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# Evidence for shield construction from the early Anglo-Saxon cemetery site of Tranmer House, Bromeswell, Suffolk

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**Summary** In 2000 excavations at Tranmer House in Bromeswell Parish, Suffolk, which is close to Sutton Hoo, revealed an early Anglo-Saxon cemetery of approximately 30 graves; of these, 13 contained the remains of shields and other weapons.

Investigative conservation and analysis of the shield fittings and associated mineralized organic remains has enabled an examination of the technical details and a reconstruction of the shields' original forms. The shields were between 380 and 690 mm in diameter and were constructed predominantly from ash (*Fraxinus excelsior*) planks ranging in thickness from 7 to 10 mm. Hand holes in the board were either oval or D-shaped, with the handle located in an off-centre position. All the boards were covered with a thin layer of skin product, front and back, but there is no evidence of seams, adhesive or edge stitching to secure the board covers. Examination using microscopy, X-radiography and metallographic sampling revealed that the shield bosses were probably raised from a single piece of metal. All the bosses had flat or slightly curved iron grips and there is evidence of three different types of handle construction. Two of the grips had remains of a carrying strap. Disc-headed and zoomorphic/geometric mounts were riveted through the shield covers and the board, grouped on opposite sides of the boss at, or slightly above, the centre line. X-ray fluorescence spectroscopic analysis of some non-ferrous decorative overlays revealed silver-copper sheet with mercury gilding, tin-lead soldered to the fittings. By detailed examination of the evidence from the shield fittings a sequence of construction for the shields has been proposed.

## INTRODUCTION

The Tranmer House site lies 500 m to the north of the Sutton Hoo cemetery, renowned for its Mound 1 ship burial and other high-status graves [1–4]. The Tranmer House site was excavated by Suffolk County Council Archaeology Service prior to the building of the current National Trust visitor centre and car park at Sutton Hoo. In total, 12 cremations and 19 inhumations (present as sand bodies) were found, with a number of further individuals suggested by residual cremated remains, Figure 1 [5]. Together they represent the south eastern extent of a larger cemetery, the westward continuation of which has been demonstrated by surface finds [6].

Although grave goods buried with the dead suggest some individuals of high standing, the presence of adults of both sexes and children indicates that this is a burial ground for a community, or a 'folk' cemetery similar to that at nearby

Snape [7]. Use of the cemetery probably started in the late 6th century and ended around the turn of the seventh century [5]. As such, it represents a significant prelude to the elite mound cemetery that was established within clear sight of it.

The funerary rites demonstrate some significant traits. A number of the cremations, some of which are contained in urns, were surrounded by ring ditches and were probably originally marked by small mounds. A number of the cremations included animal offerings, with evidence of bird, cattle, horse, pig and sheep/goat remains. The most significant find was that of an adult female, cremated together with animals, whose remains were placed in a rare bronze hanging bowl, which would have been a high-status, imported Celtic artefact.<sup>1</sup>

Of the 19 burials, 13 contained weaponry; spears were present in each case, 11 contained shields and two burials had a full set of a spear, shield and sword. This proportion



