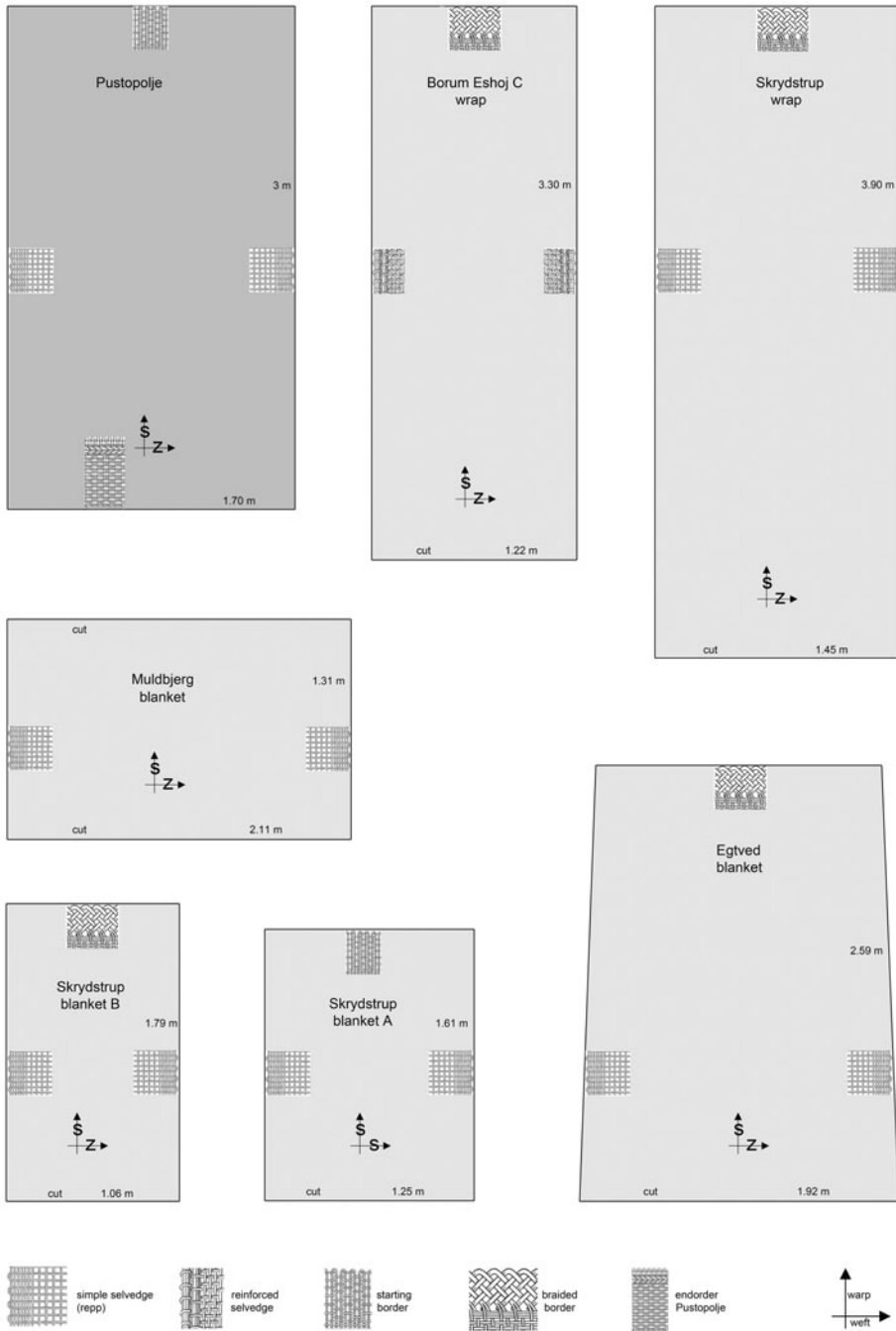


Figure 9. Dimensions and constructional details of large Bronze Age textiles from Pustopolje, Borum Eshøj C, Skrydstrup, Muldbjerg and Egtved. Measurements of the Danish finds are based on Broholm and Hald (1940), but are simplified and do not show minor irregularities in shape. (Graphics by Karina Grömer.)

Technology

The Pustopolje textile is an important contribution to our knowledge of the textile technology of Bronze Age Europe. Well-preserved textiles are rare and unevenly distributed across Europe and are seldom accompanied by textile tools (Bender Jørgensen 1992: 117–20; Rast-Eicher & Dietrich 2015: 114–18; Grömer 2016: 20–31). Starting borders like that found in the Pustopolje textile are generally assumed to indicate production using a warp-weighted loom (Hoffmann 1964: 151–83). The textiles and garments from the Danish oak-log coffins do, however, display two types of transverse borders: plaited borders and starting borders (for details, see Figure 9); both appear in almost all finds with substantial textile remains (Broholm & Hald 1940: 122–23). The Trindhøj blanket ends in fringes at both ends, which are made from closed warp loops (Broholm & Hald 1940: 37–39).

