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Contents

Projects

Conferences

Obituaries

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Analysis and conservation of a Bronze Age linen textile from Suffolk, UK

Abstract

A rare Bronze Age linen textile was found inside a socketed axe, part of a bronze age hoard dating to circa 800 BCE, discovered in Somerleyton, Suffolk, in the 1920s. The recent loan of the objects from the hoard provided the opportunity for a collaborative study of the fragmentary textile and its original context and significance. Scanning electron microscopy and energy-dispersive X-ray spectroscopy were undertaken to update and inform interpretations of its condition, character and function. The remounting of the textile was necessary for display. The conservation challenges this raised, and the solutions found, are detailed here. The wider study of the metalwork associated with the hoard and of the current state of knowledge regarding Bronze Age textiles in Britain allowed for several hypotheses to be put forward about the textile's functional significance in efficient hafting techniques and its potential votive symbolism. The Somerleyton textile serves as a reminder of the need to contextualise Bronze Age metalwork within wider networks of (organic) materials and the potential of older collections to provide new insights.

Keywords: Bronze Age, linen, textile, metalwork, hoard, votive, conservation

Introduction

This conservation project at the British Museum (United Kingdom) was stimulated by a request from Lowestoft Museum, Suffolk in 2018 for a loan for display of a Bronze Age metalwork hoard that included a small group of textile fragments. A collaborative approach to study and remounting of the textile by curators, researchers, scientists and conservators meant that different aspects could be explored and the textile investigated in its wider context. The hoard is now on display in Lowestoft Museum until February 2025.

The hoard of copper alloy weaponry, tools and the textile was found on or around the 24 August 1926 by Reverend Gerald Halsey in the garden of Somerleyton Rectory in the parish of Somerleyton in Suffolk (Ordnance Survey National Grid reference: TM 48850 97381). The textile (BM registration number 1928,0210.23) (fig. 1) was located inside a bronze axe head and is a fascinating and significant aspect of the hoard: there are very few bronze age textiles on display in the UK and, consequently, there is little public awareness of this type of survival. Later prehistoric votive and depositional practices are usually represented in academic discussions and public displays by metalwork alone (Haughton et al. 2021, 173). The Somerleyton find provides an important opportunity to broaden this view and to recognise the importance of other, non-metallic, material culture, including textiles in gaining a better, more nuanced and holistic understanding of the rationale and reasons for intentional bronze age depositional practices (Bradley 2016, 48–79) and important aspects of bronze age social-economic life (Haughton et al. 2021).

The Somerleyton hoard is typical of many hoards of

Fig. 1: The textile sandwiched between glass before remounting. The fragments are bundled together, overlapping one another (Image: ©2022 Trustees of the British Museum)

this period found in the last few decades. According to Halsey, the objects were "all [found] within a very small compass, but not actually discovered together", about "five feet" (circa 1.5 m) below the modern ground surface, with no trace of "urn or receptacle" to contain the objects (Rev. G. Halsey, 20 October 1927, BM Dept of B&MLA incoming correspondence). That the objects were "not actually discovered together" probably refers to the fact that the objects were not all in direct contact with each other. This is possibly due to post-depositional disturbance, such as taphonomic processes and agricultural activities. Alternatively, it may reflect the original disposition of the objects within an archaeological feature such as a pit or ditch. On the balance of probabilities, the objects were deposited together or over a short period of time and can therefore be described as a single hoard.

The hoard was acquired by the Department of British and Medieval Antiquities (now the Britain, Europe & Prehistory Department) at the British Museum in 1928 (registered as 1928,0210.1-33) and published in a single page note that outlined its date and contents (Anon 1928, 236–237, p. xlii). Not all such finds were published in such a timely manner, but it was believed to represent a good example of the type of associations found in English bronze age metalwork deposits.

The metalwork comprises 32 copper alloy objects; 17 socketed axes in various states of completeness (only four are largely complete); two fragments of winged axes; nine fragments of sword (one diagnostic section of sword hilt and eight undiagnostic sections of blade); one crushed spearhead; two socketed gouges; and one socketed chisel fragment. The composition of the hoard is typical of late bronze age metalwork deposition in southern England generally, and East Anglia in particular (Needham 1990; Pendleton 1999; Lawson 2018). It mainly consists of objects found in the region, and therefore perhaps most notable are the two winged axes, a type common in France and other parts of North-West Europe and possibly indicative of longer distance trade and exchange networks (O'Connor 1980, 159). The hoard is typical of the later phases of the late Bronze age in southern England, particularly the so called 'Ewart Park' phase (900 to 800 BCE), which is characterised by a sharp increase in metalwork deposits, especially in the south east of England (Rohl and Needham 1998, 105–106). However, the presence of rib and ring-and-dot decoration on one socketed axe (1928,0210.18) and linear facet decoration on another (1928,0210.16) suggests a connection to axes of a slightly later date (800 to 700 BCE) (Pendleton 1999, 142, no. 134), or a transitional typo-chronological position. It may be noted that the axe containing the textile belongs to Needham's (1990, 28–38) Class A (South-Eastern type), a common type in East Anglia, belonging to the late bronze age 'Ewart Assemblage' (Rohl and Needham 1998, 105–106) (fig. 2).

Hoards from this period and region (and many other parts of north-west Europe) are often partially or wholly fragmented, perhaps to ease the process of re-melting and recycling in a crucible of restricted size. However, the symbolic and dramatic visual spectacle of breaking weapons and tools cannot be underestimated and may have played an important part in the rationale. Motivations for this have been much debated and discussed by prehistorians (for example Pendleton 1999; Bradley 2013; 2016; Fontijn 2020; Knight 2022), and there is now a consensus among British and European prehistorians that this type of behaviour was socially and ritually significant, even if there remains scope for some deposits being recovered for utilitarian reuse and recycling, while others remained undisturbed (Needham 2001; Fontijn 2020, 86–111). In summary, the Somerleyton hoard is typical in many ways. What makes it exceptional is the presence of a hitherto underappreciated textile fragment and the possible reasons for its inclusion in the hoard.

