-The Yarm Helmet

By CHRIS CAPLE[1]

THE YARM HELMET, unearthed by workmen in the 1950's, is a composite construction 'crested' helmet[2] *of riveted, undecorated, thin, iron plates. Without close parallel at the time it could not be confidently attributed to a specific date or culture. This paper records, analyses and reassesses the helmet, showing that it is not a later copy, but an original 9-11th century helmet, comparable with the helmet at Gjermundbu. Its materials and construction speak to the growing pragmatism of arms and armour production supplying the increasing numbers of armed warriors present in this period.*

The Yarm helmet was unearthed in Chapel Yard, Yarm, North Yorkshire (NZ419 129), in the 1950s, by men digging a trench for new sewer pipes[3]. There is no record of any archaeological work done at the time to further investigate the site.

FIGURE 1
The Yarm Helmet. *Photograph by Jeff Veitch.*

Described as a 'Norman' helmet, it was placed on display in Yarm Town Hall but moved, in 1974, to the Dorman Museum in Middlesbrough. Marilyn Brown, Assistant Curator of Archaeology at the Dorman Museum, subsequently sent photographs of the helmet to both the British Museum and the Royal Armouries. Neither seemed confident about identification[4] with Russian, Near-Eastern and European origin all suggested. A letter in the local paper suggested a Viking attribution to the helmet, noting similarities to the helmets from the graves at Vendel in Sweden[5]. The helmet was subsequently transferred to Preston Park Museum (Acc. No. STCMG: 2011.0150).

The uncertainty over its date and cultural attribution, as well as limited display space meant that the Yarm helmet remained in store. In 2007, Dr Chris Caple and Jennifer Jones of the Dept of Archaeology, Durham University were invited by Julian Herbert (Preston Hall Museum) to see the helmet and advise on its future care. Given its highly rusted condition Caple and Jones suggested that controlled environmental storage was advisable and, given the discoveries of the Coppergate and Wollaston helmets in the intervening years, it was now likely that this helmet was an Anglo-Scandinavian helmet of the 8-12th century[6]. Subsequently Preston Park Museum was refurbished and the helmet put on display, with a bespoke stand and a case with a dry air environment with less than 30 % relative humidity (<30% RH). Subsequently analysis and conservation occurred in the Dept of Archaeology, following the creation of appropriate transport and storage conditions.

THE HELMET

The Yarm helmet is composed of iron bands and plates, riveted together: a circular brow band, with a dome formed above it from a nose to nape band and a lateral, ear to ear, band which form a cross (Figure 2). Triangular shaped infill plates between the bands complete the cap. This type of helmet construction, which has been referred to as *spangenehelm*, is widely used throughout Europe in the early medieval period. The helmet lacks the prominent ridge and decoration of crested helmets such as the Coppergate helmet. Below the brow band there is a spectacle (eye) mask, formed from three plates riveted together. This form of spectacle mask is similar to that seen on helmets 5-8 from Valsgärde, Sweden[7]. There are no cheek pieces on the Yarm helmet, but the lower edge of the brow band has been bent outwards at 90^{o} and is pierced at regular intervals with circular holes; it almost certainly originally supported an aventail or mail curtain protecting the back and sides of the wearer's neck. No trace of the mail, other than the attachment holes, now remains. Mail curtains (aventails) are seen on the Coppergate and many of the Valsgärde helmets. A simple iron knop with a flared top is present on the apex of the helmet. The helmet has a gently pointed dome shape, somewhere between the hemispherical domed shape of the Coppergate and Wollaston crested helmets and the later conical form of the nasal helmets such as the Wenceslas helmet (Prague). Like the Wollaston helmet[8] there is no evidence of any copper alloy fittings or attached plates. The helmet is damaged; its brow band is broken, most of the front and rear right infill plates are missing, as is the right side of the lateral band and a section of the nose to nape band. The remaining dome of the helmet has been distorted (Figure 3). This damage is consistent with the object being hit by a plough, spade or similar tool whilst buried.

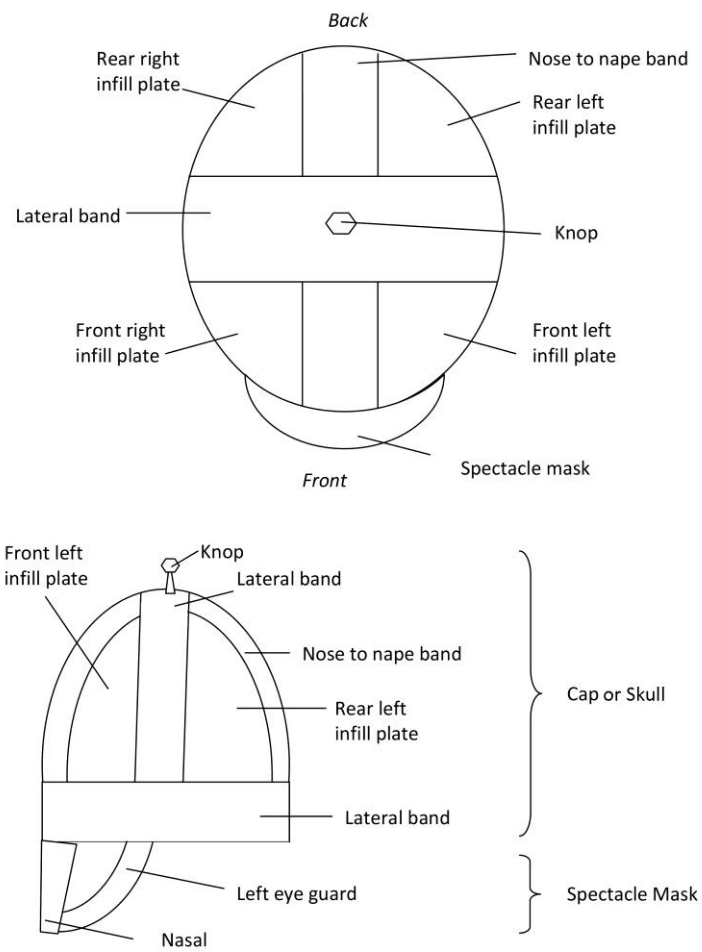

FIGURE 2
Schematic plan and side view of the Yarm helmet; elements identified[9]. *Drawn by Chris Caple.*

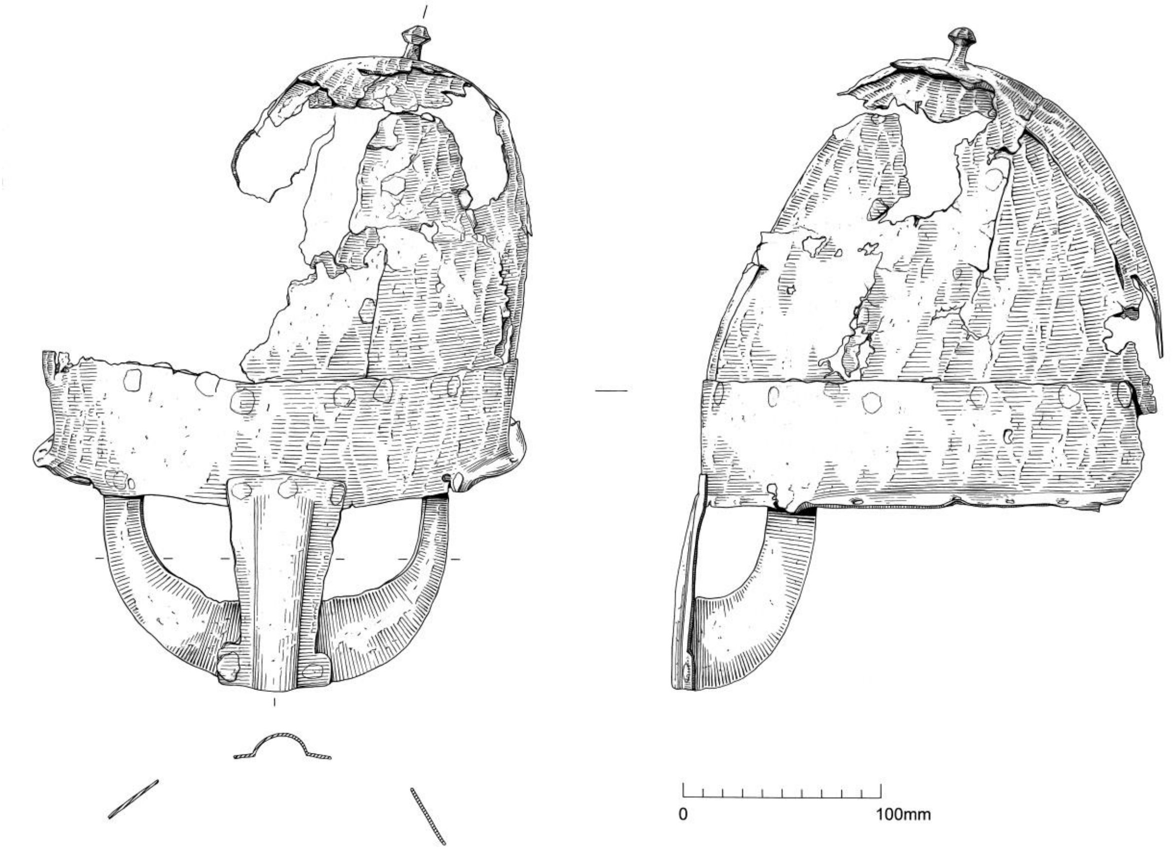

FIGURE 3
Front and side views of the Yarm helmet. *Drawn by Yvonne Beadnell.*

THE CONTEXT AND UNCERTAINTY

The town of Yarm may not initially be considered a likely location for the recovery of an early medieval helmet, as it has produced only limited early medieval archaeology. It lies in a horseshoe meander in the River Tees (Figure 4), its name is a contraction of Yarum, believed to derive from the Anglo Saxon word 'gear' (pronounced yair) meaning a pool to catch fish. The discovery in 1877 of the decorated and inscribed shaft of a sandstone grave cross being used as a mangle weight suggests the presence of an Anglian settlement on this site. Previously ascribed to Trumbert (Tunberht or Tunbeorht), consecrated as Bishop of Hexham in AD 681, the cross shaft is now dated from the lettering to the early 9th century[10]. As a result of their natural defensive qualities, good trade and transport links, river meanders, like those at Yarm and Durham, have often been used as locations for settlements / markets. Stocker has suggested that by the 10th century Yarm acted as a beach market for a Hiberno-Norse mercantile settlement, fragments of whose stone grave monuments are present in the church at Kirklevington 1½ miles to the south[11]. Noting the position of the 12th century church of St Mary Magdalene in Yarm, Robin Daniels has suggested that the original early medieval road ran along the west side of this peninsula, following the line of present day Westgate. The east side of the meander, where the helmet was found, remained more open farmland until the later 12th and 13th century development of tenement properties running off High Street occupied the area[12]. Where early medieval helmets are recovered, it is usually as grave goods from non-Christian graves, with examples from Britain e.g. Sutton Hoo and Wollaston, and Scandinavia e.g. Vendel and Valsgärde. The example from Coppergate, York was deliberately hidden in a pit.