In their discussion of the technology of the Danish Bronze Age textiles, Broholm and Hald found that two loom types would fit with the available evidence if equipped with two or more short shed rods to divide the warp: the two-beam loom and the warp-weighted loom (Broholm & Hald 1940: 134–35). Recently, the properties and peculiarities of these two looms, as well as those of the two-beam loom with tubular warp and the ground loom of Pharaonic Egypt, have been investigated by Martin Ciszuk and Lena Hammarlund (2008). In an attempt to establish criteria to identify the different looms responsible for specific archaeological textiles, they concluded that hardly any characteristics are distinctive of a single loom type. Regrouping with crossing warp threads could, however, not be done on the warp-weighted loom; and a twined starting cord excludes the possibility of a loom with tubular warp—an intact warp lock, however, is proof of such a warp (Ciszuk & Hammarlund 2008: 130–31).

Loom weights are another, less equivocal, indicator of the warp-weighted loom. In Bosnia and Herzegovina, loom weights have been recovered from Bronze Age hillforts in the Livno, Duvno, Glamoč and Kupres areas. They are pyramidal with a hole in the top, and made of fired red-brown clay. Specimens in the Franciscan Museum and Gallery Gorica range in height from 90–110mm. Similar loom weights have been found in Dalmatia (Barbarić 2006: 62 & *pers. comm.*). Spindle whorls from Middle Bronze Age hillforts in south-west Bosnia are circular, 40–50mm in diameter and appear as flat, or rounded, with smooth or ribbed surfaces.

In Scandinavia, Bronze Age loom weights are rare. Very few have been found, but include those from the remains of a building excavated near the Skrydstrup burial (Ethelberg *et al.* 2000: 232). Spindle whorls are even rarer. As yet, only one specimen, dated to the end of the Scandinavian Bronze Age (750–500 BC), has been recovered (Mannering *et al.* 2012: 102).

In the Balkans, loom weights first appear in the Early Neolithic and continue throughout prehistory, although with changing sizes and shapes (Petrova 2015: 217–18). Loom weights and spindle whorls made of fired or unfired clay, or recycled pieces of pottery, are well-known features of Neolithic settlements in Central Europe, starting with the Starčevo and Linearbandkeramik cultures (6000–4400 BC). In the Early and Middle Bronze Ages, cylindrical loom weights of the Neolithic type are relatively common (Gleser 2007), but there is a lack of spindle whorls. With the advent of the Urnfield culture in the Late Bronze

Age and the Hallstatt Period (1300–750 BC), loom weights and spindle whorls of different shapes recur frequently in settlements and even in graves (Grömer 2016: 81–85, 110–12).

The warp yarns of the Pustopolje textile are between 0.7 and 0.9mm in diameter, while the weft yarns are between 0.9 and 1.3mm. In comparison, yarns from Danish Bronze Age textiles are thicker, usually 1.0–1.5mm, and much more variable, even within individual textiles (Fossøy 2018). One item, the kilt of Borum Eshøj grave B, has warp yarns with diameters ranging between 3.5 and 4.9mm (Broholm & Hald 1940: 161–62). This and the absence of Bronze Age spindle whorls in Denmark suggest that a different kind of spindle or spinning technique was employed there. Spinning can be done solely by using the hands without a spindle, or on a spindle but without a whorl, rotating it in the hand or rolling it down the thigh. A simple crooked stick may also serve as a spindle. Spinning performed by rotating a spindle in the hand was particularly suited for short-stapled wool (Crowfoot 1931: 44–45).

In conclusion, the Pustopolje textile was probably made on a warp-weighted loom, due to the starting border and contemporaneous prehistoric finds of loom weights. The presence of spindle whorls of the same date in the region indicates that the yarn was probably made on a drop spindle. This suggests that Bronze Age textile technology and craft traditions of the Balkans and Central Europe differed from those represented by the textiles and garments from the oak-log coffins in Denmark.

