Warm and dry: a complete Roman tent from Vindolanda

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Army Tents

It has long been known that the Roman army made use of leather tents: indeed, *sub pellibus* (under the skins) was a generally accepted term for forces on campaign. Images of tents are a prominent symbol of the order and safety of the army camp in the exciting narrative of the Dacian campaigns recorded on Trajan's Column in Rome (MacIntyre and Richmond 1934, 62-4), and an anonymous author writing in the early second century AD, the so-called Pseudo-Hyginus, has even left us details of their arrangement. Pitched in orderly rows, each tent occupied an area of ten Roman feet (about three metres square) and sheltered a *contubernium* (mess-mates) of eight men. The centurion possessed a similar tent at the end of the row all to himself, and there was additional space for the baggage (Gilliver 1993; Millar and DeVoto 1994). There is some confusion in the text (and translations differ) as to the number of tents in each row, but few excavated barrack plans show the eight tent positions implied by the statement that no tents need to be pitched for the men on guard duty. As Morel (1991) points out, this text describes a marching camp, and in a more permanent base, each *contubernium* has to be housed. Neither does the Pseudo-Hyginus allocate space for lower officers or stores. Nevertheless, the actual area cleared for each tent does correspond, more or less, to ten square feet (Morel 1991, figure 72.5; Salvatore 1993). Archaeological finds of large rectangular sheets of leather have led to several attempts to reconstruct the shape and construction of the tents. Despite some brilliant deductive reasoning, the lack of fitting pieces meant that these reconstructions remained entirely theoretical, though the roof angle of 60°/120° was accurately determined and has been confirmed by subsequent finds (figure 1; MacIntyre and Richmond 1934; Groenman-van Waateringe 1967, 99-101).

Vindolanda Tents I and II

In recent years, excavations at Vindolanda have produced vast quantities of military leatherwork, including one of the first certain associations

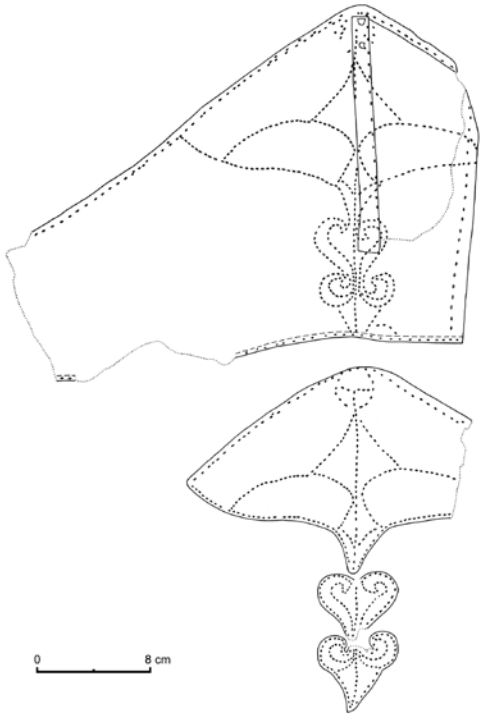

Figure 1 Door flap and decorative reinforcements from Valkenburg, South Holland. (after Groenman-van Waateringe 1967, fig. 37). Author's drawing

Figure 2 Ermine Street Guard replica tent: gable top. Author's photograph

of sheets that actually fitted together to give a recognizable tent corner (Vindolanda Tent I: van Driel-Murray 1990; 1991). The main difference from the earlier reconstructions was the greater wall height, and the realisation that the tent must have been supported on a wooden frame. Previously, it had been assumed that the guy ropes held the structure in shape, resulting in rather low pitched roofs, only about 120 cm high. It now became clear that the tent actually stood about 190 cm high and that the guy ropes actually served to stabilize the tent leather over the frame. A second association of four panels gave the overlapping flaps of the doorway and confirmed the roof angle of 60° (Vindolanda Tent II: van Driel-Murray 1990; see also Winterbottom and Mould 2009, figure 631). A curious feature of the roof/wall join was the inclusion of a narrow flap, evidently to protect the guy rope positions.

All this was sufficient for the Ermine Street Guard to undertake the manufacture of a full sized replica following the archaeological evidence as closely as possible, though substituting a decorative gable reinforcement from Valkenburg for the plainer Vindolanda version (Mayes 1994) (figures 1, 2 and 7). This involved sourcing goatskins of the right size and quality, as well as many tedious hours of hand-sewing the (literally!) miles of complex Roman seams and hems. Some of the problems they encountered can now be solved as a result of the discovery of a third tent, also from Vindolanda.