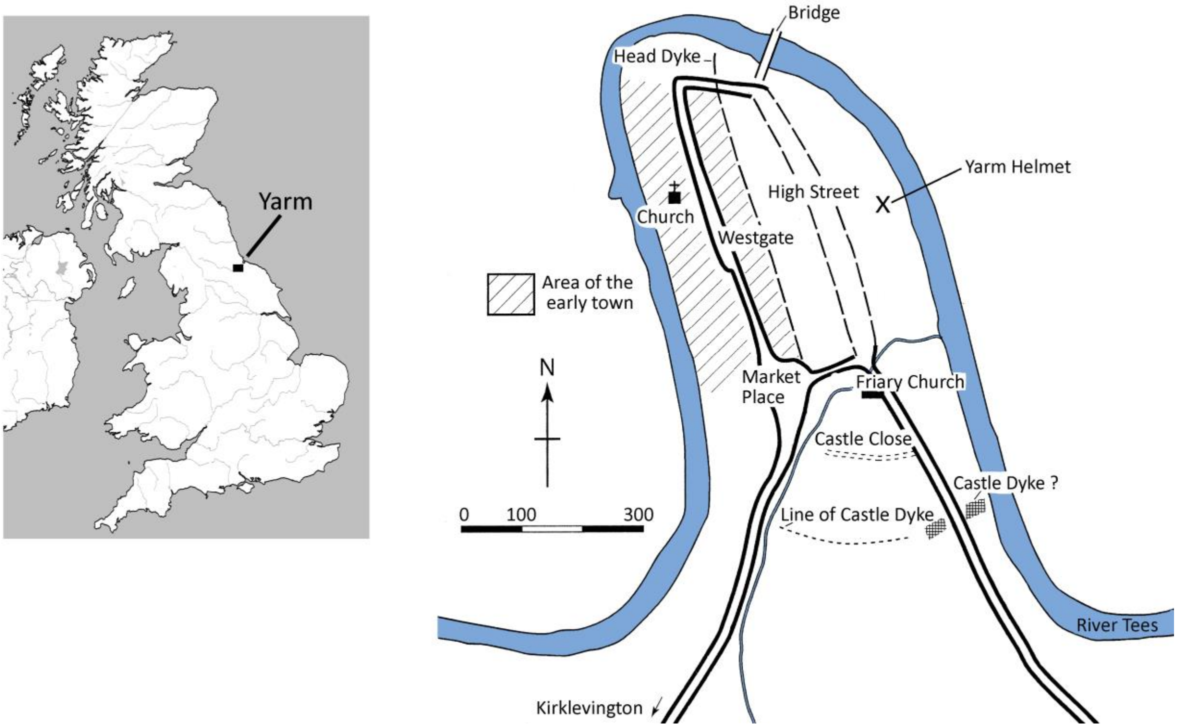

FIGURE 4

Yarm, located in a bend in the River Tees, with suggested 10th – 13th century features.

Drawn by Chris Caple from information supplied by Tees Archaeology.

From the very first there appears to have been some caution over attribution of a date to the helmet, this was in part due to the unsupervised recovery of the object and lack of follow up excavation to determine its burial context. The only examples from Britain of helmets at the time of its discovery were from Sutton Hoo[13] and Benty Grange[14]. Both of these helmets were almost completely mineralised and in pieces, very visually different to the Yarm helmet which was composed of corroded but still intact thin iron sheet. The plain form of the Yarm was also a marked contrast to the highly decorated helmets from either Sutton Hoo or comparable examples from Vendel and Valsgärde in Sweden all of which were covered in gilded or tinned copper alloy plates and crest ornaments. This resulted in understandable caution in ascribing an age or origin to the helmet. By 2007 the recovery of the 8th century Coppergate helmet from anoxic waterlogged deposits in York[15], the Wollaston helmet from a 7th century grave in Northamptonshire[16] and the Shorwell helmet from a 6th century burial on the Isle of Wight[17] had increased both the number of early medieval helmets unearthed in Britain and the range of conditions in which they have been recovered. In view of the body of information now available it seems appropriate to re-examine the Yarm helmet and provide, for the first time, a detailed record of this helmet and a re-assessment of the evidence to provide clearer indication of whether this is a genuine helmet of the 8th-12th century or a replica from a more recent era.

CONSTRUCTION

The helmet structure is formed of ten pieces of sheet iron, forty one rivets or rivet holes and a riveted knop, Figure 5. The helmet's construction started with the brow band, a strip of iron 68mm wide, 1-2mm thick forged or riveted to form a ring, onto which all the other elements of the helmet were riveted. The nose to nape band was next riveted into place, followed by the lateral band. As in the case of the Benty Grange helmet this is a single band overlapping the nose-nape band[18]. In other helmets e.g. Coppergate and Shorwell, the lateral band is in two pieces. The lateral and nose-nape bands are each attached to the brow band with two rivets. The infill plates are each attached by three rivets along their base to the brow band, two rivets on either side to the nose-nape and lateral bands and a rivet at the top which passes through both the nose to nape and lateral bands as well as the infill plate Figure 6.

Where the evidence remains, the bands and infill plates have an irregular overlap of between 8 and 26mm. The edges of all sheet iron plates and bands, especially the eye guards, are uneven and all surfaces have hammer marks; the metal deliberately left in the 'as hammered' (forged) state had not received any additional shaping and finishing.

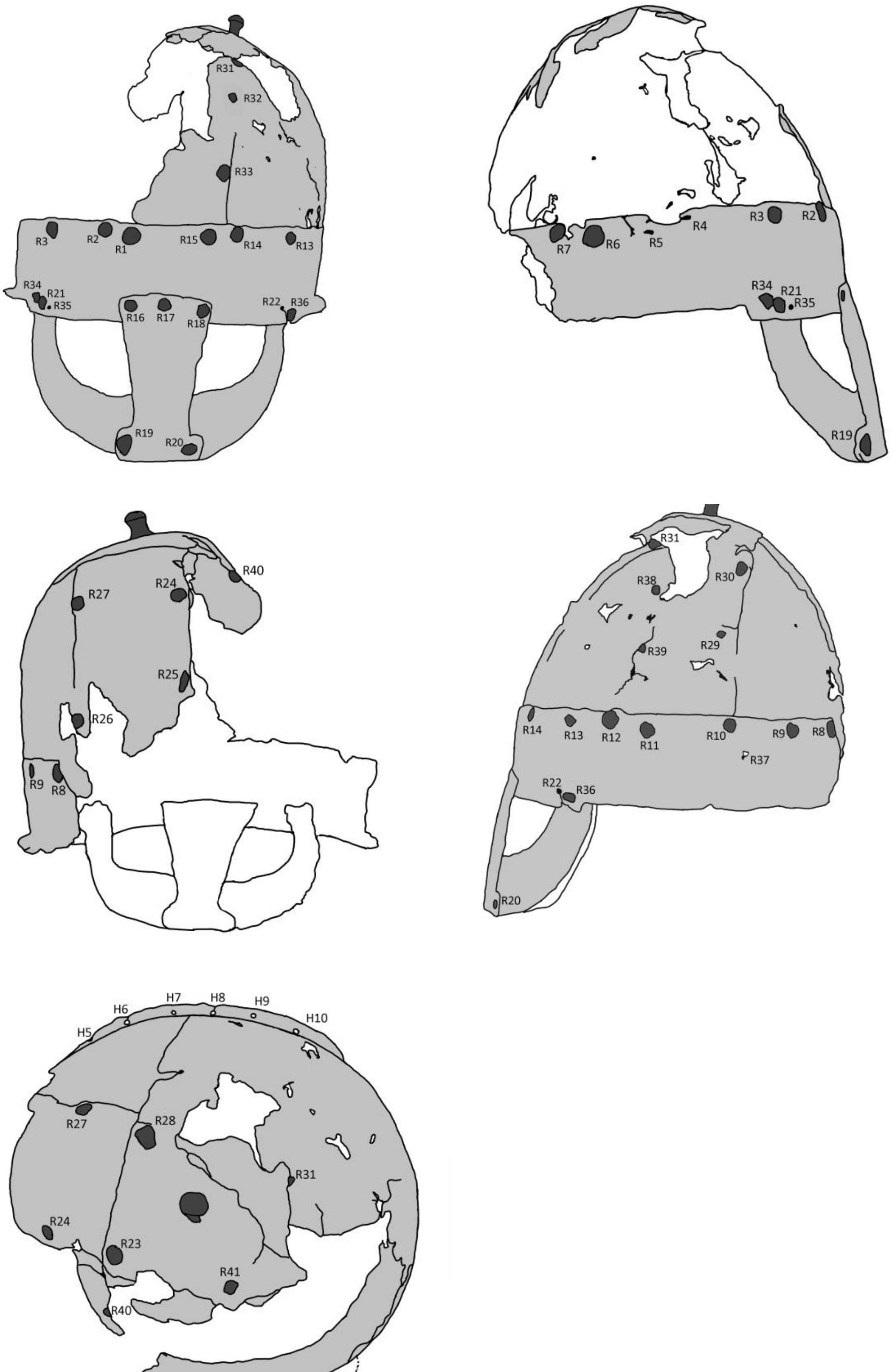

FIGURE 5
Locations of the rivets and holes (numbered). *Drawn by Chris Caple.*

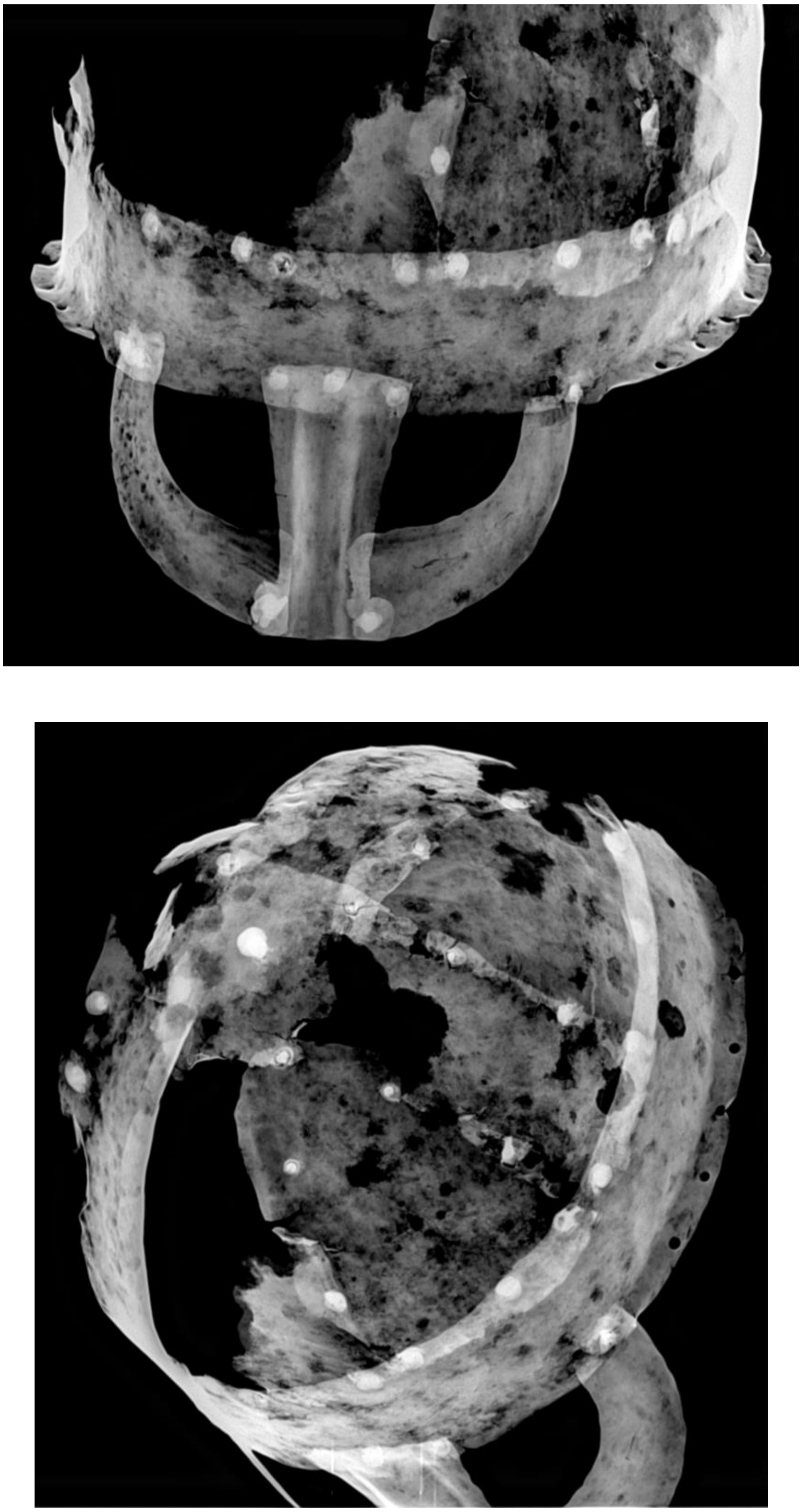

FIGURE 6
X-Radiographs of the Yarm Helmet (Merlin Gerin multi 9 C60N X-ray source, with Kodak 'Point of Care'CR120 digital X-ray imaging system. Exposure 90kv, 0.8maS). *Images by Vicky Garlick and Chris Caple.*

The X-radiographs of areas such as the eye guard plates, Figure 6, reveal forging lines, where stringers of slag are present in the metal showing the direction of forging; they have often acted as foci for corrosion. The front infill plates have a roughly shouldered triangular form, the rear infill plates a roughly shouldered right angle triangular form, the rear plates are slightly wider causing the lateral band and thus the crest and knop to be approximately 10 mm forward of the nose nape mid-point. The knop, which is 18mm high, 13mm diameter, has a flared top with four shallow facets. It is riveted through the lateral and nose-nape bands; a hammered rivet head nearly flush with the metal plate surface just visible on helmet interior.