According to Halsey the "small piece of cloth" (Rev. G. Halsey, 20 October 1927, BM Dept of B&MLA incoming correspondence) was found inside one

Fig. 2: The axe head (1928,0210.22) in which the textile was originally found (Image: ©2022 Trustees of the British Museum)

of the complete socketed axes (1928,0210.22) and correspondence suggests that it was in situ when it arrived at the British Museum. The publication of the hoard also noted that the textile was "wedged in with two lumps of bronze" (Anon 1928, 237). These descriptions are the only records of the original context and form of the textile before it was removed from the axe head. Given the publication date, it is remarkable that Audrey Henshall did not include it in her 1950s article, which listed a series of textile finds published in periodicals from all over the UK, including the Antiquaries Journal (Henshall 1950, Appendix A).

Details of the treatments the textile received after it was found are not known. In a letter of 13 December 1927, the Deputy Keeper of the Department of British and Medieval Antiquities wrote, "The woollen cloth has been removed, treated and is now under glass" (letter to Rev. G. Halsey, BM Dept of B&MLA outgoing correspondence). This mounting method sandwiched the textile between two sheets of glass (9.5 cm x 9.5 cm) with the fragments located in the centre of it. The glass was then taped around the edges, using black self-adhesive tape. It was a technique often used in the nineteenth and early twentieth centuries soon after excavation and subsequently, and there many examples still in existence (Higgitt et al. 2011; Lennard 2012, 146). It had a number of benefits as the fragile textiles were immobilised, could no longer be handled or flexed, were visible from both sides and relatively protected from environmental fluctuations. However, cleaning, consolidation and techniques used to open out such textiles before they were placed between the glass were the cause of additional chemical and physical problems, and also resulted in loss of evidence in the form of soiling and creasing, and compromising of opportunities for future scientific analysis.

Conservation

In order to prepare the textile for loan conservation and remounting was necessary as one side of the glass had become broken which meant that the mount was no longer completely rigid, and the fragments positioned adjacent to the break were vulnerable. A new mount would ensure that the fragments were no longer compressed by the glass, which had caused the weave to be visibly squashed and the fibres, inevitably, to be damaged. As the overall appearance of the mount was old-fashioned a further benefit was that remounting would increase visual accessibility for study and visual appeal on display.

Although it had already received significant interventive treatment in 1927 in order to open out and flatten it, as an archaeological textile it was important to investigate, record and preserve any remaining information and evidence. An integral aspect of the treatment was to avoid the use of adhesives or consolidants as this is irreversible and will compromise future scientific analysis (Gillis and Nosch 2007). The project also provided the opportunity to have high resolution images taken of both sides, which can be used for study purposes and will remain as a lasting record of the textile, an aspect of the documentation

Fig. 3: Remounting of the textile was carried out inside a custom-made enclosure, to maintain a stable environment of 50% ±2 Relative Humidity (Image: ©2022 Trustees of the British Museum)

process which is particularly important for fragile archaeological material (Mannering and Skals 2014, 7285–7286).

Once the glass was removed, the fragments were likely to be very vulnerable to environmental fluctuations and so conservation work was carried out in a custom-made enclosure to ensure the ambient environment was as stable as possible. The relative humidity within the 'tent' was controlled using pre-conditioned Prosorb Humidity Control cassettes set to 50%. Environmental conditions were monitored using a temperature/RH data logger (Hanwell, UK) and remained constant throughout the project (fig. 3).

The glass was opened by cutting the tape around the outer edges, which made it possible to carefully remove the uppermost broken glass. This confirmed that the textile fragments, although flattened, had not adhered to the glass and there was only the slightest trace of cloudiness on the surfaces which had been directly in contact with the fragments. The process of identifying and moving them apart from one another was undertaken very gradually and documented with photographs. Some of the pieces were adjacent to one another but not actually attached. Others, although clearly different fragments, had fibres or threads which had become entangled and were therefore not separated. After separation there were nine pieces altogether, some of which consisted of more than one fragment (fig. 4). They could then be examined more closely, technical analysis undertaken and the side with more visible technical information identified. Although the textile has now been identified as linen, it is likely that it was described as "woollen" in 1927 due to the fuzzy appearance of the fibres, which in some cases had caused the pieces to become 'joined' together. The edges of the fragments are fraying and there are many long, matted threads and fibres which obscure the surface. These fluffy, fractured, splintered and split fibres, could be the result of original use, or are possibly partly due to treatment received to clean and open the textile out before mounting in 1927. It was also evident that there were still particulates, including vegetable fibre pieces, caught on the surface. Much thought was put into planning a mount which would hold the fragments securely and be suitable for study, display, and transportation to the loan venue.