Vindolanda Tent III

Old tents tend to be cut up and reused (this is why it is so rare to find associated panels), so the discovery of an almost complete tent at Vindolanda was a matter of considerable excitement. This had been dumped, perhaps in despair, along with a considerable quantity of other worn and damaged leather equipment at the abandonment of Period II (corridor N, around AD 90-100). The decayed and fragmentary sheets of leather were cleaned and conserved at the laboratory of the Vindolanda Trust, leaving it relatively supple and with only minor shrinkage. Ripped and degraded sheets could to some extent be reconstituted, and in the final stage of sorting it was often possible to match adjoining sheets by

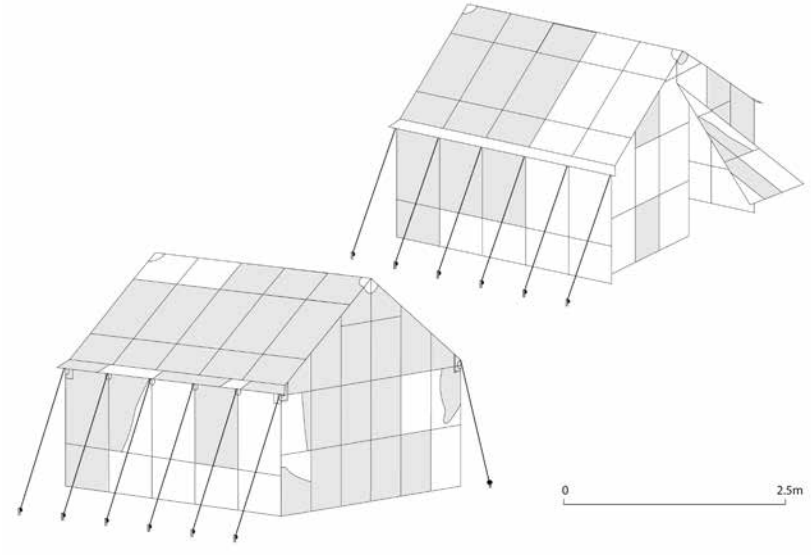

Figure 3 Vindolanda Tent III, preserved sheets shaded. Drawing © Sara Shek (Archol. University of Leiden)

fitting individual stitch holes. The sorting and fitting was an immensely time-consuming task, but was in the end rewarded by the first near-complete Roman army tent to be seen in two thousand years (figure 3).

A great disappointment was the loss of much of the front, though the hemmed edge of one of the lozenge-shaped apex reinforcements was sufficient to identify it as the top of a door flap similar to those from Vindolanda (Tent II), Carlisle (Winterbottom and Mould 2009, 1400, figure 637) and Valkenburg (Groenman-van Waateringe 1967, figure 37). In all, almost 50 more-or-less complete sheets could be assembled, together with their patches, structural reinforcements, flies, seam reinforcements and bindings. Only those sheets and fragments that could be positioned with certainty are shown in figure 3, and there remain numerous fragments with few distinguishing features which could not be assigned a definite place.

Survival and shrinkage

The tent was obviously old and in woeful condition, having been repeatedly repaired and patched (these patches were a great help in re-fitting the panels). The effects of use and weathering were very noticeable, especially in the distortion caused by sagging on both the roof and the sides. Upper panels tend to lengthen, while lower panels sag less, but seem to spread out. On the gable several panels narrow from 40-41 cm at the bottom to 37-38 cm at the top, while water collecting on the roof caused the central line of panels to bag out and stretch 4-5 cm in the length. This effect is echoed in the angle of the gable, which becomes more acute at the top, thus accounting for the variations in dimension or roof angles recorded (figure 7). The large number of associated panels here makes it possible to establish a mean, but even so, it is difficult to

assess the effect of shrinkage following excavation and conservation: this is commonly taken as ten per cent, but in some cases this would result in impossibly large goatskins, and it is evident that stretching during use is just as much a problem as shrinkage following excavation.

Tent Dimensions (figures 8–12)

Considering the effects of usage, the varying widths of seam allowances and variation in the measurements of fragmentary and often ill-fitting and distorted sheets, the given dimensions can be no more than a reasonable estimate. Excluding three obviously distorted sheets, the average length of 13 large rectangles is 70 cm (ranging between 66 cm and 74 cm) with a relatively consistent width of 48-50 cm. This would correspond to roughly 29 Roman inches (*unciae*) in the length and 20 *unciae* in width. Conversion to Roman feet (*pes* = 29.6 cm) does not give a useable fraction, but Roman inches (*uncia* 2.4 cm) would result in quite neat ideal sheet dimensions of 30 x 2 *unciae* for the 25 full-sized and 20 half-sized roof and wall panels.

The width of the gable panels is fairly consistent at about 40 cm, but in length there is much more variation. At the front, the ideal panel size seems to be 60 x 40 cm, with at the back, smaller panels of 52-54 x 40 cm: neither translate neatly into Roman dimensions. This might suggest the actual size of the available skins was the determining factor, not the abstract desire for a particular standard. There is great economy and ingenuity shown in the use of material, with triangular panels made by bisecting larger ones and small triangles fitting nicely to the oblique gable panels to give full-sized ones (table 1).