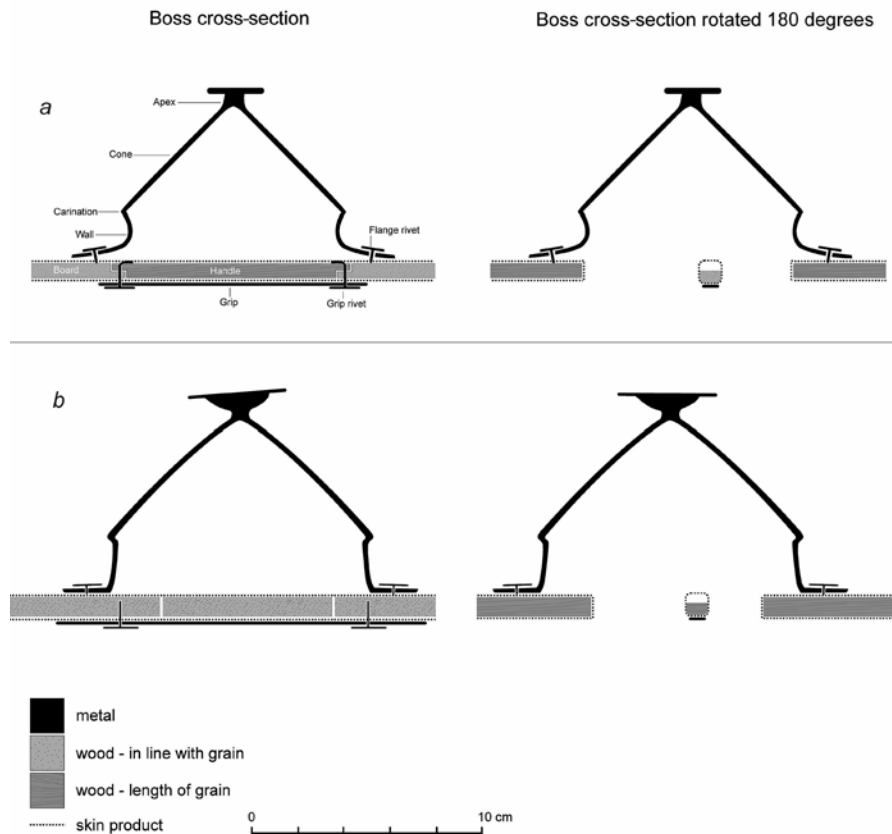


Figure 2. Cross-sectional comparison of different handle construction methods: (a) shield from grave 614, corresponding with Dickinson and Härke's Type A1 handle; and (b) shield from grave 868, a variation of Dickinson and Härke's Type C1 handle. Drawing: Kate Morton

## EXAMINATION OF EVIDENCE FOR SHIELD CONSTRUCTION

Anglo-Saxon shields were complex composite objects constructed from organic and inorganic elements. Metal fittings, including iron shield bosses, grips, disc-headed mounts and on some shields zoomorphic or geometric mounts, were attached to wooden boards covered with skin product.<sup>2</sup> While the metal shield fittings often survive, the organic material generally decays and is preserved only as pseudomorphs and casts in close proximity to the metal. This preservation process occurs after burial, when metal salts leached from the fittings act as a biocide to prevent or reduce the attack of micro-organisms. As deterioration of both the metal and organic material progresses, the metal corrosion products that are deposited at their interface create 'replacements' that preserve the shape but not the composition of the organic material [14, 15].

Examination and identification of the shield fittings revealed wood, skin product, textile and plant remains, although only the wood and skin product are original shield components. The position of the other organic remains implies that they are either clothing or coverings/linings used in the burial, but they will not be described further in this present consideration of the shield components.

## Shield board

Although there is no direct evidence to suggest the shape of the shields, evidence from other sources suggests that they were usually round [11]. Approximate shield diameters can be ascertained from the position of the boss and board mounts, which gives a minimum diameter, and the edge of the grave cut, which gives a maximum diameter, Figure 2. The 11 examples from Tranmer House suggest a range from 380 to 690 mm, corresponding to the medium-sized board identified by Dickinson and Härke [11]. This is much smaller than the Sutton Hoo Mound 1 shield, the estimated diameter of which is 914 mm [2].

The evidence from wood remains associated with the fittings suggests that the boards were made of solid rather than laminated wood, but no joins between individual board planks were found. The thickness of the shield boards can be estimated from the length of surviving, complete rivets and ranges from 7–8 mm at the centre of the shield to 6–10 mm towards the edge. The discrepancy between the centre and outer areas may indicate the varying thickness of individual planks. Evidence for curvature of the boards is inconclusive. Six of the boss angles angle down slightly (see Figure 3), and it has been suggested that this is the result of the boss having been secured to the wooden board under tension rather than as evidence for a convex board [16].