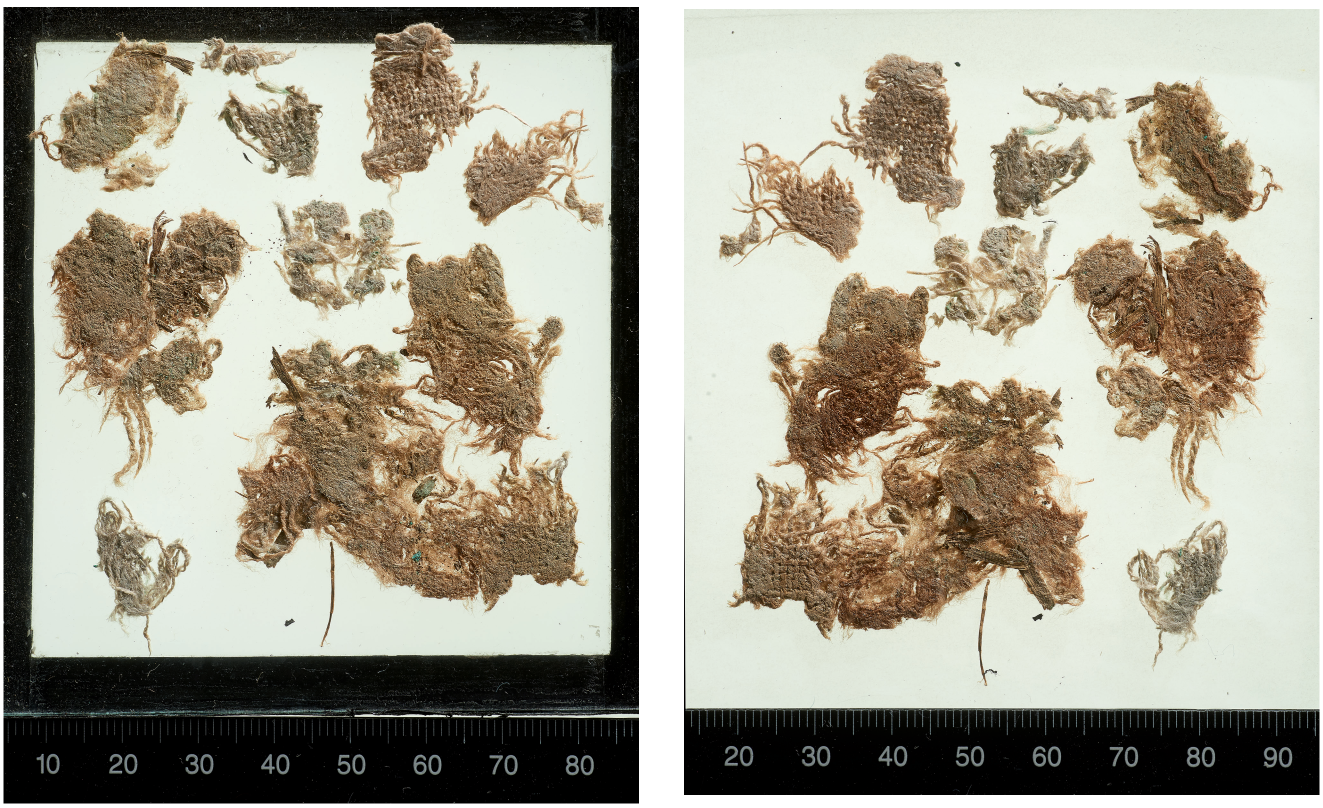

Fig 4: Left: The textile after the broken glass had been removed and the fragments moved carefully apart from oneanother, still lying on the other side of the glass frame. Right: The other side of the textile after it was turned onto another surface (Images: ©2022 Trustees of the British Museum)

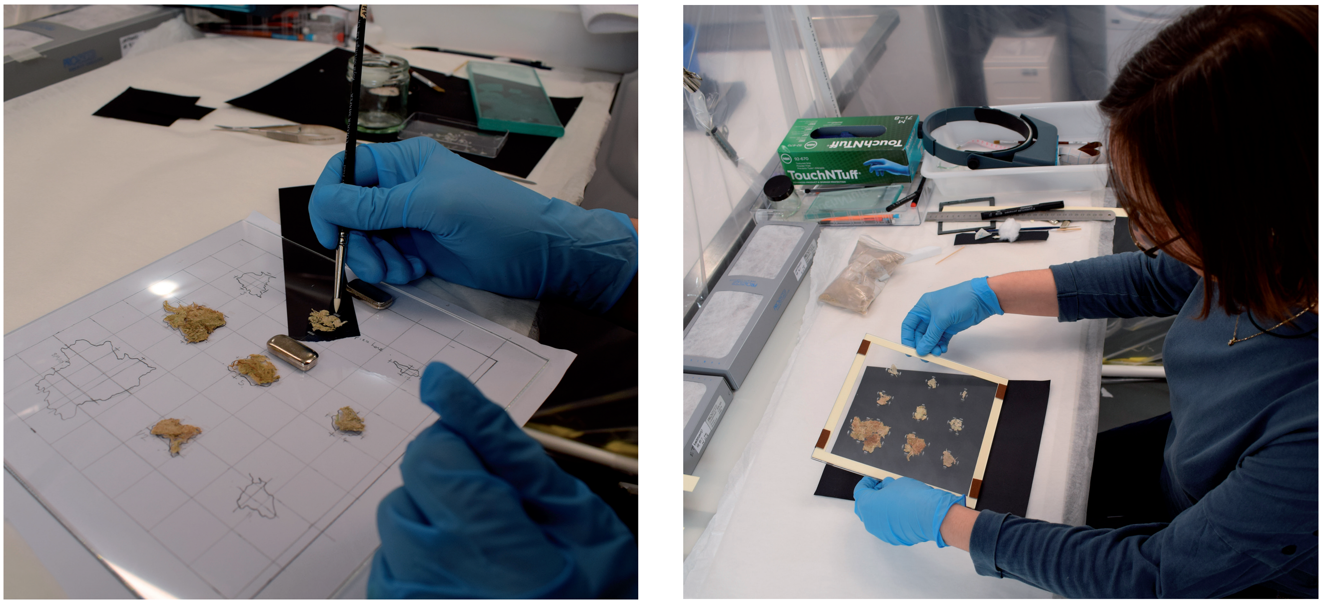

Fig 5: Left: Remounting in progress, showing the fragments being secured to the glass using silk threads and adhered paper tabs. A drawn diagram was placed underneath the glass to enable accurate placement of the fragments and thread. Right: Work in progress showing the fragments between the glass with the cream card spacer visible around the edges. Temporary adhesive tape tabs were used to hold the glass together, before the brown adhesive tape was applied right around the edges, so that the card was no longer visible (Images: 2022 Trustees of the British Museum)

Different types of textile mounting methods, such as a net overlay or 'pressure mount' (Gill 2010) were carefully considered. Transparent nylon net overlays are often used for mounting archaeological textiles at the British Museum; dyed to a discreet colour, the net can be laid over the textile and stitched around the edges and through any holes to hold it securely in place without stitching into the textile or significantly obscuring the surface (Cruickshank et al. 2002, 49–52). A pressure mount, consisting of a fabric covered board with a slight recess for the textile and a transparent Perspex sheet clipped over the top can also work well for fragmentary archaeological textiles, but in this case it was felt that neither method allowed enough visual access to the fragments.