Position	**Number**	**Size in cm**	**Roman *unciae***
Front	16 medium	60 x 40	25 x 16.5
Roof	15 large	70 x 50	29 x 20
	5 large for division	70 x 50	29 x 20
Side	10 large	70 x 50	29 x 20
	5 large for division	70 x 50	29 x 20
Back	14 medium	52/54 x 40	22.5 x 16.5
	4 for division	52/54 x 40	22.5 x 16.5

Table 1: Tent III, summary of sheet dimensions

Variation in skin sizes is reflected in the number of panels required to make up the width and depth of the completed tents. For the first time, Tent III provides us with a set of certain dimensions: walls made up of five panels 50 cm wide by six panels of 40 cm, giving an area of 250 x 240 cm = about 8 Roman feet. Even allowing for shrinkage this would make the tent no more than 9 Roman feet square. In fact, Pseudo-Hyginus does not describe the dimensions of the tent as such, only the area cleared for the tent to be pitched, so there is no actual discrepancy. The makers of Tents I and III had access to very large skins (72-76 cm long), but Tent II apparently had to make do with smaller skins (66 cm),

resulting in a different arrangement, particularly for the roof panels (table 2). The Ermine Street Guard may take some comfort from the fact that the Romans were also compelled to compromise on size and quality.

	Tent I	**Tent II**	**Tent III**
Roof	74-6 x 52-4	66	70 x 50
Wall	74 x 52		70 x 50
Gable	62 x 50	62 x 42	60 x 40
	48 x 50		
No. of roof panels	4½ x 5	5½ x 6	4 x 5

Table 2: The three Vindolanda tents: comparison of sheet dimensions (in cm).

The preserved height of Tent III is approximately 185 cm, which, allowing for shrinkage, might translate into an original height of 6.5 - 7 Roman feet (207 cm), with a wall height of 110 cm or 45 Roman *unciae* (3.75 Roman feet).

In theory some 75 skins would be required to make this tent to pattern, with smaller elements such as the eaves flaps, reinforcement patches, guy rope positions and seam reinforcements for the most part taken out of the leftovers. The Ermine Street Guard required a total of 77 skins for their tent, giving a total weight of 96 lb (43 kg). Bill Mayes noted that in rain it might absorb a further 17 lb (8 kg) of water (Mayes 1994). The logistics behind supplying a unit with tents for all its men are staggering, and explain why tents were used and recycled to the utmost. The logistics of transport were equally daunting: scenes on Trajan's Column show bundled tents being transported by boat and cart, and these would somehow have to keep pace with the marching soldiers if they were to be in place by nightfall.[1]

Seams and stitching

The analysis of the seams and stitching play an important role in the positioning of the panels and the reconstruction of the complete tent. Each side of the complex, waterproof seams used on Roman tents has a distinct form, with the folded a-side fitting against the stitched b-side in such a way that no stitch holes penetrate directly through the leather thickness (figure 4).[2] The seam may be reinforced on the inside (flesh side) with a covering strip (seam III and IV). Tent III is constructed with seam II, the seam also used for the mid first-century tents at Valkenburg. In contrast, the later Vindolanda Tents I employs the narrow reinforced seam (seam IV), a variant that is rather simpler to sew and that begins to

1 The difficulty of transport was one reason for the Napoleonic army dispensing with tents entirely, but the resulting losses from disease and, even more seriously, the hostility of the local population to the resulting billeting, plundering and lack of discipline cost the army dear.

2 Roman seams were first analysed by Willy Groenman-van Waateringe (1967), but the recognition of several new types means that the numbering proposed by Sue Winterbottom (2009, 824, figure 497) is followed here.

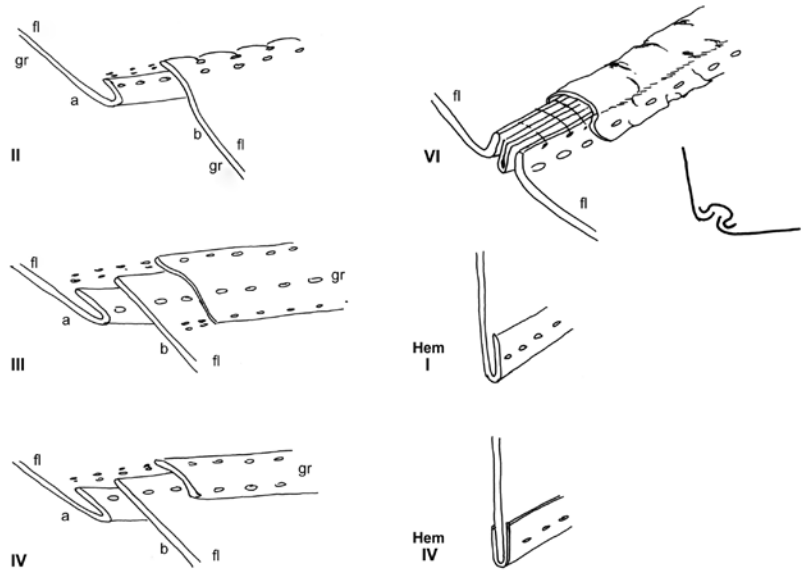

Figure 4 Relevant Roman seams and hems (from the inside/flesh side). Author's drawing

replace seam II towards the end of the first century. Given the lifespan of these strongly constructed leather tents, there is a considerable transition with seam II continuing to turn up in collections of recycled leather throughout the first quarter of the second century (Winterbottom 2009, 826, table 58).