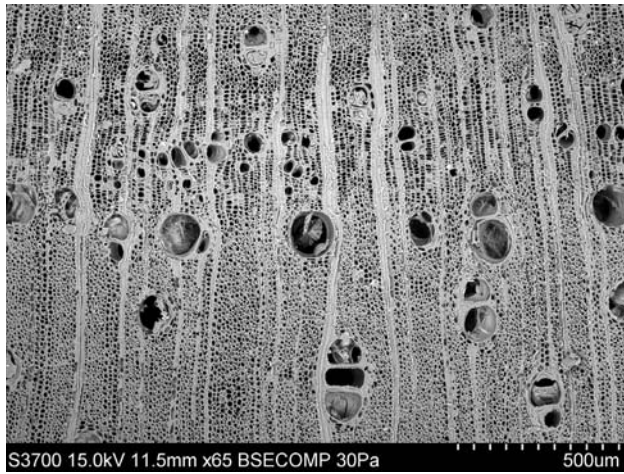


Figure 4. Transverse section of *Fraxinus excelsior* (ash wood) viewed in the VP-SEM. The image shows the vessels of two co-existing types: solitary and radially-paired multiples, sometimes with tyloses, porous rings and bi- to triseriate rays

Although most of the grips are curved, in many cases this is so slight that distortion during burial cannot be ruled out.

The wood species used for the boards were identified in seven cases. Five were made of ash (*Fraxinus excelsior*: Figure 4), one from oak (*Quercus* sp.) and the board from grave 909 from both ash and alder (*Alnus glutinosa*). In the

last case, the three upper disc-headed mounts and the shield boss were attached to alder while the lower three mounts were attached to ash, possibly indicating a repaired plank or planks. Ash wood is strong, tough and pliant; it cleaves evenly without splitting and can be steam-bent into shape, but its use for shield boards is unusual and has rarely been reported at other sites [11; p. 48]. Despite isolated pockets of modern ash trees, supported on patches of localized calcareous soils along the shores of the nearby River Deben, the acidic sand geology of the Sutton Hoo area does not favour this species and there is no documentary evidence to support their presence in the early Medieval period.

This suggests the importation of specific raw materials or pre-constructed shields, reflecting particular technological choices or cultural preferences. Alder is a local dominant species within areas of low-lying wet woodlands such as those near Sutton Hoo and along the River Deben and, like oak, it is common throughout the British Isles [17].

Evidence for the shape of the hand holes in the centre of the boards is limited, as this area is poorly preserved. However, on two shield bosses, from graves 492 and 868, small lengths (2–3 mm) of the interior edge survive, suggesting that the size of the hand hole was roughly the same as the interior of the boss. The grip location on the underside of the shield bosses, where surviving, indicates that the handles were located in an off-centre position, the

Table 1. Summary of XRF analyses for the silver overlays on the shield boss fittings

| Grave | Description                   | Ag   | Cu   | Pb  | Au   | Zn  | Sn               |
|-------|-------------------------------|------|------|-----|------|-----|------------------|
| 614   | Boss apex                     | 95.8 | 1.8  | 0.2 | 1.7  | 0.2 |                  |
| 857   | Boss apex                     | 95.1 | 3.4  | 0.2 | 1.0  | 0.1 |                  |
| 868   | Boss apex: inner band         | 86.2 | 8.5  | 0.4 | 1.6  | 3.3 |                  |
| 868   | Boss apex: outer band         | 73.8 | 20.1 | 0.7 | 1.8  | 3.0 | 0.6              |
| 868   | Boss rivet 1 overlay          | 58.3 | 40.6 | 0.4 | 0.6  |     |                  |
| 868   | Boss rivet 2 overlay          | 94.4 | 3.6  | 0.2 | 0.7  |     |                  |
| 868   | Boss rivet 3 overlay          | 93.6 | 5.3  | 0.3 | 0.8  |     |                  |
| 868   | Boss rivet 4 overlay (centre) | 81.4 | 10.1 | 0.5 | 2.3  | 0.5 | 5.2 <sup>a</sup> |
| 868   | Boss rivet 4 overlay (outer)  | 93.0 | 5.8  | 0.2 | 0.9  |     |                  |
| 868   | Boss rivet 5 overlay (centre) | 93.2 | 4.1  | 0.2 | 2.3  |     |                  |
| 868   | Boss rivet 5 overlay (outer)  | 93.6 | 4.3  | 0.3 | 0.8  |     | 1.0              |
| 868   | Disc-headed mount 1           | 95.3 | 3.7  | 0.3 | 0.7  |     |                  |
| 868   | Fish mount overlay            | 95.1 | 3.8  | 0.2 | 0.6  |     |                  |
| 868   | Bird mount overlay            | 95.1 | 3.9  | 0.3 | 0.6  |     |                  |
| 868   | Disc-headed mount 2           | 95.4 | 3.8  | 0.2 | 0.5  |     |                  |
| 909   | Boss apex                     | 92.5 | 6.3  | 0.3 | 0.8  |     |                  |
| 1013  | Boss apex                     | 96.4 | 2.8  | 0.8 | <0.1 |     |                  |

Note

<sup>a</sup> The elevated tin content may be the result of contamination by solder.