The spectacle mask is formed of a nasal plate with a raised central ridge riveted with three rivets to the outside of the brow band (Figure 5). The left and right eye guards are formed of quarter ring sheets attached with single rivets to the inside of the nasal and with two rivets to the inside of the brow band. The ends of the lateral band and the eye guard plates have a poorly finished rounded form, Figure 7. Hidden behind the brow band, little trouble has been taken to finish these pieces of metal as they are not visible.

FIGURE 7: Right eye guard, helmet interior. *Photograph by Chris Caple.*

FIGURE 8: Rear left infill plate, helmet interior. *Photograph by Chris Caple.*

The infill plates have rounded and ragged edges, Figure 8, in marked contrast to the straight edged, precisely overlapped plates of the Coppergate Helmet[19]. The impression given by the Yarm helmet is of a piece of ironwork made at the blacksmiths forge without additional refinement. The only decoration visible on the helmet is the flared end of the nasal which imitates the nostril of a beast. This feature is emphasised by the rivet which attaches the nasal piece to the eye guard, Figure 1. Traces of a feint scribed or engraved line outlining the eye hole are also partially visible on the eye guards, though it is not visible on photographs.

FIGURE 9: Slight lip on the lower side of the mail suspension holes. *Photograph by Chris Caple.*

Though it would appear logical that the cap was constructed; the brow band first, then nose to nape and lateral bands added with the infill plates subsequently riveted into place, the fact that the left side of the lateral band and the rear left infill plate share a rivet (R10), Figure 5, indicates that an error occurred during assembly requiring the removal of the earlier rivet and reuse of the hole to tie the lateral and brow bands and the rear left infill plate all together with one rivet. The similarity of the metal of the eye mask; its ragged condition and riveting, to that of the rest of the helmet suggests that all elements the helmet's present form were planned from the start. The eye mask may have been added after the cap was completed, for ease of manufacture, but does not appear to be a significantly later addition.

The form of the exposed rivet hole, where the left eye guard meets the brow band and the holes through the rim for suspension of the mail indicates that they were not drilled, but were punched through hot metal using a punch from the exterior. This process distorted the metal sheet inwards forming a slight depression into which the end of the rivet had been hammered making it flush with the external metal surface, Figure 1. On the inside of the helmet, the other side of the punched hole has a raised metal rim which has usually been filed nearly flat leaving only a slight lip which is only occasionally visible, Figure 9. The rivets on the inside of the helmet cover this lip and consequently have a very shallow domed form. The care taken to ensure that the rivets on the helmet exterior are hammered flush to the surface is not unusual, and is also seen on the Shorwell, Coppergate and Wollaston helmets[20]. Though the Yarm helmet is generally a far simpler and more crudely made object than other early medieval helmets the smooth exterior is clearly an important functional feature, presumably to avoid catching bladed weapons which could come into contact with the helmet exterior, giving excellent deflective and thus defensive qualities. For similar reasons all the bands and plates are riveted to the inside of the brow band, only the nasal is riveted onto the outside of the brow band, necessitated by its ridged form.

There is a circular hole through the left side of the brow band (R37), Figure 5, and the surrounding corrosion shows a ring of discolouration similar to that seen where a rivet head has been lost. Consequently this must be considered an original hole which used to contain a rivet, now lost. Since this rivet was not required for the cap construction, and more than one rivet would be required to secure an internal lining, it may well have been for the attachment of a chin or carrying strap.

TYPOLOGICAL CONTEXT

By the Late Roman period, the early Roman and Celtic helmets formed of a single piece of metal cast in bronze or brass or forged in iron, had been superseded by composite helmet forms. These continued to evolve into the early medieval period and a number of typologies have been developed[21]. Tweddle, following Steuer, suggested that Early Medieval helmets fall into three main types, *Spangenhelme* and *Lamellenhelme* which are found principally in continental Europe and crested helmets present primarily in England and Scandinavia[22]. Crested helmets such as that from Coppergate (York), Wollaston (Northamptonshire) or those from the cemeteries at Vendel and Valsgärde (Sweden), primarily occur in 6th-8th century contexts[23]. They have a domed shape, banded construction, neck protection and draw significant elements of their visual form and construction method from the late Roman composite helmet forms such as the third century example from Burgh Castle[24].

Helmets dated later than the 8th century example of Coppergate are scarce. The Chamoson helmet from Switzerland, initially dated to the 9th century, is now dated to the late 12th century. Coupland has noted that there are no physical remains of Carolingian helmets, though the examples illustrated in contemporary manuscripts such as the Corbie and Stuttgart Psalters, which have been shown not to be copied from Byzantine texts, depict helmets based on *spangenhelm* form. Helmets of banded quatripartite form similar to Yarm and other crested helmets, though without nasal or spectacle mask, are seen in the Stuttgart Psalter[25].

The term *spangenhelm* is often applied to any composite form of early medieval helmet with ribs or bands and infill panels[26]. In the north and west of Europe Britain and Scandinavia it is specifically a domed form helmet composed of a brow band, crossed nose to nape and lateral (ear to ear) bands with infill plates, which is well riveted together and has quadripartite symmetry, now termed a crested helmet, which becomes dominant. This form was identified by Keller ('a frame of crossed metal bands ...held at the top...and underneath by a circular head band') as early as 1906 as the form of helmet construction present in northern Europe at this period[27]. It is seen in the 6th century Frankish *bandhelm* with examples from Frankish graves such as Trivières (Belgium) and Shorwell (Isle of Wight)[28]. Werner followed by Tweddle and Hood et. al.[29] suggests that this construction method derived from the Sassanian tradition, transmitted through the Late Roman helmet forms. The convention of a raised crest running nose to nape, probably derives from the Late Roman Ridge Helmet, such as the Intercisa type, in which the crest was originally part of their construction method. In the later, Early Medieval, crested helmet forms the crest is an addition, largely decorative, to the quadripartite, bounded cross band and infill plate, form.

The Yarm helmet's riveted plate construction indicates that it is a composite helmet, of bounded cross band and infill plate form, with quadripartite symmetry, identical to other crested helmets, though lacking a crest. It has a spectacle mask similar to that seen on helmets such as Valsgärde 5, Valsgärde 6, Valsgärde 7, Valsgärde 8, Vendel 1, Gjermundbu and in fragments from Tjele (Denmark), Lokrume (Gotland), Högbro, Halla (Gotland) and Kiev, all noted by Tweddle[30]. This feature has normally only been considered as present on helmets recovered from Scandinavian contexts, stretching from late 6th to 8th century, in date, with Gjermundbu considered as an 'old fashioned' 10th century outlier. However, a piece of stone sculpture which appears to depict a warrior wearing a spectacle mask helmet, has recently been recovered, together with other loose fragments of 10th century sculpted stonework, including part of a hogback stone, from the 12th century church at Pickhill in North Yorkshire, Figure 10. This, together with the example from Yarm, might suggest that the spectacle mask was a long lived helmet form familiar to the inhabitants of north-east

England and can have an Anglo-Scandinavian rather than purely Scandinavian cultural context.

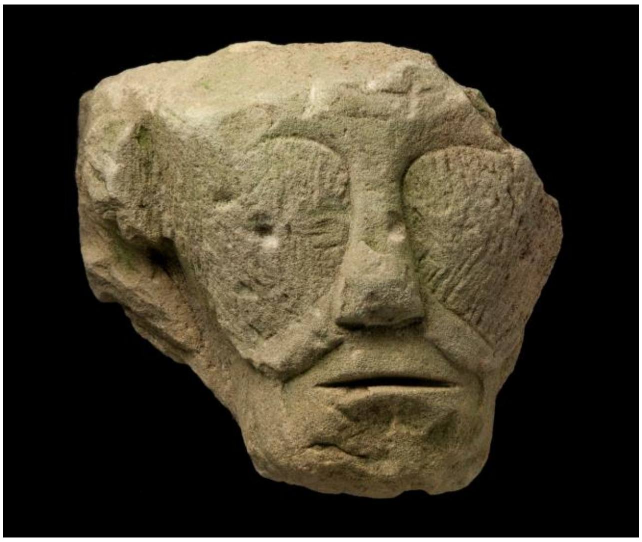

FIGURE 10
Stone sculpture fragment from All Saints Church, Pickhill, North Yorkshire. *Photograph by Jeff Veitch.*

Kirpichnikov has previously noted examples of spectacle masks from Rus' territory (Ukraine, southern Russia, Belarus) beneath sphaeroconical (Chernigov) type helmets (Kirpichnikov's type IV) from 11th century contexts such as Lykovo, Kiev and Kikoloskoie; though in a number of cases the lower parts of the eye mask are now missing. It is observable that the Yarm and Gjermundbu examples are short and protective of the eyes, the Pickhill and Kiev examples are longer and appear to run from the base of the nasal, whilst the Valsgärde and most examples from Rus' appear to have a nasal and spectacle mask combined, with the eye protection running from half way up the nasal[31]. Such a range of forms may suggest that this is a more widespread and long lived helmet tradition distributed throughout the Viking diaspora. Only in the case of Valsgärde 6 is the spectacle mask composed, like Yarm, of three riveted plates without any cut into the brow band[32]. The Yarm helmet's peripheral piercings indicate it originally had a mail curtain around the back and sides of the helmet protecting the ears and nape of the neck, like the crested helmets such as that from Coppergate. Mail was not present at the front to protect the throat, as it was on the Valsgärde 8 helmet and the lack of cheek pieces, crest and ornamentation suggest that Yarm is a later, simpler form of crested helmet.

As early as 1906 Keller had noted that by the 11th century helmets had moved away from the earlier domed to a more conical form[33]. This evolution has been discussed in detail by Tweddle and Lewis. Both noted the lack of examples of helmets from this period and the need to rely on images which occur on late Anglo-Saxon coins and depictions from Viking contexts[34]. Both suggest that the hemispherical domed crested helmets of the 6-8th century were replaced by a more pointed form of helmet such as the late 10th century Wenceslas helmet (Prague Castle)[35] , the Olomouc (Moravia) Helmet (*Kunsthistorisches* Museum, Vienna; KHM Wien A41) or the 10th-11th century Mayer helmet (Royal Armouries, Leeds, on loan from National Museums Liverpool). By the 11th century such pointed helmet forms with prominent nasal guards were worn by both Saxon and Norman warriors in the Bayeux Tapestry[36]. The images in the tapestry clearly show helmets of composite construction with brow bands, a cross frame and quarter infill plates, similar to the Yarm helmet[37]. The circular dots on the helmets may allude to the riveted construction of these helmets. Despite Musset's assertion that all the helmets seen in the Bayeux Tapestry are conical[38] careful scrutiny suggests that both a straight cone and a cone with a slight curve i.e. a pointed dome form, are present. Very limited differences in depiction are not surprising, given the limitations of embroidery. The shape of the Yarm helmet fits between the domed 6th to 8th century crested helmets and the pointed dome helmet shape, of the Wenceslas and Olomouc helmets.

The only near complete Viking helmet previously recovered in Western Europe, came in pieces from one of two Viking graves excavated in 1943 at Gjermundbu, Norway. Two holes in the only fragment from the base of the helmet, which both contained rings, may suggest that a mail curtain originally attached to the sides and back of this helmet, though Munksgaard argues that the spacing supports the presence of a leather neck guard with iron supports rather than a mail curtain[39]. The Gjermundbu grave contained the cremated remains of a high status Viking warrior, of the late 10th century, with associated grave goods including a mail shirt and numerous weapons; spears, seaxes, *skeggöx* (axes), sword and scabbard, shields, arrowheads as well as spurs and stirrups. The helmet comprised a brow band with four narrow hemispherical section ribs secured at the top with a circular plate having a central pointed knop and four large infill plates between the ribs[40]. The helmet shape is a hemispherical dome like the earlier crested helmets, though it appears to be of less well riveted construction than Yarm and does not possess the slightly more conical form. Like Yarm, and unlike the Vendel and Valsgärde helmets, Gjermundbu is a plain, undecorated helmet which lacks cheek pieces.