As the textile's previous glass sandwich had allowed both sides to be seen, and because the pieces were already flattened, it was decided to return to the idea of a transparent mount, but with modifications. The properties of glass, including dimensional stability, impermeability, rigidity and chemical stability make it preferable to acrylic (Kaye 2016). Unless it is very thick, acrylic is less rigid, it can be static and is prone to scratching. A further consideration is that the longevity of any coatings on the surface of the acrylic, which could potentially contaminate the fragments, is not known. Research was undertaken and colleagues were consulted on current projects to identify methods which could be utilised or adapted. For example, adhered paper tabs are used to secure Egyptian papyrus between sheets of glass (Leach 2005, 196); and archaeological leather has been mounted using shaped card recesses to hold the fragments in place between glass sheets (Wills et al. 2021; 2022). It was acknowledged that there is a slight risk of the glass breaking in the future; however, the benefits of being able to see the textile from both sides, the protection afforded by this type of mount and the lack of a better alternative meant that a modified glass sandwich mount was felt to be the most appropriate option.

The textile was mounted between two sheets of borosilicate glass, 2 mm thick, cut to size 20 cm x 20 cm, with dubbed corners. In order to secure the fragments to the glass the method used for Egyptian papyrus was used as a starting point and adapted. Instead of adhering the fragments themselves, they were attached to the glass using lengths of undyed monofilament silk tensioned horizontally and vertically across each fragment, the ends of which were secured with paper tabs to the glass. This was preferable because it avoided the application of paper tabs directly to the fragments. Tests to trial this method worked well and the combination of wheat starch paste and Nanocellulose paper tabs were found to provide the transparency and strength of adhesion required to attach the fine monofilament silk thread to the glass using tiny paper strips 1 mm x 3 mm. Nanocellulose paper (Japanese Mitsumata and Kozo base with Bacterial Cellulose (Gluconacetobactercilinus), 2 g/m) is a thin, semi-transparent tissue with a neutral pH. It has been used very successfully in the Organic Artefacts Conservation studio at the British Museum for making joins, fills and backings for degraded leather (Wills 2021; 2022) and other skin materials, including gut.

The threads were planned to lie across the side of the fragment which had the least technical information visible and their exact positioning was first mapped out on a diagram, which was then placed beneath the glass whilst work was in progress (fig. 5 left). Each thread was attached by locating it just outside one edge of a fragment and adhering it to the glass with a paper tab, adhesive applied. The thread was then tensioned across the fragment and temporarily held down on the glass at the opposite edge with a small but heavy metal weight. This allowed the second paper tab to be positioned and adhered; it was an extremely fiddly procedure to achieve an appropriately tensioned thread with neatly and firmly positioned paper tabs.

Once all the fragments were secured in this manner, different thicknesses of card were tested to act as a spacer, creating a gap between the glass sheets, so that the fragments touched the glass on either side but were not squashed by it. The card was cut to the same size as the glass, with a large square hole in the centre, creating a 2 cm wide border. The chosen card, Museum Board (100% cotton, 550 microns) was placed in position, and the second piece of glass located on top. Archival grade brown self-adhesive tape was adhered neatly all around the edges of the frame and the registration number applied (fig. 5 right). The tape covers the card spacer completely, making the fragments the focus within the mount. The fine silk threads and paper tabs can be seen on close inspection but are visually unobtrusive if a light surface is placed behind the glass mount. Overall, remounting of the textile using this method enables the textile to be studied, transported and displayed safely (fig. 6). Although both sides can be seen, in order to limit movement, turning is discouraged and photographic images should be referred to initially or in preference. Handling recommendations form part of the documentation and have been attached to the outside of the storage box, drawing attention to the fragility of the textile inside and best practice for access.

Conservation of fragile and fragmentary archaeological textiles raises a number of challenges and it can be difficult to provide a solution which satisfies all requirements, including ethical considerations, physical safety and visual access (Harrison and Smalley 2017). The involvement of a number of specialists in the conservation and mounting process provided a fascinating opportunity to discuss ethical considerations, past restoration and mounting practices, aesthetics and researchers'/viewers' expectations of archaeological textiles for study and on display. Having first carried out research into the

Fig 6: Left: The side of the textile with most technical information, after remounting. Right: The other side of the textile after remounting (Images: ©2022 Trustees of the British Museum)

textile's context and history, it was important for the conservator to then gain the insights, opinions and experiences of others, as the remounting process would be significant intervention on this rare textile, which would have a lasting aesthetic and practical impact on its perception and use.

There has been a gradual but increasing awareness of the importance of archaeological textiles and the preservation of evidence and information that they contain (Brooks et al 1996; Lennard 2012, 144; Margariti 2019). This means that any interventive treatment undertaken should be very carefully judged, and emphasis placed on appropriate support and mounting, planning for safe access and the provision of a suitable, stable environment. Therefore, for example, particulates and creases are often retained, even though it is acknowledged that flattening or cleaning might allow a clearer view of the textile technology. This is the case for a knotted textile from the iron age Hallstatt salt mine in Austria, which after conservation retains its original knot (Grömer et al. 2013, 400–401). In the case of the Somerleyton textile, the presence of the vegetable fibre pieces highlights the need to avoid unnecessary 'cleaning', and demonstrates that associated particulates may well contain evidence relating to the textile itself. If the textile still remained in a bundle as found, such as the one from Pyotdykes (Henshall in Coles et al. 1964, 197–198, fig. 3.), it is probable that it would be left in that configuration so as not to compromise contextual information and future analytical techniques or, at most, it would be fully documented and a partial and carefully considered minimally interventive treatment would be undertaken. If it still remained multilayered and creased, as it would have been when removed from the axe head, further information on layering, soiling or associated hidden material or objects inside could be gained using X-radiography or CT scanning. Fortunately, although evidence from the Somerleyton textile in the form of creasing, soiling and positioning has been lost due its flattening and remounting in the 1920s, it was still possible to carry out analysis which would add to the existing information.