Figure 1. Shield boss from grave 868 showing the decorated apex and five bronze rivets, see Table 1

larger space to accommodate the knuckles and the smaller the fingers. Where wood from the main board survives on the shield grips it suggests that the board hole had a straight side, implying that it was probably either D-shaped or a flattened oval [11; p. 41 and plate 8].

Evidence from the fittings indicates that all the shield boards were covered with a thin layer of skin product on both the front and back. While these remains are poorly preserved on the iron fittings, where the organic materials were in contact with copper alloys they are better

preserved, with the fibre structure clearly visible. In these cases the surface grain cannot be discerned, which may indicate an intentionally sanded finish, although no attempt has been made in this study to identify either the manufacturing processes or the species from which the skins derive. There is no evidence of seams, adhesive or edge stitching that could have secured the board covers. However, only small areas of the covering are preserved and these are often obscured by the board wood. Evidence from grave 909, where two layers of skin product are visible in cross-section between the rim of the shield boss and the board wood at the edge of the hand hole, suggests a join or overlap between the front and back board coverings. The shields from graves 868 and 909 have a calcite-, aluminosilicate- and beeswax-containing layer between their zoomorphic/disc mounts and the front board cover [18]. It is unclear whether this is an adhesive, a packing material or a preparation layer for a painted surface extending over the entire board.

### Shield boss

The bosses from the Tranmer House cemetery have convex or straight-sided cones that narrow towards a neck bearing a disc-headed apex, with a carination overhanging a wall and flange, Figure 3. A separate analysis, to be published elsewhere [5], shows that the bosses can be classified as Type 3, which date to the sixth or early seventh century [11; pp. 14–17 and 24–26], although the boss from grave 614 displays some characteristics of the earlier Type 1 form [11]. This type of boss can be made in several ways [16], but X-radiography of the Tranmer House bosses indicates that they were forged from a single

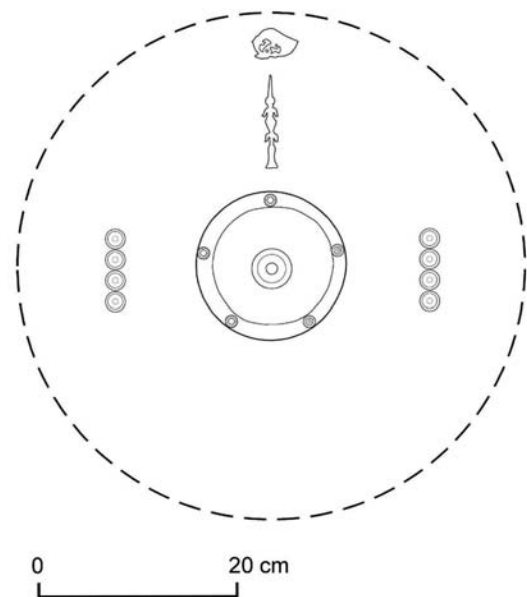


Figure 2. Metal shield fittings from grave 868, after conservation, alongside a reconstruction drawing showing how these elements were positioned on the shield. The dashed line indicates the average diameter of the shield. Drawing: Kate Morton