As each side of the seam is distinct, it is possible to match panels, predict missing sheets and sometimes position isolated fragments on this logic. The leading characteristic of the tent structure is that the folded a-side is invariably directed down to assist in rainwater run-off. Seams actually on the roof ridge are always avoided: on Tent III the ridge runs neatly across the middle of the large panels, while on Tent II, using smaller panels, the seam is slightly off-set. Whatever the case, the roof ridge panels will always display an a-seam on both short sides. Easy water run-off is presumably also the reason for the preference for the folded hem I along all edges and for the form of the heavy bound and beaded seam (seam VI) employed all around both gables. Here the beading is a folded strip with the grain side out, and the binding covers the panel edges on the inside of the tent. Well-waxed on the outside, this otherwise vulnerable point has remained secure on the Ermine Street Guard's tent.

Starting from the door flaps with a-seams opposite the opening, the gable seams are symmetrical. Curiously, this is also applied to the seams at the back, so that all gable corner panels display a b-seam opposite the bound and beaded corner seam. This might point to the manufacture of corner panels in series so they could be fitted into either gable. Whatever the reason, the result is that one line of back panels displays a-seams on both long sides as well as the bottom edge. Once recognized, such signals provide a good starting point in any re-fitting exercise.

Roof panels tend to be given more regular and more robust corner reinforcements than are used on the walls (the swallow-tailed reinforcements of seam III): this seems to be standard and can be recognised elsewhere, as at Valkenburg and Carlisle. The original stitching is almost always neat and regular, and Bill Mayes was undoubtedly correct to use seam templates to ensure the stitch holes on the many layers would line up. Without such assistance it would have been impossible to sew the heavy bound and beaded seam through all the thicknesses at one go (Mayes 1994, 185). He also observed that the gables have to be assembled first, as the exact dimension of the roof depends on the length of the gable seams. The roof is trimmed, and is then sewn to the walls with the eaves flap in between. This seam also required pre-pierced holes using the template and Mayes noted that the seam must be set about two centimetres above the actual wall top, to avoid leaking and stress on the stitching. Finally the gables are attached with a continuous bound and beaded seam. All together, the selection of skins, determining the layout and dimensions and sewing the complex seams require considerable skill – and strength, as the Ermine Street Guard found out.

Supporting structures

The only direct evidence for the supporting structure is creasing caused by the ridge-pole across the centre of the three roof panels. The presence of a ridge-pole is also implied by the fact that the leather of the roof ridge and apex was not excessively distended, while the sag of the gable precludes the use of additional struts (figure 7). Vertical posts at the corners would be necessary, with horizontal poles helping to bear the weight of the roof. The guy ropes hold the leather down over this frame and can be pegged within about 20-30 cm of the wall. Thongs remaining in the gable eyelets appear to have been used to tie the top to the tent-pole inside and the Ermine Street Guard have not felt the need for a front guy rope. Nevertheless, ropes may sometimes have been required to steady the gable posts under particular conditions: excavations at the Republican camp Casas de Reina, Spain exposed a line of metal T-shaped tent pegs set 330-360 cm (11-12 Roman feet) apart, marking the ridge lines of tents pitched about 20 Roman feet from the defensive wall (Gorges et al. 2009, 275). Vast numbers of wooden tent pegs of various sizes have been recovered from Vindolanda and the early Roman fort at Velsen, and it is probable that most of the iron pegs were actually used to tether horses.

None of the surviving tents have loops for pegging the wall foot and the very poor preservation of foot panels rather suggests earth may have been heaped up against them, as is indicated by the low banks surrounding tent positions in surviving camps in Spain (Salvatore 1993). On Vindolanda Tent I the side appeared to be a little longer than the front (as, indeed does one side of Vindolanda Tent III), but this is probably the result of shrinkage and distortion and not a deliberate feature.

Leather selection

The Romans preferred goatskin for virtually all their military equipment, as it is lighter than calf and has a high tensile strength. One of the most fascinating aspects of Tent III concerns the care taken to match skin quality with the functional requirements. The largest and best quality goatskins, complete or halved, are reserved for the roof, with less regular skins requiring repairs and infills being used for the walls (figures 10 and 11). Several of the big side panels incorporate the skin edges and have been brought up to size with infills and patches: that these often coincide with the positions of the flies indicates they were not subjected to the sort of stress that would be expected if the ropes supported the tent structurally. Smaller and less regular goatskins were used for the front, but in contrast, the less exposed back is composed of the skins of a hairy breed of sheep. The use of lesser quality skins explains the smaller size of these panels, as well as the flabby, often delaminated condition. Seams ripped repeatedly, requiring continuous care, sometimes, to judge from the stitching, carried out by professionals, but more often by the soldiers themselves (figure 9). Whether this selection is unique to this tent alone, or whether it is a response to a particular shortfall in the supply of suitable goatskins is unclear, but skin quality may be a factor to take into account in the interpretation of collections of loose panels.

