

Creature Comforts at Vindolanda: Two Unique Wool Mats with
Knotted Pile

SUPPLEMENTARY MATERIAL

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APPENDIX 1: TECHNICAL DESCRIPTION OF TEXTILE 1 (TT/88/639 with TT/88/644)

By John Peter Wild

TT/88/639/001

Heavy dark-brown pile fabric in half-basket weave with 2 sets of plied warp ('thick' and 'thin') and paired weft with rows of Ghiordes knots and selvedge (ONLINE FIGS 1 and 2).

(1) Warp: warp A: thick 2-ply, medium-hard (30–40°) S-plyed from 2 weaker (*c.* 20°) Z-spun yarns, diameter *c.* 2–2.5 mm (variable); warp B: thin 2-ply, medium-hard (30–40°) plyed from 2 weaker (*c.* 20°) Z-spun yarns, diameter *c.* 1 mm; yarn counts: in Band A at selvedge *c.* 7 thick plies of warp A per cm; in Band B *c.* 14 thin plies of warp B per cm (extrapolated to 1 cm); in Band C *c.* 7 thick plies (as in Band A); in Band D *c.* 14 thin plies (as Band B); in Band E (= ground weave) 1 thick (warp A) ply alternates with 1 thin ply (warp B) at 5–6 plies together per cm; max.l. 150 mm.

(2) Weft: medium (*c.* 30°) Z-spun (*c.* 1 mm thick), paired, *c.* 2 pairs per cm, wide spaced, max.l. 80 mm.

Selvedge in 1/1 tabby structure (pair returns without dividing): sequence from outside: 8 thick threads of warp A (Band A), then 8 thin threads of warp B (Band B), then 4 thick threads of warp A (Band C), then 4 thin threads of warp B (Band D), and finally ground weave in which single thick and thin warp threads alternate.

Pile of Ghiordes (symmetrical) knots (on one side of the cloth only): each knot clasps 2 adjacent thin warp threads (warp B) (skipping the thick warp between them), and each successive row of knots clasps same thin warp threads, leaving 1 shot of paired weft between the rows free of knots; the pile yarn (*c.* 1 mm thick) is now very weak Z-spun and in some cases definitely – and in all cases perhaps originally – paired and projecting at least 13 mm proud of surface. The first knot of the ground weave clasps the last thin warp thread of selvedge Band D.

The fragment is highly degraded, friable and disintegrating, and it is not certain that the pile covered its surface uniformly: certainly in one area of *c.* 20 mm by 20 mm there is overall pile, crushed into the ground weave.

The textile is now a uniform dark brown in colour: there is no visible distinction between the colours of warp A and B.

TT/88/639/002

Heavy dark-brown pile fabric, as TT/88/639/001.

(1) Warp: max.l. 80 mm.

(2) Weft: max.l. 60 mm.

Selvedge: no undamaged selvedge preserved, but one weft yarn (of a pair) returns intact.

Pile: no sign of pile on either face: it may have been absent.

TT/88/639/003

Six small fragments of same textile as TT/88/639/001, in assorted sizes, screwed up, with heavy damage but no sign of pile.

TT/88/639/001–003

Summary

Heavy dark-brown textile in half-basket weave, with two types of plied warp, paired weft, structurally plain but decorative selvedge, and carrying Ghiordes knots (but possibly not overall).

For more of same pile textile cf. TT/88/644 below.

Findspot: Vindolanda, Period I inner fort ditch.

TT/88/644

Heavy dark-brown pile fabric in half-basket weave with 2 sets of plied warp ('thick' and 'thin') and paired weft with rows of Ghiordes knots; cf. TT/88/639/001–003, same textile.

(1) Warp: warp A: thick 2-ply, medium-hard S-ply from 2 weaker Z-spun yarns; warp B: thin 2-ply, medium-hard S-ply from 2 weaker Z-spun yarns; 1 thick (warp A) alternates with 1 thin (warp B) thread at 6–7 plies together per cm; max.l. of woven fabric 70 mm, max.l. of longest extant projecting warp thread 250 mm.

(2) Weft: medium Z-spun, paired, *c.* 2–3 pairs per cm, wide spaced, max.l. 120 mm.

Selvedge: none survives.

Parallel to the weft the cloth edge is turned back *c.* 8 mm to reverse of fabric, possibly deliberately; on opposite edge the plied warp projects from cloth *c.* 15 mm, ending in a straight (original?) line.