Remounting of the Somerleyton textile presented a range of specific challenges, some the result of the previous restoration and mounting technique. Its original configuration was lost and the reason for the placement of the fragments in relation to one another inside the old glass frame was not known, though most likely random. Bearing this in mind, once documented thoroughly, the fragments could justifiably be repositioned. This raised the question of how the fragments should be presented in their new mount and what effect this would have on the appearance and study of the pieces. The conservator was aware that any repositioning of the fragments would signify the next stage in their existence and perception, and was concerned that the rearrangement should be justified and well considered. Through discussion, it was clear that the curatorial view was that, in their previous glass sandwich, the fragments looked cramped, jumbled and scrappy; and that their new mount should help to minimise the perception that they are not important. The view from a textile researcher was that the re-presentation of the pieces in an orderly arrangement would give the textiles a more accessible form of presentation when on display and allow quick and efficient access for study. It was agreed that a new, larger mount would allow the textile fragments to be spaced further apart from one another, organised according to weave alignment, size and colouration. It was also decided to orient the fragments so that the sides from which most information could be gained all faced the same way, even if this meant turning over three of the fragments to face the other way.

Scientific Analysis

Textile

Before remounting, scanning electron microscopy (SEM) analysis was undertaken to gain further information on the textile fibres and particulates

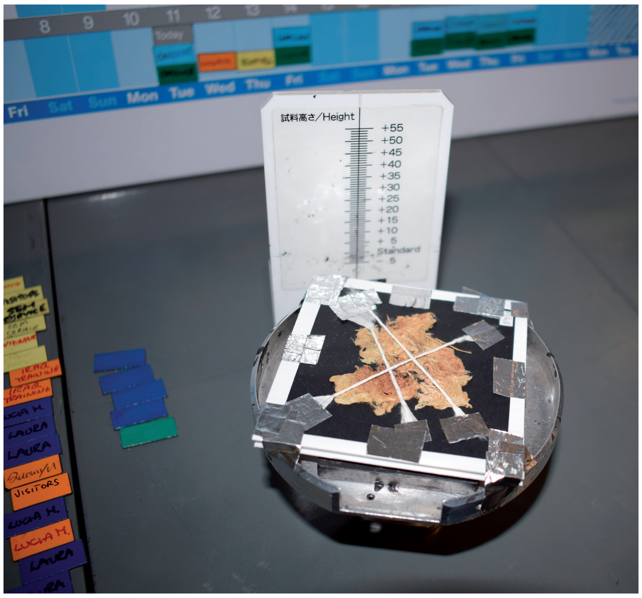

Fig 7: A textile fragment prepared for SEM with temporary Japanese tissue straps across the surface to prevent movement during imaging (Image: ©2022 Trustees of the British Museum)

present. This incorporated the use of energy-dispersive X-ray spectroscopy (EDX). Sampling was avoided as the fragments themselves were small and with careful preparation by scientist and conservator, it was possible to put each inside the scanning electron microscope without the need to remove any fibres. The most challenging aspect of this was that each fragment required immobilising inside the chamber because, when air is introduced under vacuum and released when the chamber is evacuated, this could cause it to move. A number of suitable materials and methods was considered to establish which base material and fixing method would have the least visual impact on the images. A foam base, for example, which would have been useful for pinning, could not be used as it is non-conducting, which would cause charging (white streaks) on the SEM images. It was therefore decided to secure each fragment separately onto a piece of black paper, which had been cut to fit the size of the stage inside the SEM. Thin straps of twisted Japanese paper were then secured across the surface of each fragment and held at either side using self-adhesive aluminium tape secured to the black paper (fig. 7). The ability to be able to scan over the surface of a whole fragment during imaging meant that features of interest could be identified, focused on and compared, in terms of their appearance and condition.

Variable pressure (VP) SEM was used to identify the fibres of the textile fragments. With the model of VP SEM used, Hitachi S-3700N, the preferred accelerating voltage in backscattered electron mode was 15 kV, a chamber pressure of 30Pa was selected, magnifications ranged from x20 to x400, and the working distance varied from 25 mm to 33.7 mm, as required. In order to maximise topographical features on the fibres, 3D mode was chosen in preference to Compositional.

Metalwork

The 32 copper-alloy axes and sword fragments were also systematically assessed to record their physical condition and carry out any work which might mitigate risk of transit and display. For examination purposes, a Kyowa® binocular microscope was used by conservators at magnifications of between x10 to x40, using a fibre-optic ring illuminator or a raking light source for internal areas as required. A portable Dinolite Edge digital microscope (Dinolite Edge AM 4115ZTL) at x20 to x100 magnification with adjustable polariser was used for structural analysis of the textile fibres which remained inside. In order to examine the fragments further they were X-radiographed to supply further technical information. Computed digital X-radiography was carried out using conservation equipment, a Euroteck® 225 kV cabinet and digital capture and manipulation enabled by Carestream Industrex® HPX-1 software.

Findings

Textile

SEM imaging of four fragments confirmed the presence of *Linum usitatissimum* (flax) fibres and adjacent epidermal cells. Examination under SEM gave further information on the condition of the fibres, for example that the flax fibres, stripped from fibre bundles, were flattened and compressed as a result of being sandwiched between glass mounts (fig. 8a). Particulate matter (which showed up white on the SEM image) was also visible amongst the fibres and fragmented epidermal cells. SEM-EDX analysis revealed the particles as copper, calcium and silica, as would be expected from the burial environment.