The size of the goatskins used for Tent I and III is remarkable and caused the Ermine Street Guard considerable effort to match. Eventually, through the good offices of J. Hewit & Sons Ltd (West Lothian), suitable skins were found in Nigeria. These skins are, however, quite a lot thicker and heavier than their Roman counterparts, either due to the breed or to less careful fleshing. The source of Roman goatskins remains a mystery, though developments in isotope analysis may eventually be able to offer an answer. Nevertheless, though the actual dimensions of the panels might vary, the construction principles remain the same. The end result, for the Romans as well as the Guard, was a long-lasting, wind- and waterproof tent (figures 3 and 7). This tent has been in service for at least 20 years and although it is used less frequently and under less harsh conditions than its Roman counterpart, a working life of 10 – 20 years is a not unreasonable estimate. If this is the case, Tent III may have been made around AD 80, and is likely to have seen service in the Scottish campaigns of Agricola. The Guard found that regular dubbing with oil or grease is essential to keep the leather supple and waterproof, but the main problem is ensuring proper drying before the tents are rolled up for storage. Additionally, after ten years of use, the linen twine used for stitching required replacement, though the original holes could mostly be re-used.

What the experiments make clear is that much of the soldiers' time would be spent in the cleaning and general maintenance of their tents. As the cost of the communal tent was deducted from soldiers' pay, there was a strong incentive to keep it in good condition for as long as possible (Bishop and Coulston 2006, 262). The mother of a dead soldier received

20 *denarii* as a refund for his share in the tent in AD 142: this was only slightly less than the value of his armaments, but the amount sounds like the return of a deposit rather than a realistic valuation and it would be unwise to draw inferences concerning the true cost of a military tent from this source. (Furthermore, we do not know whether it was a leather tent at all: in Egypt, where the account comes from, tents may well have been made of cloth or hair, like those of the more recent Bedouin (Gilliam 1967).)

The modular system used by the Roman tent makers means that very little goes to waste: the Ermine Street Guard were left with only a heap of necks, legs and a mass of narrow slivers (primary off cuts), as almost everything could be utilized in the production process (figures 5 and 6). Even the trimmings could be twisted into thongs to make the fly loops. Going by the nature of the refuse, tents were certainly being manufactured in the legionary fortresses of Vindonissa and Bonn, but not at any of the auxiliary forts. This might account for the worn condition and extensive recuperation of tent leather at the latter.

Figure 5 Ermine Street Guard replica tent: off cuts. Author's photograph

The reconstructed tent displays the careful selection of appropriate materials with a well-thought out strategy to direct resources to maximum effect. Standing in line and back to back, the roof and front of the tent suffered maximum exposure to the elements, while the back was sheltered.

Figure 6 Ermine Street Guard replica tent: off cuts. Author's photograph

Conclusion

Through the years it has been fascinating watching the weathering of the Ermine Street Guard's goatskin tent (figure 7). The natural creasing, the stretching caused by the weight of rainwater, the drape of the door flaps, all are reflected in the condition of the archaeological material. It is now apparent why the roof panels sag, why the gable panels tend to tear diagonally along the creases, and why the bottom panels are is such poor condition. Experiment has also shown clearly that the guy ropes are needed only to hold the tent down over a frame, thus accounting for the surprising lack of stress on the reinforced eyelet positions. The main stress is on the corner guy ropes, which steady the entire structure and have enabled the tent to withstand some quite extreme weather conditions with no ill effects. Though the tent is essentially a serviceable piece of equipment, the Guard made effective use of leather of different natural shades to highlight the design of the reinforcements on the front gable (figure 2). The reconstruction gives us a good insight into the functioning of the tent under different weather conditions, but it should be noted that the Nigerian skins are relatively thick, and the Roman tent was probably a few kilograms lighter. This experiment has had a considerable impact on the understanding of the finds from excavations, allowing better identification of fragments and also revealing the superb quality of Roman military equipment.

The three tent sections from Vindolanda represent the tent of the ordinary soldier. There were, no doubt, various different sizes and shapes for officers and for special purposes, but other than the depictions on Trajan's Column, there is no direct evidence for their construction (McIntyre and Richmond 1934, figure 3). Officer's box-tents with

Figure 7 Ermine Street Guard replica tent after a shower. Note the sagging roof line, the eaves flap and the absence of ridge guy ropes. Author's photograph

roof overhangs might be represented by series of hemmed panels with reinforced ties (as seen at Valkenburg, and also noted at Vindolanda and Carlisle) but, in the absence of recognisable associations, the attribution remains guesswork, and the pieces could equally well belong to one-man bivouac shelters or ground-sheets.

The importance of effective shelter for an army on campaign cannot be overstated. The lines of tents within the walls of the fort formed a true home for mobile forces, enhancing their sense of community and allowing men to rest and recuperate. Weatherproof shelter enabled the Romans to campaign in hostile climatic conditions, and the reassurance of warm, dry quarters at night was not only a boost to morale, but also made a very real contribution to the health and well-being of the ordinary soldiers.

The reconstruction of the leather tents discovered in Vindolanda has been immensely informative, not least in illustrating the enormous need for goatskin as well as the logistical sophistication of Roman supply systems, where meticulous preparation for campaigns and attention to the welfare of the troops formed the basis for the success of this formidable fighting force.

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Appendix

Additional information on the assembled Vindolanda III tent panels (Figures 8-12)

Roof: Impressions of the ridge fold were clearly visible across the centre of three large panels. Extra reinforcements were sewn on the inside only against the front and back edges. The panels are sewn with seam II, changing to reinforced seam III at the panel junctions. Although some of the roof is missing, the complete width and the complete depth could be assembled, giving the definitive dimensions of the tent.