. Summary of the information gathered on shield construction from the fittings and remains from the Tranmer House cemetery

| Grave | Board                 |  | Thickness (mm) | Wood          | Shield boss   |            | Grip               |             | Handle |            |             | Disc-headed mounts |               |              | Zoomorphic/<br>geometric mounts |
|-------|-----------------------|--|----------------|---------------|---------------|------------|--------------------|-------------|--------|------------|-------------|--------------------|---------------|--------------|---------------------------------|
|       | Diameter (mm) min-max |  |                |               | Diameter (mm) | No. rivets | Width (mm) min-max | Length (mm) | Type   | Width (mm) | Length (mm) | No.                | Diameter (mm) |              |                                 |
| 492   | 380-690               |  | 10             | -             | 135           | 4          | 20-43              | 117         | D2     | 23         | -           | 4                  | 25            |              |                                 |
| 560   | 440-470               |  | 7              | -             | 165           | 5          | 28-44              | 138         | A1     | -          | 83          | 4                  | 39            |              |                                 |
| 614   | 380-470               |  | 6-10           | Ash           | 135-150       | 5          | 15-36              | 115         | A1     | 22         | -           | 4                  | 38            |              |                                 |
| 857   | -470                  |  | -              | -             | -             | 5          | 22-46              | 135         | A1     | -          | -           | -                  | -             |              |                                 |
| 868   | 440-590               |  | 8-9            | -             | 150           | 5          | 31-20              | 161         | C1     | 20         | 75          | 8                  | 19            | Two gurative |                                 |
| 888   | 440-560               |  | 10             | Ash           | 160           | 5          | 20-39              | 113         | -      | -          | -           | 2                  | 14            | One lozenge  |                                 |
| 967   | -                     |  | 8-10           | Oak           | 160           | 5          | 20-42              | 179         | -      | -          | -           | 4                  | 35 and 40     |              |                                 |
| 909   | 440-630               |  | 7.5            | Alder and ash | 155           | 5          | 21-46              | 163         | A1     | -          | 73          | 6                  | 16            |              |                                 |
| 990   | 500-530               |  | 8              | Ash           | 140           | 5          | 16-32              | 170         | -      | -          | -           | 4                  | 65            |              |                                 |
| 993   | 440-530               |  | 7-8            | Ash           | 160           | 5          | 23-29              | 145         | A1     | -          | 80          | 6                  | 35 and 43     |              |                                 |
| 1013  | 380-690               |  | 7              | Ash           | 145           | 5          | 16-22              | 121         | -      | -          | -           | 4                  | 35            |              |                                 |

piece of metal, with no evidence of repairs, welds or other additions (apart from the boss from grave 868 discussed below). In nine of the bosses, the X-radiographs show the striations and uneven thickness of the metal that result from the processes by which the cone was elongated to make the neck and then attenuated at the apex. This is also visible in a metallurgical cross-section of the boss apex from grave 614, where twisting cavities suggest that the boss was made by raising a disc into a cone and extending it to make the apex, causing the inner surface to become twisted and ridged. Tool marks visible inside the majority of the bosses indicate that the carinations were formed by punching.

Analysis revealed that the silver overlays on the apexes of the shield bosses from graves 614, 857, 909 and 1013 were silver–copper alloys with traces of lead and gold, Table 1. Traces of solder on the apexes from graves 492 and 888 indicate that they may also have originally had overlays.

The apex disc from the grave 868 shield boss was a separate component fixed to the top of a cone that had been forged into a neck or pillar. The apex disc and all other decorative bronze rivets are made of copper alloy with mercury gilding and have overlays of silver sheet so soldered into position [18]. Mercury gilding was a common technique of the period; in this process an amalgam of gold and mercury is applied to the surface and then heated to approximately 350°C to drive off the mercury, leaving a thin coating of gold [19; p. 129]. Rivets 1, 2 and 3 are stylistically different to the other board fittings (apex, shield mounts and bronze rivets 4 and 5), which may indicate that they are replacements, Figures 5 and 6. X-ray fluorescence spectroscopic analysis revealed that all the silver overlays are very similar in composition, apart from the outer band of the apex and the overlay of rivet 1, both of which have a higher copper content, Table 1. This may indicate differing alloy compositions or the possible replacement of the silver overlays. Tin found in the overlay of rivet 4 may be contamination from the underlying solder.

### *Grip and handle*

All the shield bosses have flat or slightly curved iron hand grips (rather than angled or extended types), made of a single sheet of iron, with curved long sides narrowing at the centre and expanded terminals; classed by Dickinson and Härke as Type Ia1 [11; pp. 24–26]. The width of the centre and terminals differs, as does the length. Most of the grips are smaller than the boss diameter, apart from four cases (graves 868, 967, 909 and 990) where they extend beyond the boss angle.