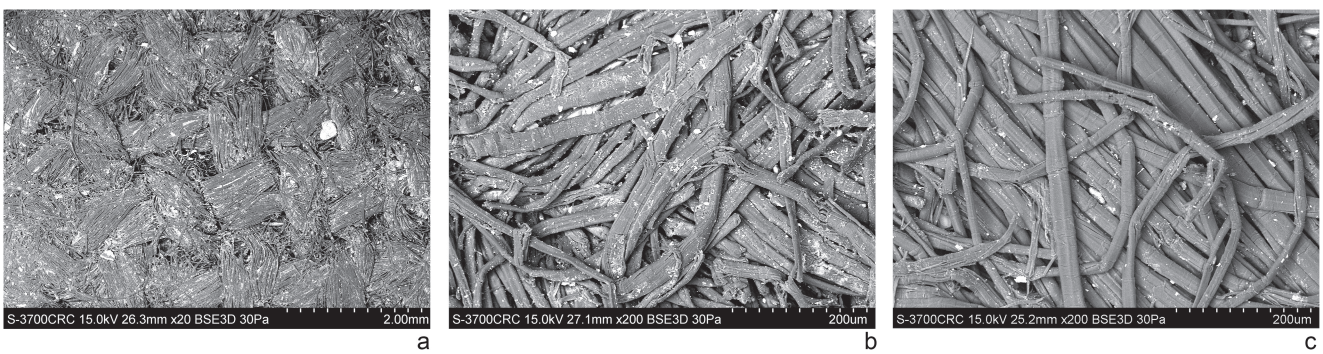

Fig. 8: SEM images: a – The weave structure compressed by the previous glass frame with visible squashing and damage to the fibres. Scale bar in mm; b – Squashed flax fibres, epidermal cells and particulate matter. Scale bar in microns; c – Flax fibres and epidermal cells showing less fracturing, splitting and squashing. The diagnostic features for flax are remarkably clear and intact. Scale bar in microns (Images: C. R. Cartwright; ©2022 Trustees of the British Museum)

a b c

Fig. 9: a – The largest textile fragment with a simple selvedge (bottom left), areas of darker orange coloured staining and unprocessed flax strips, possibly ties, caught on the surface; b – Close up showing the simple selvedge (top) and spliced threads with minimal twist in the singles, plied appearance and variable diameter; c – Close up showing vegetable fibre strips caught on the surface of the textile (Images: a ©2022 Trustees of the British Museum. b and c Susanna Harris, Somerleyton 1928,0210,23)

Another SEM image of the flax fibres and epidermal cells however, showed less fracturing, splitting and squashing (fig. 8b). The diagnostic features for flax were remarkably clear and intact, showing that the condition of the fibres varied considerably (fig. 8c).

The individual fragments vary in size and measure from between 5 mm x 5 mm to 46 mm x 47 mm. There is some green staining from copper corrosion inside the axe head, and slight yellow and orangish colouration. The consistent technical features and appearance of the weave, together with its original position in the axe head socket suggests these are fragments of the same textile. The textile is woven in balanced plain weave (tabby), with 10 to 12 threads per cm in warp and weft, with S2* yarns, consisting of two singles with slight z to no twist, plied in an S-direction. Yarns range from 0.5 mm to 1 mm in diameter. One fragment has a simple selvedge (fig. 9a and b). Using this feature to align the warp and weft, this fragment is woven with threads 0.7/0.6 mm (annotated warp/weft) mean diameter (range 0.5–1.0/0.5–0.7 mm), medium twist ply angle 36°/28° and 10/11 threads per centimetre of weaving. The warp is slightly thicker and more tightly plied than the weft. The threads have the features of splicing (outlined in Gleba and Harris 2019, 2333–2337) (fig. 9b). They are S2* plied, with little or no twist, adjacent threads show variation in diameter with the finest warp threads nearly half the diameter of the coarsest. Viewed with the SEM, the nodes of the fibre bundles are aligned, which is evidence for the use of fine fibre strips or ribbons which have not been separated into their constituent fibres.

Caught on the surface of the textile are also several short, flat lengths of plant fibre strips, a few centimetres in length and matter several millimetres wide (fig. 9c). Examined in the SEM, these strips have two distinct surfaces. One surface is the outer bark (cuticle and epidermis), nestled into the reverse are longitudinal flax fibre-bundles of the innerbark (bast) (for more details of fibre bundles see Baines, 1995, 1). Quickly prepared lengths such as these were readily stripped from the flax plant stem when fresh or dry and could be used directly without further splitting or processing. In the case of the Somerleyton textile, it is tempting to interpret these as ties used to bind the textile either to itself or into a bundle with the two lumps of bronze before it was placed in the axe socket. Considering their age, the fragments are in a remarkable condition and do not display as much of the characteristic brittleness and powdering that can be seen on many archaeological textiles. It is reasonable to speculate that the textile was used, worn and, possibly, already in pieces when they were placed inside the axe head. Once inside, the biocidal action of the copper alloy (Janaway 1983, 48) and the dark, stable environment during burial would have helped to preserve them. The variation in colour on the textile fragments may have been caused by surface soiling, their position within the axe head or, is possibly the result of a previous restoration treatment. To assess whether any orangish colourants derived from madder root might be present in areas that appeared a slight orange colour, the textile was viewed under UV light. This gave no indication of luminescence, as typically associated with these colourants and, although lack of luminescence does not completely exclude the presence of the colourant, it does make it unlikely in this context and therefore it is unlikely that the fragments were dyed (Dyer et al. 2018). A few of the threads are stained green, probably due to close contact with the metal. Traces of curly malachite corrosion product (Scott 1991; 2002) trapped within the fibres of the textile were further revealed by X-radiography, where they appeared as contrasting X-ray opaque white flecks. These particles may be similar to the particulate matter observed in the SEM images.

Metalwork

In general, the metalwork was in a sound and stable condition. In addition to the thin, compact and undisturbed layers of green malachite corrosion ($CuCo_3$ Cu $(OH)_2$) on outside surfaces of the metalwork, it was noted that dark blue copper carbonate azurite ($2CuCo_3$.Cu $(OH)_2$) was also present in granular crystalline form in the interiors of some of the axes. This specific copper corrosion product tends to form in voids and in areas where there is low access to oxygen. Also present in the interiors of the axes was the curly form of the copper carbonate malachite seen on the textile's surface.

Previous restoration treatments were also considered. A letter from R. A. Smith, Deputy Keeper of the Department of British and Medieval Antiquities, to the Reverend Halsey (BM Dept of B&MLA, 13 December 1927, outgoing correspondence) gives some information about the early treatment of the metalwork from the hoard. The letter describes how the copper-alloy finds were treated by "pickling", described as being a lengthy process. By 1927, treatments carried out on the Somerleyton hoard would be likely to have used alkaline or acidic aqueous solutions, although it is surmised that alkaline baths would have been more likely in this case, as the linen thread and fibres remaining inside the axe in which the textile was found would not have survived in an acidic bath (Jakes and Sibley 1983).