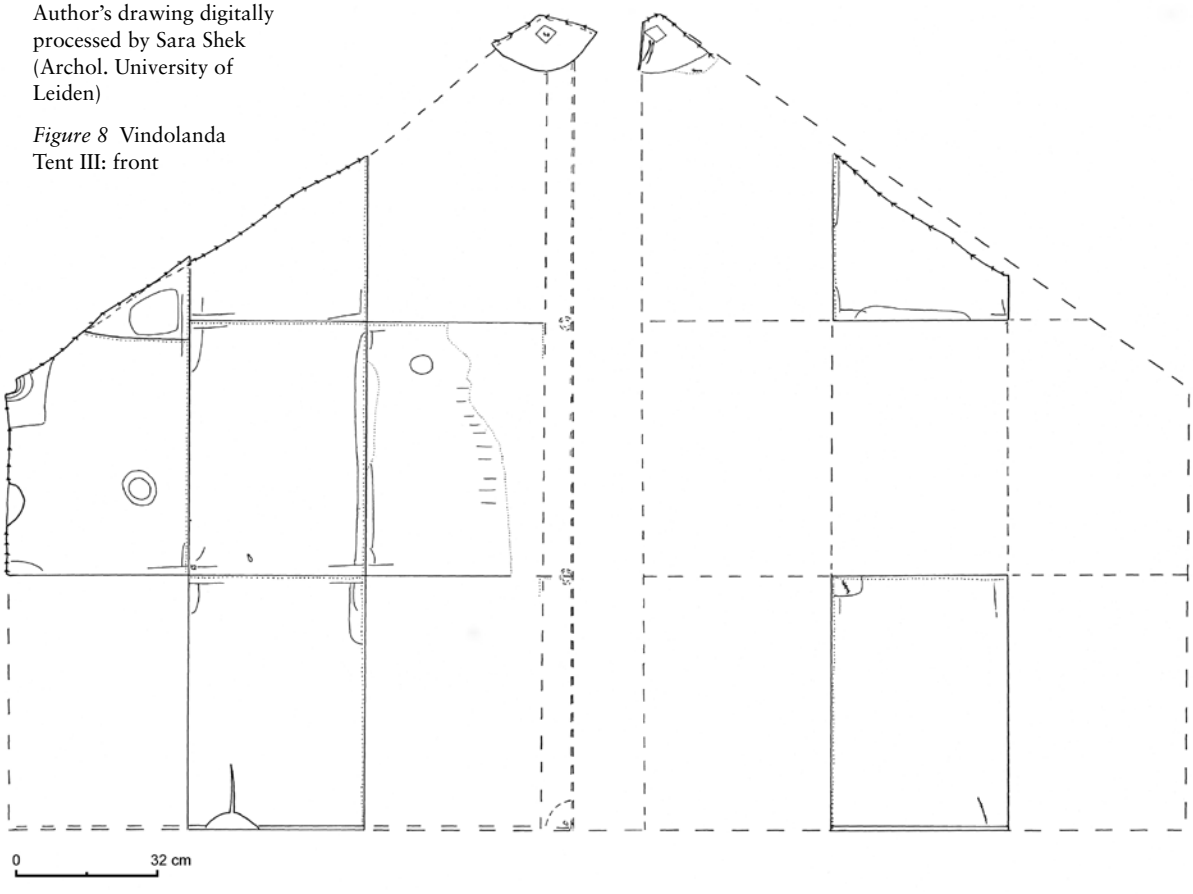
Walls: Eight wall panels survive, with smaller fragments of two more, but none made up a complete wall length. At both sides of each panel are the tie holes of a guy rope position covered by multiple circular reinforcements on the front surface, and with a pointed back reinforcement projecting across the roof seam, something also observed on Tent I. A narrow hemmed strip (the eaves flap) is sewn in with the roof/wall seam: this is intended to protect the guy rope positions, and the fragments are in poor, rather rotten and much repaired condition. Underneath, however, the tops of the wall panels are relatively well preserved. The half panels used for the wall foot are in especially poor condition, much affected by damp and contact with the ground, and it is possible that such smaller panels were intentionally placed here to simplify repair and replacement. The wall foot is finished off with the folded hem I.

Back: The back is entirely closed. Some re-enactment groups felt that the back should have been open, as seems to be implied by the term *papillio* (butterfly), but this is evidently not the case. Neither can the sides be rolled up to air the tent as all corner seams are sewn up. The gable angle is 60°/120° and the total height at the apex about 185-190 cm. It is covered with multiple repairs and patches, both inside and outside, and a number of seams have been re-stitched or patched.

Front: Not much of the front is left. One of the apex reinforcements is edged with a folded hem (hem I), and is covered by the larger lozenge-shaped reinforcement, in the same arrangement as on the gable association of Vindolanda Tent II. This would seem to prove that the doorway of Tent III is similarly composed of overlapping flaps. There are no signs of fastening loops or toggles on any of these door flaps, and the Ermine Street Guard found that the leather itself had sufficient weight to make fastenings unnecessary, except perhaps at the bottom to tie the flaps back when the door was open.