Pile of Ghiordes knots, as in TT/88/639/001: each knot clasps 2 adjacent thin warp threads (warp B), leaving 1 shot of paired weft between the rows free of knots; the pile knots are each formed of 2 weak Z-spun yarns, projecting now *c.* 13 mm from cloth surface; the extant area of fabric carries 5 rows of knots, the longest (row 1, closest to folded edge) of 13 knots, row 3 has 10 knots, the rest far fewer; row 4 has knots of varying structure: most have 2 yarns, but

second from left has 3 yarns, then 6 knots of 2 yarns (some damaged), then 1 knot of 3 yarns (one of them thin and overspun); in row 3 tenth knot from left is of 3 yarns, rest of 2, including eighth knot which includes 1 yarn of unusual silvery hue.

The fragment, dark brown in colour, is poorly preserved, but seems to have had pile overall.

Findspot: Vindolanda, Period I inner fort ditch

APPENDIX 2: INVESTIGATION OF THE RAW MATERIALS OF TEXTILE 1

By Penelope Walton Rogers

Analysis

Samples of yarn from the main warp, the fine selvedge warp, the weft of the ground weave and the pile were extracted from the best-preserved fragment, TT/88/644, in order to investigate the raw materials. The fibres were examined first by transmitted-light microscopy at x100–x640 magnification. All four samples showed the general characteristics of sheep's wool, including an irregular waved mosaic scale pattern with smooth near margins and continuous medullas which were broad and latticed in fibres over 100 microns wide.¹

The fleece-type of the wool was then investigated by measuring the diameters of 100 fibres per sample, at x400 magnification. According to the range, mode, mean and distribution (the degree of skew) of the measurements, the sample could be allocated to one of Ryder's seven fleece-type categories (ONLINE TABLE 1). The wool proved to be Hairy fleece-type in the ground weave (the thick main warp and the weft), Hairy Medium in the finer selvedge warp yarn and Medium in the pile yarn.

While the diameters were being measured, a record of any pigmentation present was also made. Natural pigmentation can be identified from the presence and density of granules in the fibre. 20–30% of the fibres in the weft yarn were moderately pigmented, indicating a mottled brown and white wool. Further samples of the weft yarn in other fragments were investigated and proved to be much the same ratio of brown to white fibres. All the other samples were originally white (though now stained from burial), except for a single brown fibre in the selvedge warp.

¹ Appleyard 1978, 26–7.

Finally, the textile was tested for the presence of dye by measuring the visible absorption spectra of solvent extracts made up from three of the samples, the main warp, the fine selvedge warp and the pile. These tests revealed a small amount of indigotin in the pile. No dye was found in the other two samples. Indigotin is the detectable constituent in dyeings made from three plants, woad, *Isatis tinctoria* L., indigo, *Indigofera* spp, and knotweed, *Polygonum tinctorium* Ait. Knotweed is unlikely as its use was largely limited to China and Japan, but indigo from tropical Asia and Africa, and woad from temperate parts of Europe and Asia are equally likely. Both plants were used for blue dye over a wide period of time and over a broad geographic area.

Comment

The aim of the investigation was to look for evidence for the place of manufacture of the piled weave. First of all, it is obvious that, in terms of fleece-type, the textile does not match any of the wool textiles from Roman Britain previously examined by Ryder.² The Hairy wools seen in two of the samples do not occur in British textiles until the ninth and tenth centuries and the Medium wool is also relatively rare until that time.³ There was a single tuft of raw wool from Vindolanda which gave a Hairy-like range of fibre diameters,⁴ but that was the tip end of a lock of wool and, since hairs tend to protrude beyond the underwool, it is almost certain that it represents the tip of a Hairy Medium fleece — and Hairy Medium types were common enough in Romano-British textiles.

Nor do the fleece-types of the pile match the wool in the piled weaves from seventh-century Sutton Hoo, Suffolk, and Broomfield Barrow, Essex, which had pile yarns made from Fine/Generalised Medium and Fine types respectively.⁵ Other piled fabrics examined by the author belong to the later period during which Hairy and Medium fleeces had been introduced into Britain, possibly by the Vikings.

Few other piled weaves of the Roman period have been examined, except for a group from northern Afghanistan, dated to the second to fourth centuries (now in the Al-Sabah Collection of Islamic Art in Kuwait). These are made from Hairy, Hairy Medium and Generalised Medium wools and a piece of lambskin attached to one is a Medium fleece-type

² Ryder 1977; 1983a, 180.

³ Walton 1989, 307.

⁴ Ryder 1977.

⁵ Ryder 1983b.