Whilst earlier crested helmets such as Wollaston and Benty Grange had central knops of a stylised boar form, Yarm and Gjermundbu have simpler knop forms[41]. The Yarm type of a simple flared top knop is similar to that seen on helmets from the earliest bronze helmets in Europe. Its recurring presence indicates a beneficial role for the knop, most probably used for attaching a coloured pennant or streamer to identify the wearer[42], crucial in the larger scale battles of the 10th and later centuries? Like the apices of Anglo-Saxon shield bosses[43], it also had a deflective defensive quality, important for the functional Yarm and Gjermundbu helmets, which were expected to see service and withstand blows from above. Might such practicalities have encouraged a change from hemispherical dome to a more conical helmet form? Could this prefigure, or provide the model for, the move from rounded Romanesque arch to the more pointed Early English/Gothic pointed arch form, which were also capable of resisting greater force from above?

Though there is a lack of context information for the Yarm helmet, the cap shape comparators clearly suggest it has a 9th to 11th century date. Given that the spectacle mask indicates that the Yarm helmet is an artefact with Viking or Anglo-Scandinavian cultural attributions it may derive from the period when there was extensive Scandinavian settlement in North Yorkshire i.e. the decades after the Viking capture of York in AD 866/7. Though it is possible this helmet derives from an earlier 9th century Viking raider or an 11th century combatant from the battle of Stamford Bridge, given its shape and features it was most probably made and used in the north of England in the 10th century.

THE QUESTION OF AUTHENTICITY

Whilst matching the form of a helmet of this period, the lack of certain context, meant that further evidence was sought, to confirm the dating of this object. This required addressing concerns regarding the thinness of the metal, exploring the likelihood of replication at a later date and analysing the iron to see if it matched the metal available in the 9th -11th century period.

THICKNESS

The iron sheet used to make the Yarm helmet is typically 1.2–1.4mm thick. For earlier researchers this appeared thin, as later helmets of the 12th-15th century period can be several millimetres thick[44]. The mineralised corrosion of helmets of the period, such as Sutton Hoo and Benty Grange, prevented accurate thickness measurements being made and gave the impression of thicker metal. However, this is deceptive as even the densest iron corrosion products occupy two or three times the volume of the original metal. Only when the barely corroded iron of the Coppergate helmet was measured (the lateral band, for example, proved to be 1.3-1.9mm thick[45]) was it appreciated that the sheet metal used to manufacture helmets in this period was typically 1-2mm thick. Thus the iron sheet used to make the Yarm helmet is comparable with its nearest contemporaries. It may be suggested that thinner metal will, when struck with a weapon, bend and, providing it does not split, adsorb the impact like a modern crash helmet, minimising the risk of damage to the wearer. Later thicker helmets deflect the weapon onto the arm or shoulder, potentially causing incapacity. Thinner metal is also lighter enabling the wearer to use it for longer periods. Stories in the sagas of mighty warriors cleaving helmets in two[46] appear unlikely with thicker later helmets; however, they are possible with the right blow on thinner lighter helmets such as Yarm, presuming that such stories are not simply a heroic trope used in saga telling.

KNOWLEDGE OF LATER PERIODS

If the Yarm helmet were a replica, given the extensive corrosion, it would have had to have been buried prior to the 1920s to achieve the corroded state seen upon its recovery in the 1950s. Thus, if there are 9th–11th century features present on the helmet unknown before the 1920s, it may be surmised that the helmet is genuine. Should any test show materials, technology or decoration which can only derive from a later period, the object will be shown to be a more modern replica. The fact that this research is taking place nearly 60 years after the discovery was made, means that question of intent; a hoax or a replica, are unlikely to be definitively answered. However, as there is no evidence that any attempt was ever made to recover money for this object, the question of a deliberate fake does not arise.

The dominant image of Viking helmets prevalent in England and Germany from the 1880s, almost to the present, is that of the horned helmet. It is first seen as a ‘Viking’ attribute in an 1876 production of Wagner's *Der Ring des Nibelungen* in the costume designs by Prof. Carl Emil Doepler. Horned helmets were based on prehistoric helmet forms and illustrations of priestly headdresses see on objects such as the Gundestrup cauldron[47]. Post 1880 the horned helmet image became widely accepted in Britain and Germany and is even occasionally mentioned in some more scholarly texts. Equally fanciful ideas of birds (ravens) or wings on helmets have an older origin[48]. In both cases the arresting power of the image has proved difficult to dislodge, 'totemic animals are not good to eat but good to think about' – Levi Strauss[49]. If a replica Viking helmet were made in England after 1880 especially one meant for public display then it would almost certainly have had horns or wings. The fact that Yarm helmet does not suggests either it is not a replica or if it is, it is a more scholarly one taken from Scandinavian sources where the 'horned helmet' image rarely appears[50].

If the helmet were 'modern', the most likely scenario for its manufacture is for a local dramatic production or a pageant of the late 19th or early 20th century when such events were highly popular followed by deliberate burial. General sources of this period such as *Chambers Encyclopaedia* of 1868, fail to give any visual examples of Viking helmets. More specific sources, such as *The Viking Age* by Paul B. Du Chaillu (published 1889), only depict the woven iron band helmet from Ultuna. However, the most likely source for examples of a Saxon or Viking helmets in the late 19th early 20th century would be provided by the illustrations in popular fiction, works such as *The Dragon and the Raven* by G.A. Henty (published in 1886). The illustrations by Staniland do not have horns, but the leaders helmets have earlier ideas of winged helmets whilst their followers wear plainer helmets drawn from continental Post-Roman *spangenhelme*, Figure 11. They are highly decorated and lack features such as spectacle masks and mail curtains which only appear with the publication of the Vendel helmets[51] and later Valsgärde examples[52]. Thus it would appear no one researching a replica helmet would have come up with anything comparable to the Yarm helmet until the publication of the helmets from the Swedish cemeteries such as Vendel I in 1927 (in French) or Valsgärde VI published in English in 1934 where the spectacle mask and mail curtain first appear. Anyone copying these later models would have almost certainly have included other key features such as decorative copper alloy plates and prominent crests. The fact that these are absent means the Yarm helmet is unlikely to be any form of replica. It only becomes convincing after the discovery of the well contexted Coppergate helmet in 1982.

FIGURE 11
C J Staniland's illustration of raiding Vikings, from G A Henty *The Dragon and Raven*, (pub. 1886). *Permission for reproduction currently being sought*.

ANALYSIS OF THE METAL

A series of 4 triangular metallographic samples, 15-18mm high and 6-8mm wide, were cut from four different plates of the helmet. They were mounted, polished and etched, and were metallographically analysed. Samples were micro-harness tested (100g load) and both the metal and multiple slag inclusions were examined analytically using a SEM with EDS facility. All metallographic work was undertaken by Dr Gerry McDonnell[53]. This revealed that all four samples were primarily composed of ferritic iron, with bands formed of larger and smaller grains indicative of folded, forged early iron, Table 1 and Figure 12.

TABLE 1
Metallographic structures and micro-harness data

	Metallographic Structure
RLP1	In the unetched condition there were some elongated stringers of slag running the length of the section. When etched the microstructure was ferritic with a

	grain size of ASTM 5, with one thin band of smaller grained ferrite (ASTM Grain Size 7-8). The micro-hardness measurements show that the larger grains (ASTM 8) have higher hardness values, both indicators of the presence of phosphorus. The overall mean hardness value of 178 $HV_{0.1}$ is indicative of hardening due to cold working.
LB1	In the unetched condition there were some elongated stringers of slag running the length of the section. When etched the microstructure was ferritic with bands of varying grain size ranging from ASTM 7 to ASTM 4-5. Most significantly Neumann Bands were present indicative of significant cold working (Figure 12). The micro-hardness measurements are similar to the values obtained from sample RLP1. The large grained ferrite had a significantly higher hardness value, again indicative of the presence of phosphorus.
LEG1	In the unetched condition there were some elongated stringers of slag running the length of the section. When etched the microstructure was ferritic with bands of varying grain size ranging from ASTM 7 to ASTM 4-5. The band with very small grained ferrite (ASTM7) also contained some grain boundary carbide, suggesting that the other bands may contain some phosphorus. The micro-hardness measurements are similar to those from the other sections.
NNB1	In the unetched condition there were some elongated stringers of slag running the length of the section. When etched the microstructure included a band of ferrite plus pearlite, ferrite plus grain boundary carbide and bands of ferrite of varying grain size ranging from ASTM 7 to ASTM 4-5. The micro-hardness measurements reflect the different microstructures, the small grained ferrite 139 $HV_{0.1}$ having the lowest value and the ferrite plus pearlite at 206 $HV_{0.1}$ the highest.

TABLE 2

Metal composition

	RLP1[54]	**LB1**	**LEG1**	**NNB1**
Silicon	0.1	0.1	0.2	0.1
Phosphorus	0.1	0.3	0.5	0.0
Sulphur	0.1	0.0	0.1	0.0
Manganese	0.0	0.0	0.1	0.0
Iron	99.6	99.3	99.9	99.5
Cobalt	0.4	0.3	0.4	0.3
Nickel	0.0	0.1	0.2	0.0
Copper	0.0	0.1	0.1	0.1
Zinc	0.0	0.0	0.2	0.0

TABLE 3

Inclusion compositions (mean data of multiple inclusions)

	RLP1[55]	LB1	LEG1	NNB1
Na_2O	0.2	0.2	0.2	0.4
MgO	2.3	0.4	0.6	1.0
Al_2O_3	10.0	9.6	6.3	6.4
SiO_2	21.2	13.4	20.1	28.1
P_2O_5	7.3	13.7	4.8	2.3
S	0.2	0.8	0.4	0.1
K_2O	1.4	1.5	0.5	2.8
CaO	3.4	1.7	0.7	3.7
TiO_2	0.4	0.1	0.1	0.2
V_2O_5	0.3	0.0	0.1	0.0
Cr_2O_3	0.1	0.0	0.0	0.0
MnO	0.8	0.3	0.2	0.6
FeO	52.5	58.0	66.0	54.0
CoO	0.2	0.3	0.2	0.2
NiO	0.0	0.0	0.0	0.0
CuO	0.0	0.0	0.1	0.1
ZnO	0.0	0.0	0.0	0.0
BaO	0.0	0.1	0.1	0.1

No evidence of carburised metal or significant amounts of low carbon steel was noted. The metal composition analyses correspond to wrought iron formed through bloomery iron production, where both manganese and phosphorus are present in the slag particles and not in the metal (Tables 2 and 3). Only during later blast furnace iron production (post 16th century in the UK) is the furnace hot enough to reduce manganese oxides to manganese and give significant manganese content in the metal. Analysis of between 8 and 26 slag inclusions in each sample showed mean levels of P_2O_5 greater than 5% (Table 3). This, together with ghosting effects and large ferrite grains with limited carbon adsorption in the metal, reflects a high phosphorus content in the ore from which this metal derives, created using the low smelting temperatures of bloomery iron production. All four sections displayed non-metallic slag inclusions running the length of the sections, typical of early (pre-industrial) iron, consequently it can be assumed that sheet iron used in the fabrication of the helmet was reduced by hammering from a bar to sheet. If the composition of the metal was uniform, the grain size of the metal would also be uniform. The variation in grain size reflects variation in the composition in particular the phosphorus content of the metal.

FIGURE 12: Sample LEG1 etched metal micrograph; bands of larger and smaller grain ferrite (width of field 0.6mm). *Photograph by Gerry McDonnell.*

Similar microstructures are commonly seen in artefacts from the early medieval period where the study of more basic items, i.e. non steel-edged knives, demonstrate that large grained ferrite and phosphoric iron was a common alloy of the early medieval period[56]. This metal alloy also appears to be that evidenced by the metallographic structures of the Coppergate helmet[57]. The inclusion analyses (Table 3) showed considerable variation in composition consistent with early iron, with no clear pattern or consistency, a feature which is again typical of inclusion compositions in early iron; data comparable to the analysis of early medieval iron work from other sites such as the material from Coppergate[58].

It is worth noting that the ferritic wrought iron of Coppergate and Yarm helmet is unlike the often carburised iron, rich in pearlite often with martensitic structures, used for later and post medieval armour[59]. It is also unlike the wrought, puddled iron and mild steel made through the indirect process prevalent from the 18th century to the present day. That metal is far more homogenous than the iron of the early medieval period[60] and often contains elements such as phosphorus and manganese in the iron metal as well as minerals associated with the higher temperature smelting and melting processes prevalent in later indirect production methods. None of which were seen in the metallographic sections from the Yarm helmet.