During detailed examination of the metalwork, despite previous restoration treatments, particulates were found in the recesses of the metalwork including black flecks of charcoal held in place by soil remains. Most of the metal objects contained no textile remains and it is possible that they had never been present. However, on the inside surface of the axe in which the textile had been found, traces of fibres and some cream coloured threads were adhered, as well as some bright green accretions which may be a combination of fibres and curly green corrosion (Scott 1991; 2002), indicating that cleaning treatments which may have been carried out were not extensive. The textile threads that remain can be seen, adhered to the central interior surfaces of the axe head, rather than pushed into the end of it. However, their location and a past conservation treatment using a transparent synthetic surface coating material, such as the acrylic co-polymer Paraloid B72, means that the examination of these residual textile fibres is now severely inhibited.

To help understanding whether the hoard was accidentally deposited or, otherwise, a small group of four unplaced axe fragments was closely examined to try to determine causes of fragmentation. Evidence on the other tools and weapons in the hoard, suggested deliberate deconstruction including bent and misshapen metal, that could not have occurred through corrosion, were then logged. It is necessary to be cautious when distinguishing between deliberate and accidental damage on ancient and corroded metalwork but it is certainly true that bending and cutting of thick cast metal would have needed considerable force, tools, possibly heat, and human agency in combination (Knight 2021).

Discussion and conclusion

Recent finds at Must Farm late bronze age pile-dwelling settlement, Cambridgeshire 850 BCE, where approximately 28 linen textiles were excavated, have drawn attention to the survival of bronze age textiles (Harris and Gleba, in press). Besides this, in Britain there are around 20 fragments of late bronze age textiles from nine sites including Somerleyton. Several of these are on display in museums in Britain and Ireland (Harris 2019, Appendix 7.1). Most impressive is the tasselled horse-hair band woven in broken twill from Cromaghs, Co. Antrim, dated 900 to 700 BCE, which is on display in the National Museum of Ireland, Dublin. An axe, with faint traces of mineral preserved textile, from Bush Barrow, Wilsford G5, is on display in the Wiltshire Museum, Devizes. There is a calcium preserved textile from an urn cremation from Bulford G47, 1900 to 1500 BCE, on display at the Salisbury Museum (United Kingdom). A textile with decorative leather beading and cow hair braid from the Whitehorse Hill cist, Dartmoor, 1900 to 1600 BCE, was recently on display in The Box Plymouth, previously known as the Plymouth City Museum and Gallery, and several bronze age fibre artefacts are on display in National Museums Scotland, Edinburgh (United Kingdom).

Others, not on display, include bast fibre and wool textiles which were preserved in a hoard from 18

Fig 10: A socketed axe (British Museum 2014,8028.1-6), found in Suffolk, a distance of around 10 km from the Somerleyton findspot, with five gold 'lock-rings' inside (Image: Rights Holder: Suffolk County Council. Shared under a Creative Commons Attribution (CC BY) licence)

Priestden Place, St Andrew's, Fife (Ewart Park, 1000 to 800 BCE) (Gabra-Sanders 1994, 36). The bast fibres textiles are woven in balanced plain weave (14/14 threads per cm) and a warp or weft faced plain weave (6/16 threads per cm) with S2* plied yarns (Gabra-Sanders 1994, 36). The bast fibre textile excavated from a mound in Killymoon, County Tyrone (1000 to 700 BCE) have up to 20/20 threads per centimetre of weaving (Wincott Heckett 2007). Technically the St Andrew's and Killymoon bast fibre textiles are comparable to the Somerleyton textile, although a little finer. A sheep's wool textile from St Andrew's hoard is woven from single z-spun yarns and are, on average, coarser than textiles of bast fibre (for discussion of LBA wool textiles see Melton et al. 2016, 347). The St Andrew's hoard contains unspun plant fibre strips described as coarse grass or other plant material, which were used as binding around an axe, the jaws of a pair of tweezers and a ring (Gabra-Sanders 1994). These northern comparisons to the Somerleyton textile and unspun flax fibres strips hint at the possible uses of textiles in hoards, and its similarities to other late bronze age linen textiles.

The presence of metalwork fragments and other objects, including a number of gold objects, placed within the sockets of late bronze age axes is a known phenomenon in Britain (especially in the south of the country) and across North-West Europe more generally (Maraszek 2006; Dietrich 2014; Dietrich and Mörtz 2019). Of particular relevance is the socketed axe found in 2011 by a metal detectorist close to North Cove, Suffolk, a distance of around 10 km from the Somerleyton findspot (British Museum registration number 2014,8028.1-6, Treasure case number 2011 T478, (Portable Antiquities Scheme 2023)) (fig. 10). Five gold lock-rings with clay cores had been placed inside the axe socket. Three of the lock-rings were excavated from the body of the axe by British Museum metals conservators. This 'hidden' hoard dates to approximately the same period as the Somerleyton hoard and can be compared with other recent finds, including four gold bracelet fragments discovered within the socket of a faceted axe of Type Meldreth, belonging to the Ewart Park phase of the late Bronze Age (Gwilt et al. 2005).

Traditionally, socket fills were interpreted as a way of storing material in a founder's hoard prior to melting and recycling. However, in his work examining late bronze age metal hoards of the Carpathian Basin, dating to Hallstatt A 1250 to 1150 BCE, Oliver Dietrich drew attention to the practice of filling socketed axes with small, fragmentary items – themselves 'miniature hoards' rather than a purely functional, space saving, measure (Dietrich 2014, 470). Identified axe fillings included fragments of sheet bronze, bronze bars, ingots, unidentified bronze fragments, lead, pins, bracelets and small gold objects. In some cases the sockets were hammered down to seal the objects inside

(Dietrich 2014, 471–472, tab.1). The presence of metals other than copper or lead in socket spaces, the inclusion of other materials and objects and the repeated pattern of this practice across multiple hoards, suggest that this is a discernible cultural practice of late bronze age hoarding (Dietrich 2014, 477, 482).