Sufficient wood and skin product survived on seven of the 11 shield grips and bosses to determine the handle construction sequence and method of insertion into the shield board. After the handle was constructed, the iron grip was attached to the back of the board, before the shield boss was finally riveted onto the front.

The majority of the handles (graves 560, 614, 857, 909, 993) had lap joints: the wooden handle, with grain direction running parallel to the length of the grip, was inserted from the front into a recessed area cut in the board wood, the grain direction of which runs perpendicular to it (Dickinson and Härke Type A1) [11]. Evidence for this can be seen on the shanks of the grip rivets, where the wood grain runs in two directions: the board wood is closest to the iron grip and handle wood next to the grip-rivet washer. On the grip from grave 614 the preservation of this area is exceptional and it is possible to determine that the board wood in the lap joint was 3 mm in depth, and the handle wood 4 mm, Figure 3. The grip rivets, where they survive on the reverse of the shield grips, are of two types: two examples have rivets hammered over on the front of the board, forming an L-shape, while the remainder terminate through a rivet washer and are domed over.

There are two exceptions to the A1 handle type are those on the shields from graves 492 and 868. In the shield from grave 492 the handle and board were made of one piece of wood with the wood grain running perpendicular to the handle length (Dickinson and Härke Type D2) [11]. This shield was also of unusual construction, with four bronze rivets attaching the shield boss to the board rather than the usual three (Table 2), and two of these rivets also attached the grip to the back of the board. It is likely that such a shield would have been less durable, as the grip could become detached or weakened if the shield boss was damaged. Examples of similar types are proposed for Sutton Hoo [2], Buckland (Dover) [20], and Lyminge II [21].

The handle construction on the shield from grave 868 was of Type C1 with an inserted handle, but the wood grain runs perpendicular to its length (a variation of that recorded by Dickinson and Härke). It is not clear how this handle was secured in place as the grip rivets only pass through the board wood and do not appear to play a structural role in securing the handle. Furthermore, there is no surviving evidence of adhesive between the joins or bindings around the grip and handle; nor does the boss angle support the join from the front as it sits beyond each end of the handle section, Figure 3. The unusual handle construction and ornate fittings could imply a ceremonial use, although evidence of wear indicates that it was also functional.

Wood remains on seven of the iron grips indicate that handle size was fairly consistent, with a width varying from 20 to 23 mm and lengths from 73 to 83 mm. Handle remains indicate the diameters of the hand holes were small compared to the size of modern hands. The handles were shorter in length than the grip, which allowed the latter to reinforce the join between the handle and the board. The handles were wider than, or of equal width as, the grip at its narrowest point. The evidence from two grips, from graves 614 and 868, which were better preserved, indicates that the wooden handles had a rectangular cross-section with straight, parallel sides. On six of the 11 shield grips the skin product from the back of the shield board cover (present between the iron grip and the wood of the handle) curves



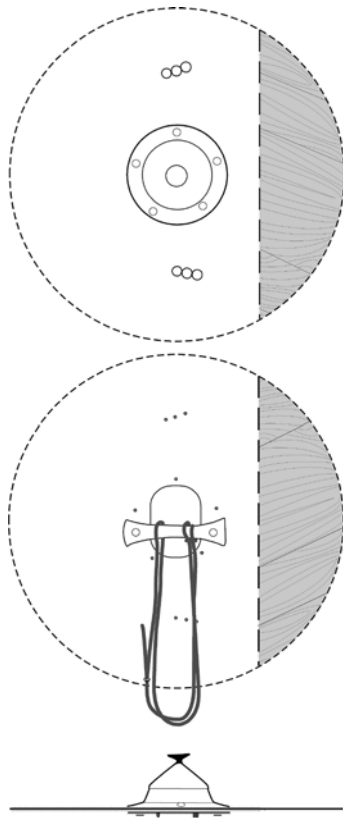


Figure 7. Reconstruction drawing of the shield from grave 909 showing the front, back and side, and the strap attachment. Drawing: Kate Morton

up around the length of the wooden handle and preserves its rounded rectangular profile, Figure 3. The presence of skin product around the handle wood indicates that the board was covered both front and back after the handle was inserted, but before the grip was attached.