Figure 8 - 12 Vindolanda Tent III: surviving panels. Author's drawing digitally processed by Sara Shek (Archol. University of Leiden)

Figure 8 Vindolanda Tent III: front



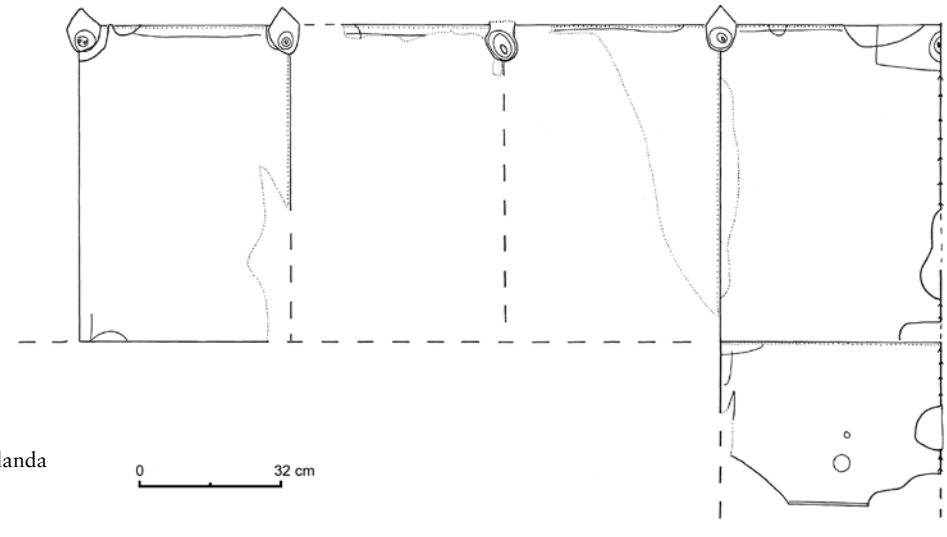


Figure 10 Vindolanda Tent III: walls