Use

According to Benac, the Pustopolje textile was wrapped around the naked body of the deceased, a man of about 60 years of age and 1.7m tall (Benac 1986). Apart from the fabric, no artefacts were found in association with the body. The textile was folded in half, and further folded in the shape of an S to fit into the burial chest where it was deposited on top of a layer of skin. The deceased was placed under the top layer (Car & Meder 2010: 26–27). The textile appears to have been used before it was deposited in the grave. Parts of the surface appear felted (Figure 4), and this also applies to the fuzzy ends of cut wool threads at the finishing border and the tassel. This is caused by use-wear or washing, although some may be due to the decomposition of the deceased. The size and shape of the textile suggests that it was a blanket, but it may, perhaps, originally have been a draped garment.

The uses of the large wool textiles from the Danish oak-log coffins have been extensively discussed. The wraps in the Skrydstrup and Borum Eshøj burials have been explained as either long skirts that might have been worn in a variety of ways, or draped or wrapped around the body as an outer garment (Broholm & Hald 1940: 155, fig. 197; Kristiansen 1974; Munksgaard 1974: fig. 52; Hansen 1980; Bergerbrant 2007: 56–58; Randsborg 2011: 41–45, fig. 14). Items designated as blankets have generally been assumed to be unspecified textiles or a form of bedding; recently, Klavs Randsborg has suggested that those from the Skrydstrup grave are long skirts (2011: 41).

Further sources of complete, early textiles have been found in the Middle East, coming in particular from Pharaonic Egypt, although all of these are made of flax and belong to entirely different technological traditions. A fourth-millennium burial in the Cave of the Warrior in the Judean Desert contained several items (Schick 2003). The largest piece merits

comparison with the Pustopolje textile. It was 1.96m wide and 0.69m long, with warp fringes at either end, and a weft fringe along one selvedge. It was folded in half across its long axis, and then folded in half again, forming a four-layered wrapping, enclosing the deceased, much like in the Pustopolje burial. According to Schick (2003: frontispiece), it had served as a long kilt, held in place by a sash.

Pharaonic Egyptian textiles appear in a great variety of lengths; Petrie mentions sheets from Deshasheh dated to the Old Kingdom that are around 9m long (Petrie 1898: 32), and another group of Old Kingdom textiles from Asyut are even longer, measuring more than 20m in length (British Museum EA 46632/3). The width, however, is rarely more than 1.3m (Vogelsang-Eastwood 1993: 6). Most items of Pharaonic Egyptian clothing were wrap-around garments, consisting of lengths of cloth wrapped around the body in a variety of ways, such as kilts, skirts, cloaks, shawls and some forms of dresses. Loincloths, bag-tunics and some dresses were cut-to-shape (Vogelsang-Eastwood 1993: 5–6).

The stitches observed in the Pustopolje textile suggest that they had served to hold the textile in place, either for the burial or during its earlier use. Unfortunately, the position of only one of these stitches has been documented, complicating interpretation. No pin holes have been detected; the thick shafts of Early Bronze Age pins mean that visible holes would be expected if the textiles had been pinned in any way. Experiments based on the dress depicted on a Bronze Age figurine from the Lower Danube have been carried out to explore how the Pustopolje textile could have been worn as a draped garment (Grömer *et al.* 2013: 235–37). The results were inconclusive, leaving us without a clear answer to the question of the textile's use. We may conclude, however, that as it offers no evidence of tailoring, the Pustopolje textile was used as it came off the loom, either as a large blanket or coverlet, or as a draped garment.

Conclusion

The Pustopolje textile fits well into the context of contemporaneous Bronze Age textiles, except for the presence of an end border. The size and shape corresponds to those of well-preserved textiles and garments found in Denmark, but it appears more even and more competently made than these. Technologically, the Pustopolje textile is more closely related to contemporaneous textiles from Central Europe. The warp-weighted loom is known to have been used there, while evidence suggests that either a different loom, or perhaps several different types of loom, were in use in Scandinavia at that time. Similarly, the lack of spindle whorls in Scandinavia suggests that the employment of a different technology may explain why Scandinavian yarns are coarser and less even. The wool, too, is comparable to wools from Central Europe, yet different from Scandinavian wools (Rast-Eicher & Bender Jørgensen 2013). Finally, the Pustopolje textile is among the earliest, known examples of dyed textiles in Europe, and offers an enticing glimpse of Bronze Age textile colours other than those available from the various shades of naturally pigmented wool.