Based on these findings a tentative construction sequence for the shield can be proposed as follows:

1. Board constructed
2. Hand hole cut
3. Handle inserted in front of board (Type A1)
4. Front of board covered with skin product (board mounts attached – grave 868 only)
5. Back of board covered with skin product (board mounts attached in most examples)
6. Hand grip riveted to back of board
7. Board covering trimmed away for hand hole and back cover wrapped around handle
8. Shield boss riveted to front of board.

### *Straps and bindings*

The evidence for bindings is inconclusive as, although nine grips show evidence of associated textile and skin product, these are probably from garments or associated body coverings on which the shield was resting in the grave.

The remains of carrying straps were found around the shield grips from graves 909 and 993. On the former, three strips of skin product (two at one end of the handle and one at the other) are preserved around the grip and side of the handle. A strip of skin product of exactly the same dimensions (14 mm wide and 4 mm thick) is preserved around the axis of a buckle found in the shield area of the same grave, suggesting the presence of a carrying strap, the length of which could be adjusted. The strap was probably attached at one side of the handle by a 'strap hitch' knot, while the opposite end was passed around the handle and fastened with the buckle in a simple loop, making a secure but adjustable strap, Figure 7.

Six strips of skin product on the shield grip from grave 993 suggest another possible skin product carrying strap. Three thongs at each end of the handle, 6 mm wide and 2 mm thick, are preserved on the outside of the grip (away from the shield board) and around the edge of the wooden handle.

### *Shield mounts*

Seven shields featured iron disc-headed mounts and three had decorated copper alloy fittings; only one shield was without any mounts, Table 2.

The location of iron disc-headed mounts in the graves indicates that they were grouped on opposite sides of the boss at, or slightly above, the centre line. It is not possible to determine their location relative to the handle as the orientation of the shield bosses in the graves was not recorded.

The position of the copper alloy mounts on the shields from graves 868, 888 and 909 varied. The shield from grave 888 had only three mounts: one lozenge-shaped and two discs, positioned in a row to one side of the boss. Grave 909 contained six disc-headed mounts arranged in two rows of three on opposite sides of the boss, Figure 7. The mounts from these shields were riveted along the grain of the board wood or at a slight angle to it.

In many graves the position of the mounts relative to each other, where maintained by a corrosion bridge or organic remains, suggests that they were set edge to edge and were almost touching. The size of the disc-headed mounts is uniform on most of the shields, with the diameter of the copper alloy examples ranging from 16 to 19 mm and those of iron from 25 to 65 mm in the finds from most graves, with two exceptions. Grave 993 contained two groups of three disc-headed mounts arranged in a triangular pattern on either side of the boss. The mounts that form the base of the triangle, closest to the boss, are larger (43 mm) than the mount forming the peak of the triangle (35 mm). The disc-headed mounts in grave 967 are of two distinct sizes (35 and 40 mm) with one large and one small mount positioned either side of the shield boss, although their exact position is unknown as the shield fittings were displaced in the grave.

Surviving organic remains on the reverse of all the shield mounts (apart from those from grave 868, see below)

indicate that they were riveted through the board and the back and front shield covers. The function of the disc-headed mounts is not clear; there was no evidence in the organic remains to suggest that they supported or strengthened plank joins, but they may have held supplementary layers of skin product board cover in place, which might account for the extra depth of their rivet shanks compared to those found on the boss angles [11]. Alternatively, they may have been purely symbolic or decorative.

A circle of skin product, approximately 21 mm in diameter, was absent from around the rivet shank on two iron disc-headed mounts from grave 990. This could be an original hole cut in the skin product, or possibly the result of contraction away from the rivets as a result of shrinking the board cover. Such a hole is not visible on any other disc-headed mount from the cemetery, perhaps due to poor skin product preservation or overlying wood that obscures it.

The high-status shield from grave 868 had disc-headed mounts arranged in two rows of four on either side of the boss. The two zoomorphic mounts on this shield were positioned off-centre, projecting outwards from the boss with the bird of prey towards the edge of the board, Figure 6.