(Walton Rogers unpublished). Mottled brown wool comparable with the weft yarn of the Vindolanda piece is present in warp yarns from two fragments (and pigmented goat hair had also been used). The Afghani pieces had brightly dyed piles on undyed grounds, their colour being better preserved than in the Vindolanda example. The red and yellow dyes used suggested that some had been made in central Asia, possibly Afghanistan itself, and others in western Asia.

Without further work on comparable piled weaves from other parts of the Roman world, it is not possible to suggest a place of origin for the Vindolanda piled weave on the basis of the raw material alone. Similar fleece-types were probably available in mainland Europe, even though they did not reach Britain. Nevertheless, the similarity between the Vindolanda fragments and the Asian piled weaves from Afghanistan is striking.

ONLINE TABLE 1. Fleece-types of yarns in pile weave TT/88/644 (Textile 1).

(Statistics for each sample are based on the measurements of the diameters of 100 fibres. Measurement in microns (1 micron = 0.001 mm))

Sample	Range	Mode(s)	Mean±S.D.	Skew, distribution	Medullas	Pigment	Fleece-type
Thick S-ply warp	17-87, 118-129	multi	44.5±20.4	+0.43, continuous	33% (3 kemp)	0	Hairy (white)
Fine S-ply selvedge	16-51, 66	31	31.5±8.5	+0.66, skewed positive	1%	1%	Hairy Medium (white)
Z-spun weft	14-81, 101,143	24	41.3±21.8	+1.04, skewed positive	34% (2 kemp)	20-30% moderate	Hairy (mottled brown)
Pile yarn	15-52	32	32.8±7.6	+0.19, symmetrical	1%	0	Medium (white, dyed blue)

APPENDIX 3: TECHNICAL DESCRIPTION OF TEXTILE 2 (TT/85/030/001–003 with TT/85/055/001/2)

By John Peter Wild

TT/85/030/001

Heavy pile fabric in tabby weave with 2 sets of plied warp (dark and light) and plied weft with rows of Ghiordes knots and selvedge, also showing dark/light pattern effects.

(1) Warp: warp A: dark 2-ply, medium-hard S-plied from 2 weaker Z-spun yarns, overall diameter *c.* 15 mm; warp B: light 2-ply, medium-hard S-plied from 2 weaker Z-spun yarns,

overall diameter *c.* 15 mm (but actually thicker than warp A); count of A + B is *c.* 8–9 per cm (39 per 50 mm).

(2) Weft, soft dark-brown 3-ply, medium-hard S-plied from 3 weaker Z-spun yarns, overall diameter 2–3 mm variable, *c.* 3 per cm, spaced out (11 per 50 mm).

Selvedge in plain 1/1 tabby structure: sequence from outer edge: 8 dark warp A threads, then (probably) 8 light warp B (locally missing), then probably 4 warp A, then probably 7 light warp B, then regular alternation of a (thin) dark warp A and a (thicker) light warp B in ground web; the first 16 (thin) warp A threads are clasped by 8 dark knots, then light knots clasp warp A threads over rest of textile (except for 2 instances of just 3 dark knots). Selvedge zone free of knots *c.* 35 mm wide. Surviving length of intact selvedge 130 mm.

Pile of Ghiordes (symmetrical) knots: each knot (whether dark- or light-brown) is built from 6 single weak Z-spun yarns (yarns *c.* 0.5 mm thick), not apparently twisted together (but might = 3 pairs); knots in succession weft-ways clasp adjacent pairs of (thinner) warp A threads, ignoring all (thicker) warp B threads; knots only inserted when shed drawing warp A forward is open (no knots clasp warp B threads); each successive knot warp-ways clasps same 2 warp A threads as its predecessor had done. Knot base 4–5 mm across weft-ways, *c.* 4 mm warp-ways; once projecting knots (pile) now mostly worn down to level of base fabric (flattened fibres and fibrillated fibre ends visible under Scanning Electron Microscopy). It was once clearly long enough to have a soft resilient handle.

Decorative scheme: the dark- and light-brown stripes in the warp clearly visible in the selvedge zone (and on the back of the fabric) and in the contrasting areas of dark- and light-brown pile are for decorative effect, possibly once enhanced by dyeing. Whether the isolated groups of dark-brown knots on a light-brown background are intentional is not certain.

Both sides show evidence of long and intensive wear.

Findspot: Vindolanda, Period I inner fort ditch.

TT/85/030/002

Heavy pile fabric as 030/001

(1) Warp, max.l. 40 mm.