Although rare, a number of late Bronze Age textiles inside or in close proximity to weapon sockets have been found. One interpretation of these is that they act as plugs, or some kind of padding to help secure the wooden haft into the socket (Henshall Appendix 1 in Coles et al. 1964, 198; Wincott Heckett 2012, 432). This is a particularly interesting possibility because a recent interdisciplinary experimental study of bronze age axe head morphology through time concluded that organic hafting technology and method was a more important factor in the efficiency of axes than the design of metal axe heads per se (Dolfini 2023). A linen textile was preserved inside the socket of a bronze socketed axe belonging to a late bronze age hoard from Sublaines, France (Hundt 1988, 261). It is not only textile organics that have been found inside socketed tools and weapons. A bung of oat or barley straw, from Rhine am Mainz, blocks the mouth of an axe, trapping inside fragments of an axe and chisel (Dietrich 2014, 477; Hansen 1996–1998, 23). At Pyotdykes, Angus, Scotland, a bound knob of textile, reportedly with specks of a tarry substance on the surface was found inside the socket of a spearhead in a hoard dated 800 to 150 BCE. It is woven in plain weave (tabby) with 15/10 threads per cm, using S2-plied threads or either flax or nettle fibre (Henshall Appendix 1 in Coles et al. 1964, 198). Another textile from the socket of a knife from Nydie Mains, Fife (750 to 600 BCE), is also woven in tabby with 8/10 threads per cm, using S2 plied threads, identified as flax (Hedges 1974). Both are technically and functionally comparable to the Somerleyton textile.

On balance, a functional use, as padding or packing material designed to create a tight bond between a bronze axe head and its wooden haft, is the most likely interpretation of the Somerleyton textile fragment. However, the aforementioned examples of votive offerings, including from the Near North Cove hoard, raise the possibility of a less prosaic rationale. It is possible that textile fragments could have possessed value connected to their prior owner, wearer or maker (Harris 2017, 691–692). In this respect it may be notable that the North Cove axe head contained items of personal adornment known as 'lock-rings', which may have been worn in the hair, as earrings or on clothing (Eogan 1969). A third possibility is that the textile fragments could have served a functional role in hafting while also retaining a talismanic significance drawn from their prior use as clothing, bedding or in other contexts of everyday life.

The Somerleyton textile also raises the possibility that other axes containing metalwork fragments also contained textiles when they were deposited, and that the fragments from Somerleyton are a rare survival rather than an unusual instance. Developments in methods to identify ephemeral traces of textiles in metal corrosion products may reveal more instance of textiles in Bronze Age hoards in the future (Davis and Harris 2023). Many hoards from this period contain partly fragmented objects, the process of which may have stripped out evidence of hafting techniques. Furthermore, many of the hoards reported today are found by metal detecting rather than in controlled archaeological excavations. The Somerleyton textile is therefore an important reminder of traces that might be missed or overlooked if their age and significance is not recognised.

The Somerleyton hoard project provided an opportunity to re-examine this fascinating and rare example of a bronze age textile. With the exception of the fibres and fabrics from Must Farm Timber platform, examples of English bronze age textiles are still relatively rare (Harris 2019, 174–179; Haughton et al. 2021, 176–178), especially those in good condition, and the analysis of the linen fragments from Somerleyton has therefore added to wider knowledge. Although it had become separated from its original context, for the purposes of conservation it was important that as much of its history, associated objects and context were explored and researched as part of the remounting project. Haughton et al. (2021) have drawn attention to the significant absence of joined-up thinking when discussing textiles in the wider context of bronze age society and economy in England. Although their focus was specifically wool textiles, their key messages apply more broadly, most notably that we risk over-emphasising the role of bronze due to its preservation and dominant presence in the language and labels that govern the period (Haughton et al. 2021, 173).

The Somerleyton linen textile, whether used as padding or packing in the hafting process or else carefully placed inside a bronze socketed axe as an offering in its own right, serves as a neat reminder of the importance of the haft-blade assembly of Bronze Age tools and weapons and the interconnectedness of objects, materials and technologies during the Bronze Age. For instance, the making of a fully finished axe and a length of linen textile would each have required a range of linked skills, time investments and resources. By the late Bronze Age almost all English socketed axes featured a loop with which to fasten or secure the axe head onto its wooden haft. This may have been done using leather thongs or other materials, including ligature made of lime-bast and even textile strips. As we have seen, textiles, perhaps rags or scraps or purpose made pieces, could have been used to obtain a tight(er) fit between wooden haft and metal axe head and therefore a more efficient axe (Dolfini 2023). Further experimental work is required in order to test this possibility. Not just a bronze axe head, the total, finished object required different materials, skills and techniques to produce.

More speculatively, if the textile had been placed inside the socketed axe as an offering, akin to the lock rings from nearby North Cove, it could have held a different kind of meaning, one that nevertheless reflected the relationships between different materials. For the middle Bronze Age, Needham (2001, 292) has argued that some hoards may have been made up of bronze objects that reflected different genders, concepts or identities. A similar point has been made by Matthews (2008) in discussing prehistoric hoards containing different natural materials and substances that may have conveyed different but complementary meanings related to identity and personhood. The fragmented nature of the Somerleyton textile does not preclude this interpretation. During the British early Bronze Age, it is likely that sherds of pottery from important vessels and stray beads of exotic material such as amber took on significance as heirlooms or talismanic objects (Woodward 2002). It is possible that pieces of textile could have been carried similar meaning(s). Indeed, for many (pre-) historic periods fragments of clothing may have been taken as mementos, heirlooms or relics: emblematic of people, powerful individuals and loved ones, including those who have passed away (Lillios 1999, 242, 252; Harris 2017; Harris 2019; Davis and Harris 2023).

In summary, the remounting of the Somerleyton fragments allowed the re-examination, documentation and photography of a rare and important textile. A collaborative approach meant that different aspects raised by the prospect of conserving archaeological textiles and the specific requirements of this textile could be addressed, and placed in a fuller and more productive context, in order to provide the most appropriate solution to allow the textile to be remounted for safe display, loan, study and interpretation in the future.

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