SURVIVAL

If the Yarm helmet is of 9th-11th century date as the metal, helmet construction, helmet typology and state of knowledge concerning Viking helmets prior to the 1950s all suggest, then the question of its survival must be considered. How could a thin iron object survive barely a couple of feet below the streets of Yarm for 800-1000 years?

Initially prompted by the presence of blue green minerals on the surface of the helmet and following a detailed microscopic examination, a qualitative elemental analytical survey was undertaken of the corroded helmet surfaces with an EDXRF system[61]. It revealed that the metal and corrosion of the helmet were composed entirely of iron, the absence of copper, tin, silver or gold indicating that the helmet had not been decorated with non-ferrous metals nor had it been beside a copper object corroding in the ground. Small quantities of manganese were also detected; with much higher levels on the outside than on the inside. Whilst trace levels of manganese may derive from the iron, the higher levels on the helmet exterior are derived from the soil suggesting close contact of the helmet exterior with the soil but not with the interior. One corrosion fragment (Ya) was removed and subject to SEM[62] analysis, other small samples were subject to XRD and FTIR analysis[63]. Fragment Ya (approx 16mm in length) was a completely corroded section through the front right infill plate. It had blue-green, yellow and red corrosion minerals present on its exterior (Figure 13) beneath which were a series of cracked and fissured dark brown black mineral layers.

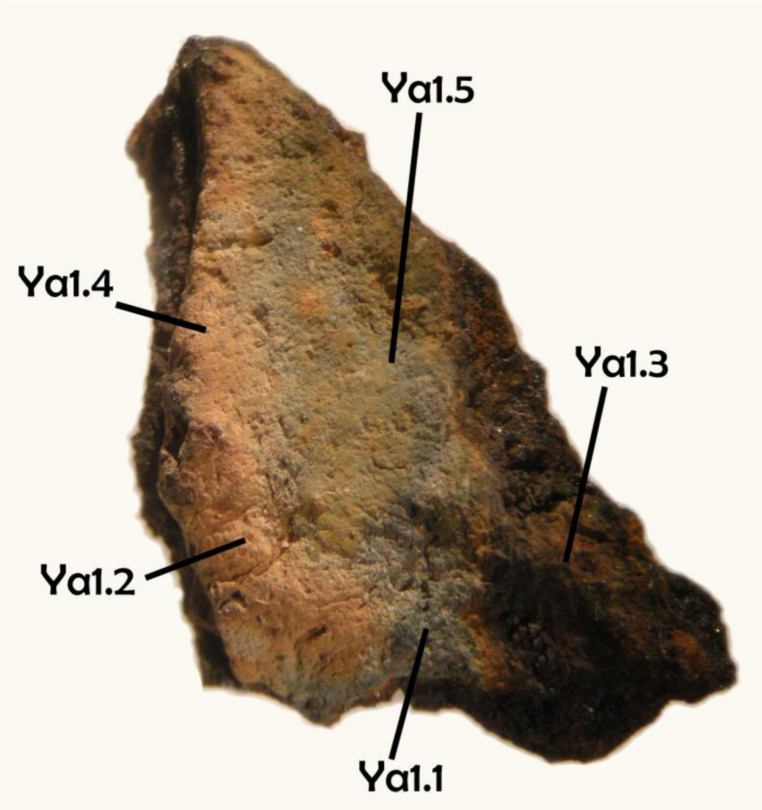

FIGURE 13

Optical microscope image of outer surface of fragment Ya. A compact green, red, and black mineral corrosion crust fragment removed from the front right infill plate. *Photograph by Chris Caple.*

Analysis of the exterior surface under the SEM, (Table 4) revealed high levels of iron and oxygen (iron oxides) as expected throughout the sample. The silicon and aluminium (as well as calcium, magnesium and potassium) detected are present from the alumino-silicate clay minerals present in the soil particles which had become incorporated in the corrosion crust. The blue green colouration occurs where analysis reveals the presence of phosphorus which, from comparison with other occurrences of a blue mineral on archaeological ironwork, suggests the presence of the hydrated iron phosphate mineral vivianite ($Fe_3(PO_4)_2 \cdot 8H_2O$)[64]. This mineral normally forms in anoxic waterlogged burial environments rich in organic phosphates, usually human and animal waste. When first uncovered it turns a vivid blue colour, in dry oxygenated conditions it fades to the pale blue green mineral, such as that seen in the centre of sample Ya1 (Figure 13). The red / yellow corrosion areas are low in phosphorus and are probably iron oxides, oxyhydroxides and carbonate minerals such as goethite, haematite, lepidocrocite and limonite and siderite ($FeCO_3$).

TABLE 4
Elemental compositions of the coloured corrosion products of the outer surface of sample Ya.

Element (weight %)	Sample Ya1.5	Sample Ya1.1	Sample Ya1.2	Sample Ya1.4	Sample Ya1.3
	Blue / green		Red / yellow		Black
Carbon	nd	6.259	9.871	10.305	7.427
Oxygen	24.055	39.860	45.528	40.597	44.700
Magnesium	0.753	0.860	0.310	0.290	0.117
Aluminium	1.065	1.162	2.219	1.126	0.225
Silicon	3.081	2.325	6.025	3.085	0.366
Phosphorus	5.386	4.429	0.714	1.152	0.457
Sulphur	0.962	3.360	3.327	4.494	2.543
Potassium	0.399	0.284	0.741	0.590	nd
Calcium	0.599	4.347	5.598	7.189	2.657
Manganese	0.849	0.858	0.495	0.454	nd
Iron	62.851	36.255	24.922	29.931	41.507

The presence of sulphur may suggest an iron sulphur minerals such as iron sulphide (FeS), pyrite (FeS_2 – cubic form) or marcasite (FeS_2 – orthrombic form). An underlying black layer, exposed where the green and red/yellow outer layers are missing, has low levels of phosphorus, silicon and aluminium present, suggesting less interaction with the soil and its minerals, as might be expected deeper in the iron corrosion crust and is probably principally composed of magnetite (Fe_3O_4).

Of the seven samples analysed by XRD, only one (Yc) from the inside of the helmet, had sufficient crystallinity to enable their mineral compositions to be identified; iron oxyhydroxides (FeOOH), siderite ($FeCO_3$), akaganeite (βFeOOH) and iron sulphite hydrate ($(Fe_2SO_3)_2.5H_2O$)[65]. The presence of iron oxy-hydroxide minerals, especially the β phase, akaganeite, would normally be expected from iron corroding in chloride rich oxidising conditions[66]. The mineral siderite is, however, formed by iron in a reducing (anoxic or hypoxic) environment[67]. The presence of hydrated iron sulphite is more unusual and it appears likely that this mineral has formed as an oxidation product of one of the iron sulphides. FTIR analysis of the sample Ya1.5 also suggested the presence of vivianite on the helmet exterior[68]. The presence of the minerals vivianite, siderite and iron sulphides indicates that the helmet had been buried in anoxic, waterlogged conditions. This would have preserved it, even though it was composed of thin iron sheet, for many years. The distribution of vivianite (Figure 14) and the high concentration of manganese minerals only on the helmet exterior indicate contact between the iron surface and waterlogged soil rich in human occupation material.

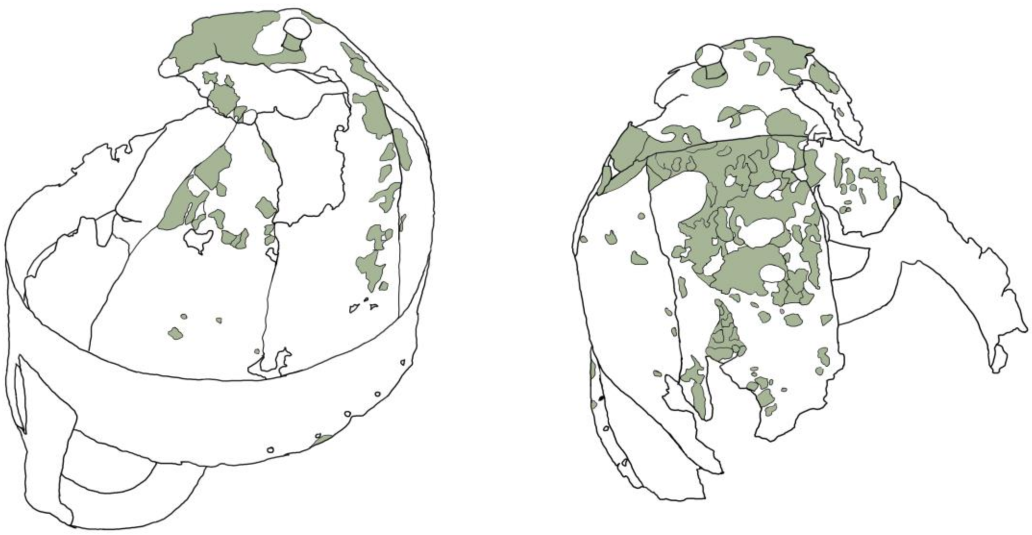

FIGURE 14
The visual evidence of the extent of pale blue-green vivianite minerals on the Yarm helmet. No traces were found inside the helmet. *Drawn by Chris Caple.*

The interior shows no such deposits, which may indicate the presence of internal material (padding or inner cap) or simply an empty space i.e. the helmet initially sitting upright covered in soil. Given that a 'Viking' grave is unlikely given the lack of other archaeological evidence from the area[69] and the accidental loss of such a large, potentially recyclable / reusable item is inherently unlikely, it appears most likely that this helmet was hidden in a pit containing decaying organic refuse, somewhere unlikely to be searched, and was never recovered. Subsequently, following disturbance and damage to the helmet in the ground, the conditions changed becoming oxic, causing the vivianite to fade, the iron sulphite hydrate to develop and leading to the formation of iron oxides such as akaganeite giving the red rusted appearance of the artefact partially obscuring its previous burial history. The only photograph from the initial discovery of the object (Figure 15) clearly indicates that when recovered, corrosion from oxic conditions was well advanced and had already eaten through the sheet metal of the helmet. Thus, the disturbance which damaged the helmet and led to oxic conditions occurred whilst it was still buried in the ground, probably 18th or 19th century digging in the area. Whilst the rate of corrosion is not a reliable indicator of date, for example vivianite has been uncovered associated with the bodies of American soldiers recovered in Vietnam[70], such a completely corroded, dense corrosion crust and mineral sequence moving from anoxic to oxidising conditions is unlikely to be seen on a modern object[71].

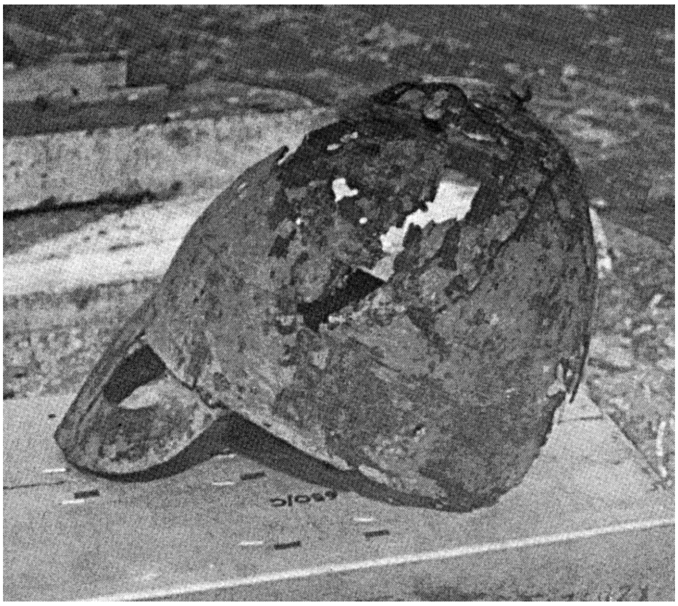

FIGURE 15: The helmet photographed immediately after discovery in the 1950s showing that the damage had occurred prior to recovery. *Image by Jeff Veitch.*

OBJECT BIOGRAPHY

Having established that this is a 9-11th century helmet, which has been preserved through initial burial in waterlogged conditions, it is possible to explore the object for evidence for use in its life history.