(2) Weft, max.l. 70 mm.

Selvedge (max.l. 35 mm), as on 030/001: selvedge zone and part of area of dark-brown knots survives.

Other fragments, unnumbered: c. 13, unrecordable, totalling c. 117 cm².

TT/85/030/001–002

Summary

Heavy tabby-weave pile fabric with dark and light plied warp and plied weft, plain selvedge, overall Ghiordes knots on warp A: dark/light contrasting pattern visible as stripes in warp, areas of dark/light knots. The dark-brown warp and weft are both highly pigmented; the warp close to selvedge is off-white with suggestion of red dye; the knot yarns are white wool with suggestion of blue dye. One large, several small fragments. Compare TT/85/055/001/2 below (same textile).

Findspot: Vindolanda, Period I inner fort ditch.

TT/85/055/001/2

Heavy tabby-weave pile fabric with plied warp and weft, same textile as TT/85/030/001.

(1) ?Warp, 2-ply, S-ply from Z-spun yarn, c. 9 per cm (overall), max.l. 25 mm.

(2) ?Weft, probably 3-ply, S-ply from Z-spun yarn, darker than (1), c. 4 per cm, max.l. 40 mm.

Pile: Ghiordes knots clasp pairs of adjacent threads from same warp sheet, as TT/85/030/001.

Traces of 4–5 knots survive, c. 4 mm base diameter weft-ways. Knot yarn weak Z-spun, 4 single yarns in knots (not 6 as in TT/85/030/001).

Medium brown. No sign now of internal colour differentiation, but weft darker than warp, as in TT/85/030/001.

Findspot: Vindolanda, Period III *via principalis* to west of trench VIA.

APPENDIX 4: WOOL USED IN TT/85/030/001–002 (TEXTILE 1) COMPARED WITH TT/85/644 (TEXTILE 2)

By Penelope Walton Rogers and Isabella von Holstein

Introduction

Investigation of the wool used in pile-weave Textile 1 from Vindolanda (TT/88/644 and TT/88/639) demonstrated that it had been made with fleece-types that were probably not commonly available in northern England in the first century A.D.⁶ A similar pile weave, Textile 2 (TT/85/030) above, identified in the 1985 collection of finds, has now been sampled for comparison with the first. Microscopy of the new samples has shown that, while there is a broad similarity between the two textiles in the use of colour (pigmented wools and dyes), the nature of the wool is different. No significant conclusions can be drawn concerning the place of manufacture of the second piece, but some comments can be made on the different characteristics of the two textiles and how they will have appeared when new.

Method of analysis

A single yarn was extracted from each of the two ground warp yarns, the selvedge warp, the weft and the dark and pale pile yarns, making six samples in all. Each sample was prepared for microscopy as a whole mount (longitudinal view) in water. Measurements of fibre diameters were made at x400 magnification with a transmitted-light microscope fitted with an eyepiece graticule. The accuracy of this measuring system has previously been checked against standards provided by Dr Michael Ryder, and the results achieved by this means are known to be directly comparable with Ryder's published results⁷ and those of others who have submitted to similar testing.⁸ The diameters of 100 fibres were measured in each case and the samples allocated to one of the seven fleece-types posited by Ryder.⁹

A system which measures diameters using fibre cross-sections and a scanning electron microscope has been developed recently for mineralised textiles.¹⁰ This has been

⁶ Wild and Walton Rogers 2007.

⁷ Ryder 1969; 1983a.

⁸ Ryder and Hedges 1973.

⁹ Ryder 1969; Walton Rogers 1995.

¹⁰ Rast-Eicher 2008, 121–55; Gleba 2012.

compared with Ryder's system, although it does not appear to have been tested against Ryder's control standards and at present the results of the two systems are not directly comparable.

Results (ONLINE TABLE 2)

All samples in TT/85/030 were on average finer than those taken from the textile previously tested. Means were 24.5–28.9 microns for TT/85/030 and 31.5–44.5 microns for TT/88/644, while modes (most common measurements) were 21–24 microns for TT/85/030 and 24–32 for TT/88/644 (ONLINE TABLE 2).

The fleece-types in TT/85/030 were Hairy Medium in the warp and Generalised Medium in the pile. The wool in the weft yarn was difficult to categorise, as it fell at the borderline between Generalised Medium and Semi-Fine: this was a period when the Semi-Fine (previously known as the Shortwool fleece type), and other more evolved fleeces, were emerging from the Hairy Medium and Generalised Medium types¹¹ and it is possible that this particular sample represents a transitional type. The fleece-types in this textile are different from those in the four samples from TT/88/644, which were identified as two Hairy, one Hairy Medium and one Medium.