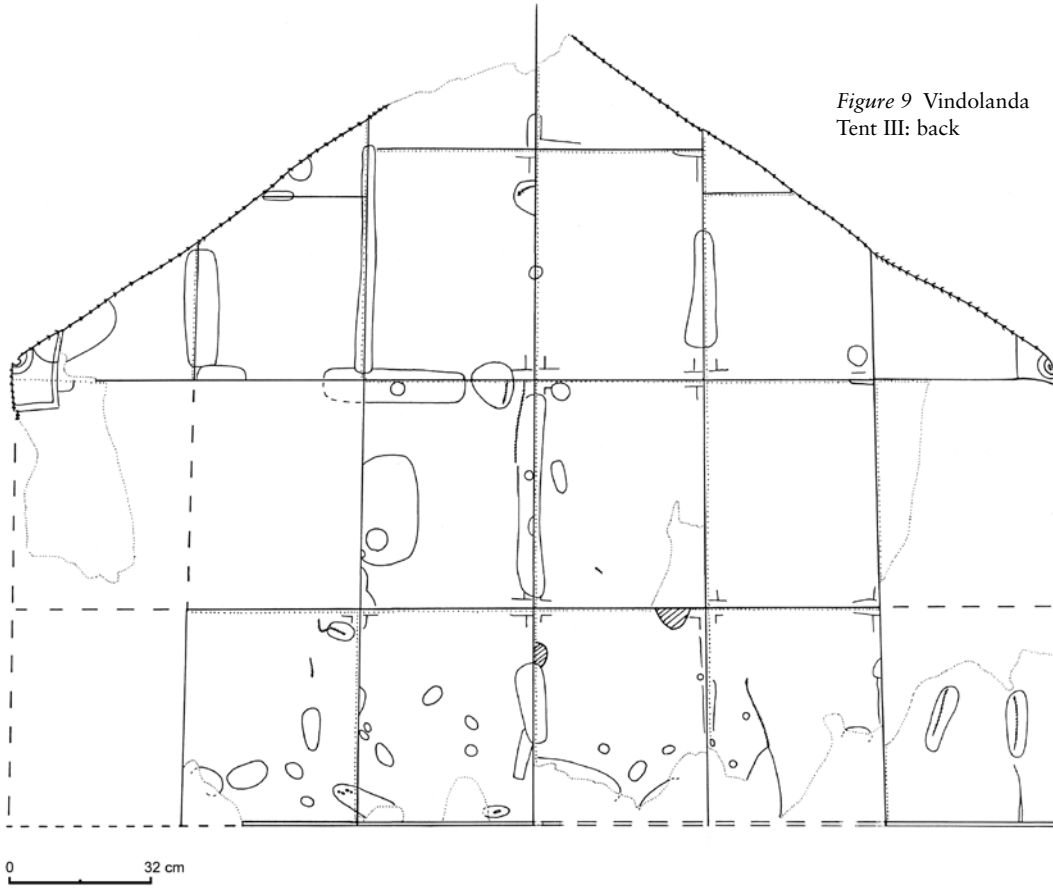


Figure 9 Vindolanda Tent III: back

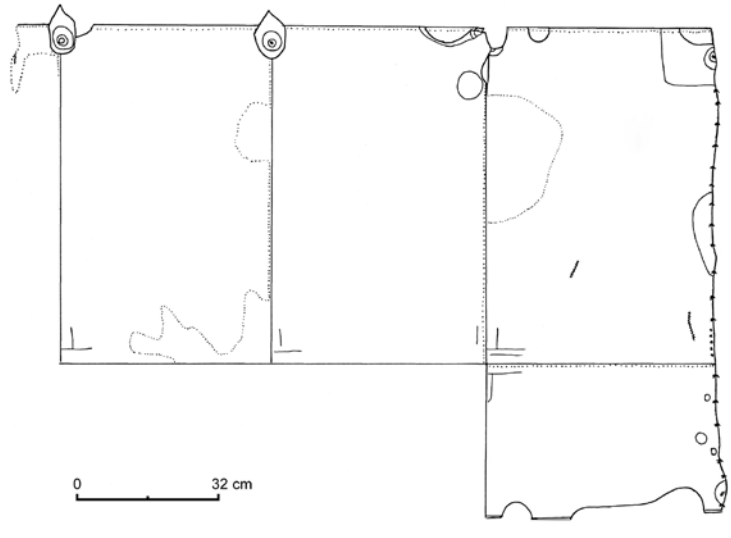


Figure 11 Vindolanda Tent III: walls

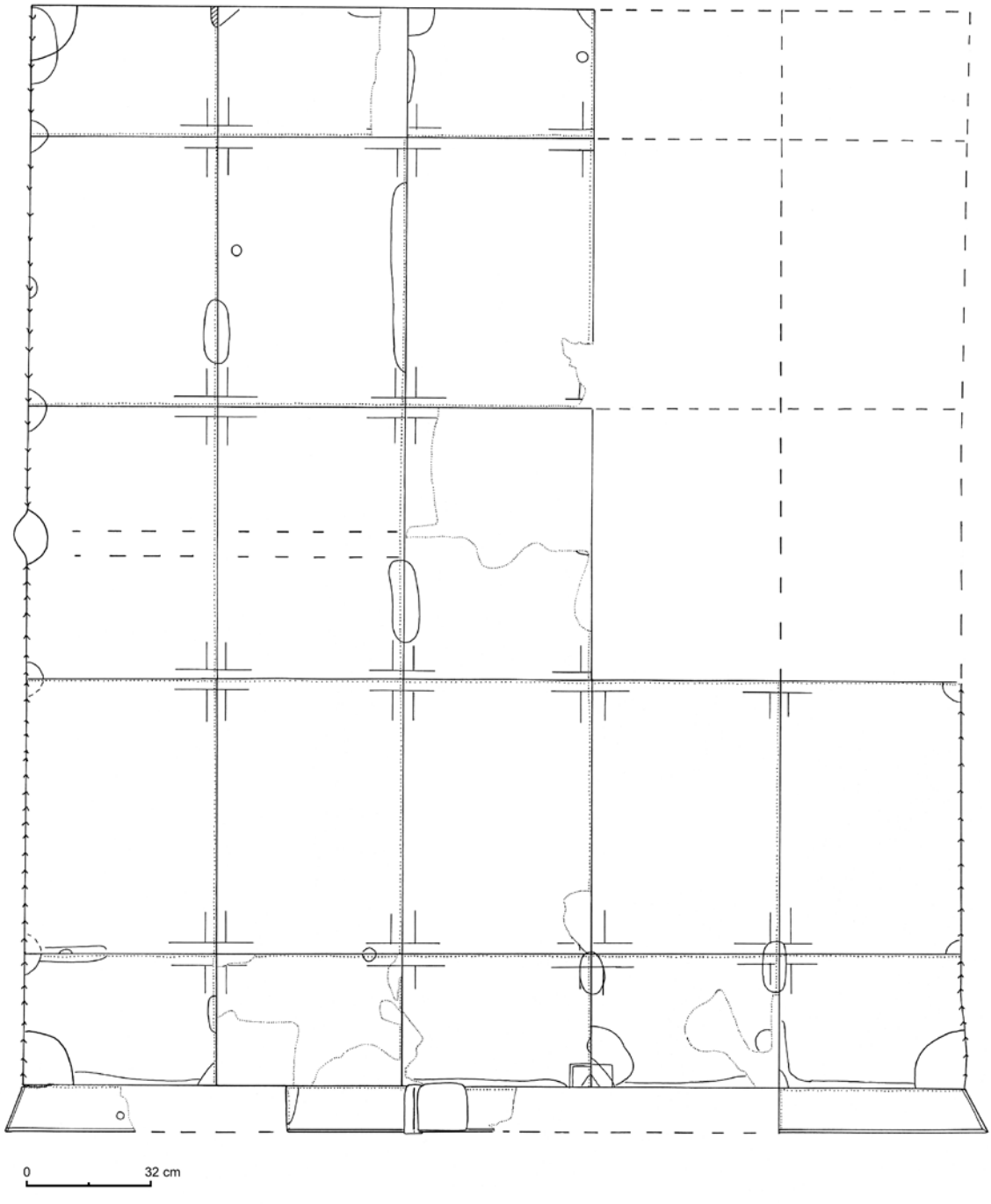


Figure 12 Vindolanda
Tent III: roof