The lower edge of the brow band has been crudely bent outwards at 90^{o} to form an out-turned lip typically 8.5mm wide (6.5 to 10mm) on either side of the spectacle mask. The cut edge indicates that the lower part of the brow band was cut using a chisel to slice through the hot metal and then bent back, Figures 1 and 6. The bend ran along the inner edge of the mail suspension holes, a line of least resistance, which indicates that the holes existed before the bending took place. Since the rim runs right up to the edge of the mask, it is likely that the spectacle mask was already in place when the bending occurred. This all points to the fact that this bending event occurred after the rest of the helmet was assembled, either a change in the planned format the end of the manufacturing process, or more probably a later alteration in the helmet's life. The reason for this alteration is far from clear; pushing the mail curtain further from the wearer's neck could suggest problems with his face or neck, perhaps an inflamed injury or wound, or possible a new owner. It might possibly have lifted the helmet edge clear if the user had replaced the original mail curtain with a mail coif. It certainly occurs before the object went into the ground, as the corrosion has not cracked at this point, as it would had this been done had the bending occurred after the helmet's discovery. This out turned-rim is not seen on any other early medieval helmet and though it appears a 'modern' feature, it could only have occurred prior to burial.

After a long period of burial, the helmet was damaged, probably by a plough or digging tool, which broke the brow band, knocked the knop and top of the cap 12^{o} off vertical and distorted the helmet, which has 'sprung' open so making the helmet appear unusually large (Figure 3). Calculating the original circumference from the relatively intact left side and assuming the helmet was originally symmetrical, suggests an original circumference of circa 685-695mm, just a little larger than the average early medieval helmet circumference, Table 5. The Coppergate helmet showed that high status helmets could be bespoke and not symmetrical[72], though as Yarm is a later more crudely made product it is unlikely to be a bespoke manufacture, thus it appears a reasonable assumption that it approximated to symmetrical. Wester has suggested that the average head circumference is 590mm and it has been suggested that early medieval helmets had a padded lining or inner (arming) cap within the helmet to make them fit on the head and cushion blows[73] as a tight fitting helmet would lead to blunt trauma damage to the skull of the wearer. The most certain traces of such a leather padded lining or arming cap have been recovered from the Wollaston, Shorwell and Planig helmets[74], though insufficient evidence remains to fully record the nature and thickness of such a lining or cap. Although none have yet survived from the early medieval period, examples of skin caps (*pilleus*) are recorded beneath Roman helmets and padding linings / soft inner helmets are seen for the wearers of great helms, such as that surviving from an English 15th century tournament helmet from Innsbruck[75]. Despite detailed scrutiny, no mineral preserved organics could be seen on the inside of the Yarm helmet. A padded lining or arming cap of around 16mm in thickness would have been required for a warrior with an average head to wear the Yarm helmet. The thin metal helmet designed to bend when receiving blows corresponds with a helmet sized to have a substantial padded lining in order to make it capable of bending when receiving blows without damage to the wearer[76].

TABLE 5
Examples of Late Roman and Early Medieval helmet circumferences.

Helmet	Circumference (mm)	Diameter (mm)	Reference
Yarm	680-690	218	
Sutton Hoo	741	236	(Bruce-Mitford 1978, 152)
Gjermundbu	660	210	(Wester 2000, 1225)
Brough Castle	660	210	(Johnson 1980)
Valsgärde 6	640	204	(Arwidsson 1934, 244), (Wester 2000, 1217)
Shorwell	620	197	(Hood et al 2012, 85)
Coppergate	618 / 640	200	(Hood et al 2012, 86) / (Wester 2000, 1218)
Valsgärde 5, 7, 8	610	194	(Wester 2000, 1217)

The presence of a third rivet hole in addition to the two rivets on the right eye guard, seen most clearly in the X-radiograph, suggests, since there are only two rivets and associated holes on the left eye guard, that either there has been repair following damage or the position of the right eye guard was changed during assembly. The mail suspension holes are smooth showing some wear, however, they have not developed into the tear shaped holes characteristic of extensive wear. This would suggest that the helmet had been well used before burial, but it was not in constant use for many decades. The fact that all the plate edges are smooth is also consistent with some wear, probably from polishing, or at least de-rusting, the helmet. There are no marks from conflict or later repairs visible on the helmet save those mentioned above. It can be presumed, therefore, that the helmet was placed in the grave or deposited in a pit within a few decades of its creation. The extensively corroded and damaged edges were carefully examined for evidence of deliberate piercing, as would occur if a helmet were deliberately holed or broken. Weapons were often deliberately broken or damaged (sacrificed to remove them from the functional world) when they were buried in graves; the Wollaston Helmet had its nasal bent back into the helmet making it unwearable whilst the blade of the Viking sword from Sanday was broken and replaced in its scabbard[77], however, no such marks were detected on the Yarm helmet. From this evidence a life history for the object can be proposed, Table 6.

TABLE 6
Summarised biography of events of the helmets manufacture, use, burial and recovery

Phase		Activity
Manufacture	A1	Iron forged to shape. Brow band formed as a ring, the nose to nape and lateral bands riveted on. Infill plates riveted into place and the nasal and eye guards riveted into place forming the spectacle mask. Knop added and the holes for mail punched through and mail attached.
	A2	Padding added to the helmet interior or more likely a separate arming cap created.
	B1/A3	Spectacle mask position may have been altered late in the manufacturing process (A3) or as a later repair (B1)
Use	B2	Use is limited as wear on the mail suspension holes is smooth but not tear shaped. No evidence of damage during use.
	B3	Edge of brow band bent outwards, probably from a change of user or injury to the existing user.
	B4	Helmet interred in a pit, possibly initially sitting upright in the ground and covered with soil.
Burial	C1	Burial, iron corrosion proceeds slowly due to the waterlogged anoxic conditions which have formed characteristic minerals.
	C2	Hit and damaged by a plough or digging tools.
	C3	Subsequent iron corrosion occurs at fast rate due to the presence of oxidising conditions.
Recovery & Display	D1	Unplanned helmet recovery during digging of trench for sewer pipe. Minor damage upon recovery. Object cleaned with a wire brush, leaving surface marks.
	D2	Displayed in Yarm Town Hall, later in storage at the Dorman Museum, later the Preston Park Museum. Corrosion continued in early uncontrolled display and storage environments.
	D3	Object displayed in the Preston Park Museum in stable low RH conditions preventing further corrosion. Researched, analysed and then cleaned.

WHAT THE HELMET TELLS US ABOUT THE PAST

The numbers of combatants in conflicts, recorded in early medieval texts are very unreliable, but in the 5th to 7th century most authorities regard them as small. Though earlier suggestions that the term army could be used for any force over 36 men (Laws of Ine)[78] may not be sustained by modern interpretations and translations[79], Hawkes has suggested that an Anglo-Saxon army typically numbered 80-200 whilst Hines estimates 250 men[80]. With armies this small most conflicts involved just a few tens of men and the actions of the individual warrior mattered. The high quality steeled weapons recovered from the graves of kings and warriors may have provided a significant advantage in individual combat situations, their decorated form emphasising their symbolic power and the prestige of their owner. However, by the 11th century the population had increased and armies were larger; an estimated 1000 men fought at the battle of Mynydd Carn (AD 1081)[81], whilst the Norman forces at Hastings are estimated at between 6000 and 7500[82]. In such large armies the activities of any individual warrior rarely mattered; battles were won by good tactics and large numbers of well disciplined and well armed troops.

The functional benefit of a helmet depends on the nature of combat. In individual warrior combat, being without a helmet conveyed an image of confidence in not needing protection. Any protective benefit from the helmet was balanced against loss of vision, reduction in mobility and weight that a helmet would bring. Once conflict was between larger number of soldiers, utilising tactics such as shield walls and archers raining arrows down on massed ranks of men, there were considerable risks from blows and missiles coming down from above, consequently there was significant benefit for every man to wear a helmet. In such warfare any reduction in vision from wearing a helmet mattered little. Given these developments in the nature of armed conflict it is no surprise that the use of helmets greatly increases through the 10th and 11th century. The lack of armour, presumably mail and helmets, is seen by Viking writers as a key factor in the loss of the battle of Stamford Bridge in 1066[83]. At the same time models of military service developed by the Franks and Anglo-Saxons, which also influenced the Vikings, required land holders to supply a set number of men with defined levels of military equipment. This together with increasing volumes of arms and armour required for the larger number of men involved in conflicts, encouraged the adoption of standardised forms of weaponry and protection, and would almost certainly have led to reductions in quality, perhaps even reductions in the thickness of metal.[84]

Our present collection of early medieval helmets depends upon the original number, the nature of their use in the past and the preservation mechanisms which have ensured their survival to the present. Helmets were scarce throughout north-west Europe in the 6th to 8th century. Although a large number of graves from this period have been excavated, only the richest male graves have produced evidence of helmets such as Sutton Hoo and the Vendel and Valsgärde cemeteries. These are primarily elite (chieftain / royal) burial sites and helmets appear to be a sign of leadership; traditionally German kings were crowned with a helmet. Although few in number, the helmets from this era have survived as they were buried by non-Christian leaders as grave goods and, given their symbolic role, have significant decorative elements. The later examples of the 7th and 8th century such as Coppergate (recovered from its hiding place in a pit or well rather than a grave)[85] are less heavily decorated than their predecessors, with only a boar figure knop at Wollaston and Benty Grange helmets. However, it is in the later Christian early medieval, 9th–11th century period without deposition as grave goods, from which helmets very rarely survive. There are just a handful of helmets from Europe for this period; the Wenceslas helmet (preserved as a personal relic), an early nasal helmet from Olomouc, Moravia in the *Kunsthistorisches* Museum Vienna (survival mechanism unknown), the Gjermundbu helmet (from a late pagan Viking grave)[86] and now the Yarm helmet (hidden or discarded in a pit)[87]. Given their functional role they are serviceable and undecorated.

It may be imagined, given their frequent mention in the sagas, that in the pre-Christian Viking era, circa 8/9th–10/11th century, helmets were widely used, and might be recovered as grave goods; however, they are almost entirely absent. Despite numerous Viking weapon graves in which swords and spears were frequently buried[88], it is clear from the lack of helmets, they were simply not part of the warrior's accoutrement. It is possible that they continued their previous rare regal role and were passed onto a successor, but this would have only applied to a small number[89]. Wester suggests that our ideas of the use of helmets in the Viking age comes principally from saga literature which is only written down in the late 12th to 13th century[90], when helmet use had become widespread. Both writers and some artists in this later period projected their present realty onto the past, adding helmets to earlier generations of bareheaded warriors[91]. By the time the Vikings actually started to use helmets in the 10th/11th century, they had largely become Christian and deposition of grave goods had stopped. The example from coming from Gjermundbu occurs as part of a grave assemblage representing the grave of an old die hard believer in the old Norse gods.

The Bayeux Tapestry shows that by the mid to late 11th century helmets were worn by all Norman knights and infantry (and some of the archers) as well as the Saxons clustered around Harold, who are normally interpreted as the housecarls, though not members of the Saxon *fyrd* despite an edict that they should do so by Ethelred II (AD 978-1013, AD 1014-1016)[92]. A similar picture of increasing numbers of helmets is suggested by the will of Archbishop Aelfric (AD 1003/4) who bequeathed 60 helmets to his king[93]. So helmets rare now were not then, the reason that there are virtually no surviving helmets from this era is the lack of preservation mechanism. As demonstrated by the border scenes on the Bayeux tapestry, arms and armour were scavenged from the fallen after the battle[94] and were undoubtedly endlessly reused and recycled. They were too valuable and bulky to be easily lost or discarded. The Christian burial tradition without grave goods meant none were buried. In the following period, of the 12th-19th century, only a few examples of early helmets survive as part of the armouries, usually in castles. Even there, the tradition in such places, was to use old armour as raw material to make new pieces of armour or effect repairs[95], this greatly reduced the numbers of examples of helmets and other armour surviving intact from earlier periods.

The evidence of the Bayeux Tapestry would also indicate that by the late 11th century mail curtains had fallen out of use on helmets, as either the mail shirt (hauberk) had been extended to form a hood or warriors wore a separate mail coif. Both fitted the wearer more closely and potentially gave better protection to the neck of the wearer as well as permitting greater unencumbered movement of the head than the mail curtain of a helmet. It remains uncertain in the depictions of the Bayeux Tapestry whether the coif is integral part of the mail hauberk or separate. When loading the Norman ships the hauberk is clearly shown but the coif is not visible, suggesting either it is folded inside out of view or was more likely a separate garment, not pictured[96]. Similarly cheek pieces, which were present on the earlier crested helmets are no longer present on the Yarm helmet, the helmets depicted on the Bayeux Tapestry or the few examples we have of later nasal helmets. This may also be attributed to a declining need for this feature given the increased use of the mail, it also made helmets lighter and cheaper to manufacture. The one defensive feature retained from the earlier crested helm was the nasal; protection for the face against the slashing sword blow. Archbishop Aelfric's will of AD 1003/4 not only bequeathed 60 helmets, but also 60 hauberks to his royal master[97] and it can be suggested that by the 11th century, the helmet is part of a concept of a holistic protection system which includes mail. The price of a hauberk; £7.00, is mentioned in the Jumièges charter (1045-9)[98] indicating that this protection was expensive, the preserve of the professional warrior or leader, however, like many other craftsmen, much of a warrior's wealth was invested in the tools with which he plied his trade. The Yarm helmet illustrates the decreasing emphasis on symbolism and decoration in helmet appearance and the increasing importance of functionality. Plain functional helmets, like that from Yarm, are by the 10th and 11th century becoming increasingly used as part of a protective defensive system, one of the tools of a warrior's craft.