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References

- BARBARIĆ, V. 2006. Nekropola u Vičjoj luci i gradina Rat na otoku Braču—nova razmatranja. *Vjesnik za Arheologiju i Povijest Dalmatinsku* 99: 43–62.
- BENAC, A. 1986. *Praistorijski tumuli na Kupreškom Polju* (Centar za balkano loška ispitivanja Djela 5; Akademija nauka i umjetnosti Bosne i Hercegovine Knjiga 64). Sarajevo: Akademija nauka i umjetnosti Bosne i Hercegovine.
- 1990. Recently excavated Bronze Age tumuli in the Kupreško polje, Bosnia, Yugoslavia. *Antiquity* 64: 327–33.
<https://doi.org/10.1017/S0003598X0007798X>
- BENDER JØRGENSEN, L. 1992. *North European textiles until AD 1000*. Aarhus: Aarhus University Press.
- BERGERBRANT, S. 2007. *Bronze Age identities: costume, conflict and contact in Northern Europe 1600–1300 BC* (Stockholm Studies in Archaeology 13). Lindome: Bricoleur.
- BROHOLM, H.C. & M. HALD. 1940. *Costumes of the Bronze Age in Denmark*. Copenhagen: Nyt Nordisk Forlag/Arnold Busck.
- BRONK RAMSEY, C. 2005. *OxCal Program v3.10. Manual*. 2005. Oxford: University of Oxford Radiocarbon Accelerator Unit (<http://www.rlaha.ox.ac.uk/oxcal/oxcal.htm>).
- CAR, G. & F. MEDER. 2010. Izvješće o provedenim konzervatorsko-restauratorskim radovima na fragmentima grobnog plašta iz prapovijesnog zemljanog tumula br. 16, Pustopolje Kupreško, u vlasništvu Franjevačkog muzeja i galerije Gorica, Livno, Bosna i Hercegovina. Unpublished report, Hrvatski Restauratorski Zavod, D-382/2010.
- CHRISTENSEN, K. 2006. Dendrochronological dating of Bronze Age oak coffins from Denmark and Schleswig. Bronze Age oak-coffin graves. *Acta Archaeologica* 77: 163–246.
- CISZUK, M. & L. HAMMARLUND. 2008. Roman looms—a study of craftsmanship and technology in the Mons Claudianus project, in C. Alfaro & L. Karali (ed.) *Purpureae Vestes II. Vestidos, textiles y tintes*: 119–33. Valencia: University of Valencia Press.
- CROWFOOT, G.M. 1931. *Methods of hand spinning in Egypt and the Sudan* (Bankfield Museum Notes, Second Series, 42). Halifax: Bankfield Museum.
- ETHELBERG, P., E. JØRGENSEN, D. MEIER & D. ROBINSON. 2000. *Det Sønderjyske landbrugs historie volume 1: sten- og bronzealder*. Haderslev: Haderslev Museum og Historisk Samfund for Sønderjylland.
- FOSSEY, S.H. 2018. The production of Scandinavian Bronze Age textiles: skill and creativity, in L. Bender Jørgensen, J. Sofaer & M.L.S. Sørensen (ed.) *Creativity in the Bronze Age: understanding innovation in pottery, textile and metal production*: 115–126. Cambridge: Cambridge University Press.
- GLEBA, M. 2012. From textiles to sheep: investigating wool fibre development in pre-Roman Italy using scanning electron microscopy (SEM). *Journal of Archaeological Science* 39: 3643–61.
<https://doi.org/10.1016/j.jas.2012.06.021>
- GLESER, R. 2007. Zylindrisches Webgewicht der Bronzezeit von Büschdorf, Kr. Merzig-Wadern, und vergleichbare Funde in Mitteleuropa, in R. Gleser (ed.) *Zwischen Mosel und Morava*: 127–73. Bonn: Dr Rudolf Habelt.
- GRÖMER, K. 2016. *The art of prehistoric textile making: the development of craft traditions and clothing in Central Europe* (Veröffentlichungen der Prähistorischen Abteilung 5). Vienna: Naturhistorisches Museum Wien.
- GRÖMER, K., H. RÖSEL-MAUTENDORFER & L. BENDER JØRGENSEN. 2013. Visions of dress: recreating Bronze Age clothing from the Danubian region. *Textile: Cloth and Culture* 11: 218–41.
<https://doi.org/10.2752/175183513x1379321037403>