Both textiles were made with a combination of mottled brown (natural fleece colour) and white yarns in the ground weave. A blue colour was noted in the pile of both fabrics and confirmed analytically as a dye in TT/88/644. A reddish tinge in the selvedge of TT/85/030 was also noted, although no dye was detected in the selvedge of TT/88/644.¹² A similar arrangement of naturally brown wools in the ground and dyed white wool in the pile was observed in two pile weaves of the second to fourth centuries from Afghanistan.¹³

Comment

Hairy wools tend to be associated with mountain breeds and the hardy double-coated sheep of the North Atlantic islands; the Hairy Medium is more common among hill breeds; and the other fleece-types might be expected to come from flocks in more carefully managed lowland flocks. It is likely, however, that flocks were more mixed in the past than they are nowadays

¹¹ Ryder 1983a, 130–3.

¹² Wild and Walton Rogers 2007, 77.

¹³ *ibid.*, 77–8.

and it is known that among primitive breeds Generalised Medium types can occur in a predominantly Hairy Medium flock.¹⁴ It should also be noted that a single workshop situated in, say, a river basin, might draw on wool from hills and mountains a relatively short distance away. It would therefore be necessary to test many more pile-weave samples to see if a pattern emerged before any conclusions could be drawn on the regions in which the wool is likely to have been produced. Stable isotope analysis should also provide insight into the climatic zone in which the wool will have originated.¹⁵

Setting aside the problem of the geographic sources of the pile-weave textiles and their raw materials, some further observations can be made, based on the fleece-type analysis. The nature of the wool has an effect on the handle of the fabric and in this respect there was probably a difference between the two when in use. Hairy fleeces are sometimes termed ‘carpet wools’ because of their robust hard-wearing nature and Medium wools are also relatively hard and smooth to the touch (they are found, for example, in the longwool breeds used for worsteds). The Hairy Medium and Generalised Medium wools on the other hand are softer, more ‘woolly’ and more prone to felting. Anyone running a hand across the pile of TT/85/030 and TT/88/644 would probably have noticed a difference between the two, and during use as sleeping mats,¹⁶ their different wear properties may well have become evident.

These two pile-weaves were obviously made within the same general weaving tradition and probably looked similar to the naked eye. Microscopy, however, has demonstrated subtle differences between the two that suggest that one was softer and warmer in use, and the other more hard-wearing.

¹⁴ Ryder 1983a, 47.

¹⁵ von Holstein *et al.* 2016.

¹⁶ Wild and Walton Rogers 2007, 3.

ONLINE TABLE 2. Fleece-types of yarns in TT/85/030 (Textile 2)

(Statistics for each sample are based on the measurement of the diameters of 100 fibres. Measurements in microns (1 micron = 0.001 mm))

Sample	Range	Mode(s)	Mean \pm S.D.	Pearson Coeff. of Skew, distribution	Medullas	Pigment	Fleece-type
<u>Textile 2 (TT/85/030)</u>							
Dark S-ply warp	14-94	22	28.9 \pm 13.6	+0.84, skewed positive	8%	\geq 44% dense & moderate	Hairy Medium (mottled brown fleece)
Pale S-ply warp	14-60, 119	22	26.7 \pm 12.9	+0.80, skewed positive	4% (1 kemp)	1%	Hairy Medium (white fleece)
Selvedge dark warp	11-18, 94, 104	multi	28.9 \pm 13.9	+0.54, skewed positive	7% (2 kemp)	\geq 10%	Hairy Medium (off-white fleece, red colour)
S-ply weft	10-57	24	24.5 \pm 7.2	+0.31, symmetrical	5%	\geq 24% dense & moderate	Unclear: see text (mottled brown)
Dark pile yarn	15-50	21	25.7 \pm 7.5	+0.44, skewed positive	0	0	Generalised Medium (white fleece, dark colour)
Pale pile yarn	12-50	22	26.0 \pm 6.2	+0.55, skewed positive	0	0	Generalised Medium (white fleece, blue colour)

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SUPPLEMENTARY ILLUSTRATIONS

ONLINE FIG. 1. Textile 1 (TT/88/639/001) showing selvedge (above, now curved). Warp runs horizontally on photograph. (*Photo by J.C. Batcheller*)



ONLINE FIG. 2. Detail of selvedge area of replica of Textile 1 by Caroline Thomson. (*Photo by J.P. Wild*)