Most early medieval helmets are composite constructions; single pieces of shaped metal forming helmets, such as Sutton Hoo are rare. The 10th century Gjermundbu, Yarm and Mayer examples cited above are composite helmets as are those illustrated on the 11th century Bayeux Tapestry. However the Wenceslas and Olomouc helmets, suggested as roughly the same date, are single pieces of forged iron[99]. This single piece of forged metal forming the cap of the helmet becomes the dominant construction method through the following centuries, the origin of these early examples suggesting that this tradition emerges from eastern Europe. They gradually replaced the composite helmet, though examples of composite conical nasal helmets may continue to be used into the 12th century in Britain and north-west Europe[100].

CONCLUSION

The Yarm helmet has the riveted, bounded cross band construction form consistent with the 6-11th century helmets seen in England and Scandinavia. It lacks the crest, cheek pieces and copper alloy decoration of the 6th-8th century crested helmet forms but like them has evidence of originally possessing a mail curtain to protect the neck. It has a spectacle mask, a form only seen on Scandinavian influenced helmets of 6th-11th century date. The shape of the helmet lies between the hemispherical domes of the crested helmets and the pointed dome form of the nasal helmets. It has a plain functional appearance, ironwork left in the 'as hammered' state. This corresponds with the plainer, more functional forms of arms and armour developed for the larger groups of fighting men present in the armed conflicts seen from the 10-11th century.

The helmet is manufactured from early (wrought) iron, made using a phosphorus rich ore and the bloomery process. Hammered and folded into shape with different plates made from different blooms, this inhomogeneous metal is identical to that seen and used in other early medieval artefacts and unlike iron normally used in the post medieval period. It's initial deposition in an oxygen-starved (anoxic) burial environment explains the unusual preservation of this helmet, though later damage tore out part of the helmet and resulted in more aggressive corrosion of the remains. Though the slim possibility that it is a modern replica still exists, the spectacle mask and mail curtain were not features normally understood as present on Saxon/Viking helmets prior to the discovery and publication of Valsgärde VI published in 1934. Even after their discovery such a plain and simple helmet would not correspond with public perception of a 'Viking' helmet. Any helmet 'knocked together' in the 1940s based on discoveries at Sutton Hoo would not be made of phosphorus rich iron derived from a bloomery forge, but mild steel. Thus the balance of probability now clearly lies that this is a genuine Anglo-Scandinavian helmet of late 9th to 11th century date, most probably from the 10th century. The presence of this helmet strengthens the arguments for 10th century Anglo-Scandinavian trading activity / settlement at Yarm.

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ACKNOWLEDGEMENTS

I would like to thank Jennifer Jones who, together with assistant curator Julian Herbert, first drew attention to the possibilities of this helmet as an original 10th century object and made the case for further research. Thanks are due to Christine Hutchings curator at Preston Park Museum and her predecessor Gemma Lewis for facilitating access to the helmet, their efforts to ensure the continued well being of the helmet and their support throughout this project. Essential to this research were colleagues who supported recording and analysis of the helmet Dr Gerry MacDonnell (metallography), Dr Ivana Evans (X-ray diffraction), Yvonne Beadnell (drawing), Jeff Veitch (photography), Vicky Garlick (transport container), Beatriz Fonseca de Mendonca (FTIR). I am also deeply appreciative of the insightful comments of colleagues such as Dr Thom Richardson ex Deputy Keeper of Arms and Armour at the Royal Armouries (Leeds) who examined the helmet as well colleagues including Dr Barry Ager, Dr Sue Brunning, Sir David Wilson, Dr Sue Harrington, Prof. John Hines, Prof James Graham Campbell, Dr Sonja Marzinzik and Dr Gareth Williams who commented on a draft version of this paper and provided valuable information, references and advice. Thanks also go to colleagues, in particular Prof. Sarah Semple, who has helped fashion this into something readable. However, any errors and omissions remain those of the author.

FIGURE CAPTIONS

FIGURE 1: The Yarm Helmet. *Photograph by Jeff Veitch.*

FIGURE 2: Schematic plan and side view of the Yarm helmet; elements identified[9]. *Drawn by Chris Caple.*

FIGURE 3: Front and side views of the Yarm helmet. *Drawn by Yvonne Beadnell.*

FIGURE 4: Yarm with suggested 10th – 13th century features. *Drawn by Chris Caple from information supplied by Tees Archaeology*.

FIGURE 5: Locations of the rivets and holes (numbered). *Drawn by Chris Caple.*

FIGURE 6: X-Radiographs of the Yarm Helmet (Merlin Gerin multi 9 C60N X-ray source, with Kodak 'Point of Care'CR120 digital x-ray imaging system. Exposure 90kv, 0.8maS). *Images by Vicky Garlick and Chris Caple.*

FIGURE 7: Right eye guard, helmet interior. *Photograph by Chris Caple.*

FIGURE 8: Rear left infill plate, helmet interior. *Photograph by Chris Caple.*

FIGURE 9: Slight lip on the lower side of the mail suspension holes. *Photograph by Chris Caple.*

FIGURE 10: Stone sculpture fragment from All Saints church, Pickhill, North Yorkshire. *Photograph by Jeff Veitch.*

FIGURE 11: C J Staniland's illustration of raiding Vikings, from G A Henty *The Dragon and Raven*, (pub. 1886). *Permission for reproduction currently being sought*.

FIGURE 12: Sample LEG1 etched metal micrograph; bands of larger and smaller grain ferrite (width of field 0.6mm). *Photograph by Gerry McDonnell.*

FIGURE 13: Optical microscope image of outer surface of fragment Ya. A compact green, red, and black mineral corrosion crust fragment removed from the front right infill plate. *Photograph by Chris Caple.*

FIGURE 14: The visual evidence of the extent of pale blue-green vivianite minerals on the Yarm helmet. No traces were found inside the helmet. *Drawn by Chris Caple.*

FIGURE 15: The helmet photographed immediately after discovery in the 1950s. *Image by Jeff Veitch.*

TABLE CAPTIONS

TABLE 1: Metallographic structures and micro-harness data.

TABLE 2: Metal composition.

TABLE 3: Inclusion compositions (mean data of multiple inclusions).

TABLE 4: Elemental compositions of the coloured corrosion products of the outer surface of sample Ya.

TABLE 5: Examples of Late Roman and Early Medieval helmet circumferences.

TABLE 6: Summarised biography of events of the helmets manufacture, use, burial and recovery.

END NOTES

[1] Dept of Archaeology, Durham University, South Road, Durham DH13LE.
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[2] In terms of construction the Yarm helmet is a crested helm similar to the Coppergate helmet, though it lacks a crest. It may also be considered a broadly in the 'spangenhelm' tradition, if the term is used in its wider form of an early medieval segmented helmet formed of a frame with infill plates, rather the stricter definition of inverted T shaped plate construction of Steuer (Steuer 1987; Stary et al 1999).

[3] 'Whose titfer? A right poser', *Evening Gazette* 2nd February 1974.

[4] The exchange of letters occurred in January and February 1974 between the curator of the Dorman Museum, G.G. Watson, the Master of the Armouries A.R Duffy and an unnamed curatorial assistant at the British Museum. A.R. Duffy commented 'At first I was doubtful about the genuineness of the helmet such is its botched workmanship..... I know of no close parallels from the East, though possibly something somewhat similar of Russian origin might be sought.'

[5] 'It's A Viking Helmet, Says Clive', *Evening Gazette* 25th February 1974.

[6] Caple and Jones 2008. Yarm Helmet (North Yorkshire) HER 0483.

[7] Tweddle 1992, 1111-1123.

[8] Read 2006.

[9] The terms right and left are used throughout as for the helmet wearer i.e. proper right and proper left).

[10] The stone was found by Canon Greenwell of Durham being used as a mangle weight. The original interpretation is recorded in the history of the St. Mary Magdalene Yarm Church: <http://www.yarmchurch.org.uk/church-history/> [accessed April 2, 2018].
More recent recording and interpretation of the Humbert stone is presented in The Corpus of Anglo-Saxon Sculpture, Volume VI, North Yorkshire (Lang 2001, 274-6**)** available online:
< http://www.ascorpus.ac.uk/catvol6.php?pageNum_urls=447&totalRows_urls=449> [accessed April 2, 2018].

[11] Stocker D. 2000, 200-203. Kirklevington is probably an earlier Anglo-Saxon church site, from which carved stone fragments of 10-15, 10th century stone monuments from elite burials, with Hiberno-Norse cultural traits, have been recovered:
<http://www.ascorpus.ac.uk/catvol6.php?pageNum_urls=170> [accessed April 2, 2018].
It may well represent the burial place of a mercantile Hiberno-Norse group.

[12] Medieval roads from the south converge on this loop which appears to have been an early ferrying or bridging point of the River Tees. Following the early medieval settlement on the west side of the peninsula (Heslop 1990, Daniels 2010) a castle may well have been established on the high round to the south-east close to an area later occupied by a Dominican friary and currently by Yarm School. Excavations in the ground of the school produced 12th century pottery which together with the current topography and written records to Castle Dyke and Castle Close suggested the presence of an early earth and timber Anglo-Norman castle. The castle does not

appear to have ever been rebuilt in stone. By the early 13th century High Street had been established with characteristic long narrow medieval tenements on either side; each with a narrow frontage on the roadside running down to the river or the edge (east side) or the earlier Westgate settlement (west side). The town had borough status by 1273.

[13] Bruce-Mitford 1978.

[14] Bruce-Mitford and Luscombe 1974.

[15] Tweddle 1992.

[16] Meadows 1997; Read 2006. Read suggests a 7th century date (2006, 38).

[17] Hood et al 2012.

[18] Tweddle 1992, 1093.

[19] Tweddle 1992, 930-1.

[20] The helmet must be well supported to punch holes through from the outside and not distort the helmet shape, a very deliberate act. Flush exterior riveting is normal for plate armour of any quality throughout the medieval period. Unusually the helmet from Olomouc, Moravia (Figure 22) has its suspension holes punched through from the inside suggesting a later addition or less able blacksmith/armourer.

[21] Henning 1907; Arwidsson 1977; Steuer 1987; Gamber 1992; Gamber 1993.

[22] Tweddle 1992; Steuer 1987.

[23] The dating of the Valsgärde and Vendel finds by Ament, Arrhenius, Bruce-Mitford, Arwidsson and Arbman is discussed in Tweddle (1992, 1091) and the dating for the site as whole more recently by Ljungkvist (2008) and Norr (2008). These finds and other possible fragments of helmets are mentioned by Frisk (2012).

[24] Tweddle 1992, 1087; Johnson 1980. Helmets in the Late/Post Roman Period: <http://www.durolitum.co.uk/articles/helms.html> [accessed December, 2017].

[25] Coupland 1990. The Stuttgart Psalter images of quadripartite form helmets similar to Yarm are seen at: <https://commons.wikimedia.org/wiki/Category:Stuttgarter_Psalter_-_Württembergische_Landesbib_Bibl.fol.23#/media/File:Stuttgart_Psalter_fol23.jpg> [accessed April 2, 2018].

[26] Edge et al 2000.

[27] Keller 1906, 85. The form and even decoration of helmets is also referred to in contemporary text.

'His head was encircled by a silver helmet
that was to strike down through the swirl of water,
disturb the depths. Adorned with treasure,
clasped with royal bands, it was right as at first
when the weapon-smith had wonderfully made it,
so that no sword should afterward be able to cut through
the defending wild boards that faced about it.'