- HANSEN, H.H. 1980. Skrydstrup-kvindens dragt. *Aarbøger for Nordisk Oldkyndighed og Historie* 1978: 139–49.
- HOFFMANN, M. 1964. *The warp-weighted loom: studies in the history and technology of an ancient implement* (Studia Norvegica 14). Oslo: Universitetsforlaget.
- HOFMANN-DE KEIJZER, R. 2016. Dyeing, in K. Grömer, *The art of prehistoric textile making: the development of craft traditions and clothing in Central Europe* (Veröffentlichungen der Prähistorischen Abteilung 5): 140–69. Vienna: Naturhistorisches Museum Wien.
- KRISTIANSEN, K. 1974. Glerupfundet. *Hikuin* 1: 7–38.
- MANNERING, U., M. GLEBA & M. BLOCH HANSEN. 2012. Denmark, in M. Gleba & U. Manning (ed.) *Textiles and textile production in Europe: from prehistory to AD 400*: 91–118. Oxford: Oxbow.
- MARIĆ BAKOVIĆ, M. & G. CAR. 2014. Konzervatorsko-restauratorski radovi i rezultati najnovijih analiza na tekstilnome plaštu iz prapovijesnoga zemljanog tumula Br. 16, Pustopolje, Kupres. *Cleuna* 1: 30–47.
- MUNKSGAARD, E. 1974. *Oldtidsdragter*. København: Nationalmuseet.
- PETRIE, W.M.F. 1898. *Deshasheh* (The Egypt Exploration Fund Memoir 15). London: Egypt Exploration Society.
- PETROVA, V. 2015. History of the warp-weighted loom from the Neolithic until the end of antiquity (according to archaeological data from the present-day Bulgarian lands). *Studia Archaeologica Universitatis Serdicensis* 5: 115–218.
- RANDBORG, K. 2011. *Bronze Age textiles: men, women and wealth*. London: Bristol Classical.
- RAST-EICHER, A. 2008. *Textilien, Wolle, Schafe der Eisenzeit in der Schweiz* (Antiqua 44). Basel: Archäologie Schweiz.
- 2015. Schnidejoch: Neolithische, bronzezeitliche und römische Geflechte und Gewebe, in A. Hafner (ed.) *Schnidejoch und Lötschenpass. Archäologie der prähistorischen, römischen und mittelalterlichen Passübergänge in den Berner Alpen, Bd. 1*: 30–38. Bern: Archäologischer Dienst des Kantons Bern.
- RAST-EICHER, A. & L. BENDER JØRGENSEN. 2013. Sheep wool in Bronze Age and Iron Age Europe. *Journal of Archaeological Science* 40: 1224–41. <https://doi.org/10.1016/j.jas.2012.09.030>
- RAST-EICHER, A. & A. DIETRICH. 2015. *Neolithische und bronzezeitliche Gewebe und Geflechte. Die Funde aus den Seufersiedlungen im Kanton Zürich*. Zürich & Egg: Kanton Zürich Baudirektion.
- REIMER, P.J., M.G.L. BAILLIE, E. BARD, A. BAYLISS, J.W. BECK, P.G. BLACKWELL, C. BRONK RAMSEY, C.E. BUCK, G.S. BURR, R.L. EDWARDS, M. FRIEDRICH, P.M. GROOTES, T.P. GUILDERTSON, I. HAJDAS, T.J. HEATON, A.G. HOGG, K.A. HUGHEN, K.F. KAISER, B. KROMER, F.G. MCCORMAC, S.W. MANNING, R.W. REIMER, D.A. RICHARDS, J.R. SOUTHON, S. TALAMO, C.S.M. TURNER, J. VAN DER PLICHT & C.E. WEYHENMEYER. 2009. IntCal09 and Marine09 radiocarbon age calibration curves, 0–50,000 years cal BP. *Radiocarbon* 51: 1111–50. <https://doi.org/10.1017/S0033822200034202>
- REZAEI, H.R., S. NADERI, I.C. CHINTAUAN-MARQUIER, P. TABERLET, A.T. VÍRK, H.R. NAGHASH, D. RIOUX, M. KABOLI & F. POMPANON. 2010. Evolution and taxonomy of the wild species of the genus *Ovis* (Mammalia, Artiodactyla, Bovidae). *Molecular Polygenetics and Evolution* 54: 315–26. <https://doi.org/10.1016/j.ympev.2009.10.037>
- SCHICK, T. 2003. *A 6,000-year-old nobleman: finds from the Cave of the Warrior*. Jerusalem: The Israel Museum.
- VAN BOMMEL, M.R., I. JOOSTEN & R. HOFMANN-DE KEIJZER. 2012. Dyestuff, mordant and condition of an early wool textile from Pustopolje, Bosnia-Herzegovina. Unpublished report, project CinBA. Vienna: Natural History Museum Vienna.
- VAN STRYDONCK, M. 2012. Radiocarbon dating report: Kupres—Bosnia Herzegovina, in the archives of the Hrvatski Restauratorski Zavod and the Franjevačkog muzeja i galerije Gorica, Livno. Unpublished report, KIK/IRPA Brussels.
- VOGELSANG-EASTWOOD, G. 1993. *Pharaonic Egyptian clothing*. Leiden, New York & Cologne: E.J. Brill.

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