This arrangement is deduced from their position in the grave and evidence from the organic remains; the wood grain runs along the length of the shield and the rows of disc-headed mounts. Remains of skin product from the back board cover, present on top of the rivet washers, indicate that the mounts were riveted in place after the front of the shield board was covered, but before the back cover was applied, hiding the mount attachments from view, see shield construction sequence above. Wood remains on the edges of the rivet washers suggest that the rivets were hammered flush with the surface. The attachment of these mounts was different to that seen on other shields. X-ray fluorescence (XRF) analysis of the zoomorphic mounts revealed that, with a few exceptions (Table 1), the compositions of their silver overlays were similar to those on other elements of shield 868. These analytical results, combined with their matching decoration, suggest that they were part of a suite.

The underlying metal of the shield mount contained copper, some tin, small quantities of lead and zinc, with traces of gold and silver, and is similar to the composition of hand grip rivets found on the Sutton Hoo Mound 1 shield [3]. Analysis showed no solder between the gilt copper alloy mount and a silver overlay on one disc-headed mount from grave 868, indicating it was attached after mercury gilding, Table 1 [18].

## CONCLUSIONS

Investigative conservation of the shield fittings from Tranmer House shows that in general they were constructed in line with known Anglo-Saxon methods. Where the

shields are unusual is in the predominance of ash as the wood of choice for the board. Ash is a heavy timber, but it is resistant to splitting, which would have made it effective in its role in absorbing weapon blows and this may, perhaps, underpin its selection in these shields.

Evidence was preserved for the method of handle construction and board covering, as well as the size of weapon; none of these shields was large by Anglo-Saxon standards. The shield from grave 868 was unusually richly ornamented with a suite of silver and gilt fittings, most notably a bird of prey and monstrous shield, which may have been sacred motifs designed to add another layer of protection in battle [12]. These zoomorphic mounts and unusual constructional features, such as the previously unrecorded variation of handle construction and possibility that the board bore a preparatory coating or paint layer (also present on the shield from grave 909), support the conclusion that it was a high-status object.

It is unusual to find surviving evidence of a carrying strap and the remains found in two of the graves at Tranmer House serve as reminders of the functionality of the object. In particular, the very high levels of preservation of organic remains on the handle and buckle from grave 909 provide detailed evidence of the shield strap attachment.

The close collaboration of conservators, scientists and Anglo-Saxon specialists, has enabled an interpretation of the methods of shield construction at the cemetery. Analysis of the group as a whole places them in a wider context and supports the interpretation of the Tranmer House cemetery site. This study builds on an existing body of work, but has added new findings to further the understanding of the Anglo-Saxon shield. Ultimately, while the shield was fundamentally a utilitarian object, it was used at the cemetery both to honour the deceased and as a symbol of the society's ability to defend itself.

## APPENDIX

Wood samples were examined in three different planes (transverse, radial longitudinal and tangential longitudinal) using a high-resolution biological microscope (Leica Aristomet) with dark field reflected light at magnifications ranging from  $\times 100$  to  $\times 1000$ . The variable pressure scanning electron microscope (VP-SEM: Hitachi S-3700N) was used to examine poorly preserved or problematic samples.

X-radiography and stereomicroscopy were used to examine the construction of the shield bosses and a cross-section of the boss apex from grave 614.

X-ray fluorescence (XRF) spectroscopy was used to analyse non-ferrous metal decorations on the boss apices, angle rivets and board mounts. As only uncleaned surfaces were analysed, the results in Table 1 are not fully quantitative.

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## NOTES

1. For this burial a programme of accelerator mass spectrometry radiocarbon dating, combined with Bayesian modelling, has been undertaken. It suggests a chronological bracket (at 95% probability) for the cremations of cal. 520–585 [5]. The Tranmer House inhumations have a similar date range and although a few may extend into the early seventh century none is as late as the great ship burials of Sutton Hoo Mounds 1 and 2.
2. For accuracy, the term 'skin product' is used throughout the text to refer to the coverings found on the shields as it has not been possible to determine the exact nature of the material and any subsequent processing, for example tanning.