(*Beowulf, ll. 1448-1554*)
Description of a helmet in Beowulf suggests, if correctly understood and translated (Alexander 1973) suggests a helmet as silvery (white) metal, presumably either iron (polished or cleaned metal) or tinned foils visible on the exterior. The foils such as those seen on the Valsgärde and Sutton Hoo helmets, may be what is referred to as 'adorned with treasure'. 'Clasped in royal bands' presumably refers to banded construction of a crested helmet or *spangenhelm* construction. The final line appears to be a reference to the boars crest seen on Wollaston and Benty Grange helmets. This description seems to correspond well with the physical helmet evidence; though as an oral history tale from the 7th-9th centuries before being written down circa 1000 CE/AD, it can refer to helmets anywhere across this period. Other literary references to helmets are discussed by Norr (2008).

[28] Hood et al 2012.

[29] Tweddle 1992; Hood et al 2012; Werner 1949-50.

[30] Tweddle 1992, 1104-1129.

[31] Tweddle 1992, 1129; Kirpichnikov 1971.

[32] Tweddle 1992, 1120; Arwidsson 1934.

[33] Keller 1906, 90-91. This development of the pointed domed helmet by the 11th century was also noted by Kirpichnikov (1971) in the 37 helmets which had been recovered in the territory of the Rus' (Russia, Ukraine Belarus), by 1971.

[34] Tweddle (1992, 1129) and Lewis (2005, 42-3) explore the evolution to conical form. Tweddle explores visual depictions (1992, 1104, and 1131). Sources such as the Franks casket of 8th century date (Webster 2010) show three warriors all depicted wearing a stylised helmet form which appears to show helmets with nasals, cheek pieces and mail curtains as well as a crest. The overall helmet shape may be regarded as between hemispherical and conical form.

[35] Wilson regards the nose-guard and lower rim of the Wenceslas helmet as 'clearly tenth or eleventh century date' (Wilson 2004, 223) whilst Ager (pers. comm.) suggests the dating is derived from a 14th century tradition. Lewis (2005, 48), Ager and Wilson all recognising that the brow band and nasal is probably a later addition to the cone.

[36] Musset 2002; Lewis 2005. Lewis has noted that nasal guards are not depicted in manuscript sources prior to the 12th century, save for the Bayeux tapestry (Lewis 2005, 49). Surviving manuscripts of this period normally have Romanesque/Frankish cultural affinities, thus the nasal guard, so prominent in the Bayeux tapestry, Coppergate and Wollaston helmets, as well as the spectacle mask, may have Anglo-Scandinavian origins.

[37] Musset 2002, 234-240.

[38] Musset 2002, 45.

[39] Munksgaard 1984, 87.

[40] Tweddle 1992, 1125-1127.

[41] No evidence was recovered to suggest the helmet exterior was painted or covered in leather as has been suggested for Trivières (Hood et al 2012, 92).

[42] Bronze Age examples had a thin central hole presumed to be for a feather plume (Mödlinger et al 2013). This form of decorative symbolism was an important feature seen on many helmets, usually presumed to show allegiance. The earlier boar form of knop/crest on Wollaston and Benty Grange probably related to a symbol or allegiance important to the wearer, however, this could not easily be changed. The simpler knop, to which a colour streamer could be attached, speaks of a more functional helmet which can be re-tasked to show allegiance by the quick addition of the correct coloured streamer. The flared top ensuring that it would not accidentally fall off as it would a point. Knops are absent from the earlier decorative Valsgärde helmets where crests fulfilled some of the same functions.

[43] Whilst the spike, rod and disc forms of apex identified on early Anglo-Saxon shield bosses by Dickinson and Härke (1992) have a similar role in strengthening a sheet metal dome and protecting the wearer from incoming blows, none has exactly the same flared and pointed form as the knop on the Yarm Helmet.

[44] In 1974 curator of the Dorman Museum G.G. Watson commented 'The iron sheet is very thin and it seems doubtful that it could have ever been intended for combat.' A similar concern over thinness of the metal was also raised over the Washingborough helmet (LCNCC 9734.06). This helmet, whose remains comprise a corroded rim and top of the cap (dome) seemingly forged from a single piece of iron with 22 rivets and rivet holes around the base of the rim, is most probably the shallow dome of a kettle helmet (rim now missing) of 12-16th century date. It was recovered in 1860 from the river Witham (White 1979, 3). The rim thickness is approximately 2 – 2.5mm, but the metal of the sides and top of the dome are around 1mm thick. The thickness of plate armour of the 13th to 16th century, though rarely measured has been suggested as '1-2mm thick'. Tournament helmets, worn for shorter times and which more usually survive, are thicker.

[45] Tweddle 1992, 954.

[46] Wester 2000, 1222.

[47] Frank 2000.

[48] Frank 2000, 200. Meinander (1983) usefully explores such ideas in Scandinavian publications, whilst Sir David Wilson has explored such ideas in European art largely of the 18th and 19th century (1997).

[49] Frank, 2000, 205.

[50] Frank 2000, 202.

[51] Stolpe and Arne 1927.

[52] Arwidsson 1934; Arwidsson 1942; Arwidsson 1954; Arwidsson 1977.

[53] McDonnell, 2017.

[54] Metal composition mean values; RLP1 n=2, LB1 n=14, LEG1 n=10, NNB1 n=6. Standard deviations for all elements = 0.1%, save for Co = 0.32% and Fe = 0.3%.

[55] Inclusion composition mean values; RLP1 n=8, LB1 n=26, LEG1 n=26, NNB1 n=24. For standard deviations, shape and other inclusion details see McDonnell 2017.

[56] Rubinson 2010; McDonnell and Ottaway 1992.

[57] Lang et al 1992, 1019-1026; McDonnell 1992.

[58] Thiele 2015; McDonnell 1992; Blakelock and McDonnell 2007; Rubinson 2010.

[59] Williams 1972; Williams 1978.

[60] Tylecote 1976, 128; Blakelock and McDonnell 2007.

[61] Oxford Instruments ED 2000 Energy Dispersive X-Ray Fluorescence system. Caple 2017a.

[62] Hitachi TM3000 Scanning Electron Microscope with an Oxford Instruments SWIFT ED microanalysis capability. Caple 2017b.

[63] Perkin Elmer Spectrum Two FTIR System, utilising a diamond attenuated total reflectance objective. Caple 2017c.

[64] Cronyn 1990, 180-1.

[65] Caple and Evans 2017.

[66] Neff et. al. 2005; Koleini, F. et. al. 2013.

[67] Neff et. al. 2005; Matthiesen et al 2003.

[68] Caple 2017c.

[69] Viking graves lack almost any defining characteristic (Williams et al 2014, 177-182; Price 2008; Halsall 2000, Redmond 2007) making such an origin, even a previously unrecognized boat burial, possible. However, a grave with a high status item such as a helmet is likely to contain other grave goods and be part of a wider cemetery. The fact that no further Viking or Anglo-Scandinavian items have been recovered from a town which has seen continuous occupation since the 12th century, mean that it is more likely to be an isolated find hidden in a pit than the only item yet recovered of a burial / cemetery.

[70] Vivianite is rarely recovered from modern contexts (Mann et al 1998), though it is a frequent occurrence in archaeological anoxic deposits containing ironwork, such as those from Coppergate, York (O'Connor 1992, 907).

[71] Dr Thom Richardson, having seen many examples of corroded arms and armour in his role as deputy master at the Royal Armouries, was confident that it was the corrosion crust expected of an early medieval artefact as were experienced conservators Jennifer Jones and Chris Caple.

[72] Tweddle 1992, 1037, Figure 484.

[73] Wester 2000, 1227.

[74] Read 2006, 40; Hood et al 2012, 90-91. There were also traces of organic remains inside the helmet at Sutton Hoo which could have been traces of padding or a cap. The presence of rivet holes for the attachment of leather or fabric lining bands, to which the internal helmet lining would be sewn, are seen on helmets from the 13th century and later; the river Witham helmet,

being one such example. Rivet holes for linings are absent from earlier helmets such as Coppergate, Wollaston or Yarm.

[75] HJRK B44 *Kunsthistorisches* Museum, Vienna. In Rus' territory 14th century Arab sources refer to felt linings on the inside of *shishack* helmets (a highly developed form of sphaeroconical helmet) whilst 12th century sources initially describe a *prilibitsa* as a soft hat or arming cap worn beneath the helmet, sometimes made of wolf fur (Kirpichnikov 1971).

[76] The issue of the lack of space for a padding lining or arming cap was one of the criticisms levelled at the initial reconstruction of the Sutton Hoo helmet, leading Nigel Williams to create a new restoration in 1968-9 (Williams 1992, 74).

[77] Read 2006, 39; Owen and Dalland 1999.

[78] Sawyer 1971

[79] Williams et al 2014, 85.

[80] Davies 2004, 23.

[81] Davies 2004, 59.

[82] Morillo 1994 to Gravett 1992.

[83] Finlay 2005; 98-99.

[84] Williams et al 2014 106, 110. In Rus' territory a similar phenomena is noted at a slightly later date (Kirpichnikov 1971), where decorated helmets, usually of sphaeroconical (Chernigov) type, primarily occur in earlier 9th and 10th century contexts. By the 12th and 13th century larger numbers of plainer forms are being manufactured, often composed of four plates, rising from a brow band, with rippled edges riveted together (Williams et al 2014, 105).

[85] Tweddle 1992, 1125-1128.

[86] Grieg 1947; Munksgaard 1984; Tweddle 1992, 1125-1128; Wester 2000.

[87] Though there are references in earlier literature to helmets such as that from Hunthills in Scotland (1851) and the Ards peninsula in Northern Ireland (1903) (Barry Ager pers. comm.), no physical remains are currently known. There are also examples from Russia and eastern Europe such as Giec in Poland and the territory of the Rus' (Kovács 2003, Kirpichnikov 1971).

[88] Wester 2000, 1223. Hjardar and Vike (2016, 158) suggest that there are around 6,200 Viking Age weapon burials, and only at Gjermundbu is there a helmet.

[89] The presence of an axe, sword or spear identified the owner as a freeman, warrior and hunter. Later Viking laws required men to posses and show these weapons if required or be fined; so their presence in earlier graves may well suggest they acted as indicators of status going into the afterlife. Helmets, however, were much rarer and used as a sign of leadership and may have been passed from generation to generation and thus not been buried (Hjardar and Vike 2012, 154-9; Frisk 2012). In contrast, Beowulf though clearly describing the decorated, gilded, boar crested, cheek pieced and masked helmets of the 7th century talks both of princes giving helmets and mail shirts to his followers (thanes) (Beowulf line 2867-9) and a row of old and tarnished

helmets (Beowulf line 2762-3) (Alexander 1973) which would suggest their number were not that small, and certainly they were not uncommon by the 8th and 9th century well before Christian burial rites were widely practised in the Viking world.

90 Williams et al 2014, 24; Wester 2000, 1221-3.

91 If berserks existed as 'men without armour' who fought 'in a frenzy like dogs' as suggested by Ynglinga Saga (Ewing 2008: 118-121) and were not a mistranslation (Simek 1993, 35) then they would have been without helmets, but only very small numbers of such warriors would ever have existed. Suggestions of leather and wooden helmets, such as Iron Age examples from Uglemose, Birket, Lolland in Denmark (Copenhagen 1995; 31-2) which might have subsequently perished can be made, but no convincing argument why expert Viking, Frankish or Saxon metalsmiths would not to make such an important item in iron has been made.

92 Williams et al 2014, 90. Such literary evidence counters suggestions that their extensive presence on the Bayeux Tapestry is simply an artistic convention.

93 Keller 1906, 80; Musset 2002, 45.

94 Musset 2002, 262-4.

95 Edge et al 2000, 1228.

96 Musset 2002, 192-3. The absence of mail over the head in a number of depictions when only wearing hauberks (Musset 2002, 204-206) may suggest that the coif was normally a separate garment at this time, certainly not always integral to the hauberk.

97 Keller 1906, 80.

98 Musset 2002, 47.

99 Helmets like Gnëzdovo 1, a composite riveted construction from two pieces, and Nema, forged from a single piece of iron, coming from the Rus' territory, have been suggested as the precursors to the Wenceslas and Olomouc (Moravia) helmets (Kirpichnikov 1971).

100 Leslie Southwick noted two examples of conical domed helmet forms with spectacle (eye) masks extended down over the mouth with pierced breathing holes, illustrated in 12th century manuscripts (Southwick 2006, figures 1 and 2). These might suggest that the spectacle mask evolved into an immovable face plate and eventually the Great Helm of the 12th and 13th century.