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SUTTON HOO: RE-IMAGING THE SHIP AND CHAMBER

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The cemetery at Sutton Hoo in East Suffolk includes tumuli dating to the sixth–seventh centuries AD. The largest contained an intact ship-burial. The man commemorated is not identifiable, but is often presumed to be Rædwald, rex Anglorum c AD599–624/5. Excavation was curtailed by the outbreak of war in 1939. Despite subsequent re-excavation and lengthy research, questions remain.

Information dispersed in the definitive publication is correlated and developed. Digital 3D imaging of the ship's iron fastenings are used here to extrapolate curved lines of missing rivets and superimpose them on the burial chamber plan. A digital roof reconstruction is also presented.

Mechanisms of collapse of the objects are deduced from their positioning and damage, revealing space for access to the chamber. A cross-section depicts the calculated height of the deck and known tilt of the ship. Residues of phosphate, Middle Eastern bitumen, tar and tape cumulatively suggest embalming practices. A temporary coffin and a bed on which possessions were placed are proposed.

The most valuable object relinquished is deduced to be the ship. Fragments of a possible anchor are identified. The suggested identification of the iron stand as a raised light would allow supporting ships to follow.

Keywords: Sutton Hoo; early medieval; iron; embalming; ship; digital reconstruction

INTRODUCTION

The name Sutton Hoo resonates with every student of the Anglo-Saxon period. The estate is now in the care of the National Trust and developed with a museum, restaurant and visitor centre. An elevated look-out enables the cemetery and its setting to be appreciated. The Edwardian building has been renamed Tranmer House and, with contemporary furnishings, provides the setting for owner Mrs Pretty's excavation of four mounds in 1938–9. Now screened by a plantation, the site overlooks the River Deben. There is evidence of prehistoric cultivation, Anglo-Saxon flat graves and as many as eighteen tumuli, two of which contained clinker-built ships. The vessel beneath Mound 2 had been robbed. However, Mound 1 was found to contain the sandy outline and iron fastenings of a 27m-long ship, together with an intact assemblage of grave goods.

Even eighty-three years after its discovery by local archaeologist, Basil Brown, questions still remain to be satisfactorily answered, or have yet to be asked. Some theories persist,

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others have been discarded – only to be revived subsequently.[1] A stimulus is provided by the best modern research. Of particular relevance is an earlier, richly-furnished 'princely' burial beneath a mound at Prittlewell in Essex.[2] In addition, the digital survey of the ship below Mound 1 has adjusted the shape the buried hull assumed.[3] This provides the basis for the following, and any future, reconstruction of the chamber built amidships.

EXCAVATION IN 1939

Something not obvious to the public and scholars is the incompleteness of the contemporary record of the ship, notwithstanding the best efforts of Charles Phillips. Having been asked to take over the excavation, he assembled within one month an exceptionally able team to deal with all aspects of what became a rescue operation.

The ship was Phillips' priority. He prevailed upon the expert, Lt Cdr J K D Hutchison, to convince Mrs Pretty, the landowner, of the necessity for a professional survey and record of its impression.[4] Afterwards the two men adjourned to the site for a lengthy discussion, sadly not recorded. The survey was necessarily postponed until the burial deposit had been removed. Twenty-seven days later Hutchison returned with his team from the Science Museum. Photographs show that Basil Brown assisted them in taking the lines. Meanwhile, accompanied by Phillips, Hutchison investigated its construction before returning to London and his post in Special Operations. The outbreak of war explains why it fell to one of Hutchison's assistants to provide the 'Provisional Plan' for a temporary exhibition. A S Crosley's inadequate grasp is patent in the article he published after Hutchison's death, enabling him to claim sole credit.[5] None of the original data survived. For this reason, two aims of the British Museum's 1960s re-excavation of the subsequently war-damaged ship were to address outstanding problems with the provisional record and to create an archaeological plan of the remains of the hull.

RE-EXCAVATION 1965–7

The author's involvement in Sutton Hoo began in 1964. Upon joining the then huge Department of British and Medieval Antiquities, she was tasked by Rupert Bruce-Mitford with setting up, firstly, the Sutton Hoo research programme in an annexe of the British Museum, and the re-excavation of the ship impression to begin the following year (fig 1).[6]

1. Vierck 1980a.
2. Blackmore *et al* 2019.
3. Tanner *et al* 2020.
4. Phillips 1975, 733.
5. Crosley 1943; Bruce-Mitford 1975, 378.
6. This was the beginning of a friendship with Basil Brown. In 1965 Yvonne Crossman became the second member of the team as administrator and archaeological surveyor. That role and her considerable, but never recognised, contribution to the research programme is here acknowledged.

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(a)

(b)

Fig 1. a) the southern combe in 1965 showing its proximity to Mound 1 (right); b) lifting the rivets in 1967. A portion of the stem post remains in the trench cut in natural banded sand.
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In 1967 work on the definitive publication advanced with an enlarged staff including Angela Evans. The author's investigation of the archaeology of the burial deposit resulted in a reconstruction of the large cauldron, the complex chainwork and new reconstructions of iconic objects – the lyre, iron 'stand' and 'whetstone'.[7] Perceptions and detail scattered throughout the three volumes remain difficult to access. A further volume, planned to synthesise conclusions of researchers and specialists, did not materialise. Digital publication is overdue. We are fortunate that Martin Carver's subsequent excavation of other graves in the cemetery has placed Mound 1 in a wider immediate context. His published research has also provided an accessible interpretation of the burial.[8] He is currently playing a leading role in the full-size reconstruction of the ship on a site opposite Sutton Hoo.

ARCHAEOLOGICAL ANALYSIS

The ship realisation

An opportunity for new research was facilitated by the reconstruction of the Mound 1 ship. In 2016 the Riverside Trust initiated the project. A sister charity, the Sutton Hoo Ship's Company, was given a brief to use the original materials and contemporary technology. Accurate plans of the hull were essential, and a thorough expert reappraisal was commissioned. Pat Tanner and Julian Whitewright were confronted with disparate information, comprising a photographic record and paper reconstructions. The solution they adopted was to plot each rivet in three dimensions to create an adjusted digital image of the hull.[9] Their brief required assessment of missing information, such as propulsion, displacement, rowing geometry and performance capability. That data underpins the new 3D reconstructions created for presentation here, namely, internal ship structure, the space amidships, the deck level and the chamber roof. The recorded tilt of the ship is shown.

Underground movements

As I had contributed to volume 1 on the subject, the Woodbridge team requested an updated archaeological analysis of forces that had impacted the ship in the ground.[10] Fundamental was an appreciation of what was visible in photographs, namely, the ship's pronounced list to starboard (south). Phillips had ignored any implications, merely noting that the ship had a slight lean. However, Crosley recorded it as six degrees from the vertical. Our re-excavation substantiated the list and showed that it was consistent. In other words, the whole hull had been free to tilt at an early stage before the backfilled soil below it had become compacted.[11] When exactly had the slippage taken place?

7. Further input was interrupted when Bruce-Mitford deputed me to head the post-excavation programme on the Anglo-Saxon Graveney ship (Fenwick 1978).
8. Carver 1998, 2005. See Evans 1986 for a beautifully illustrated handbook.
9. Tanner *et al* 2020, fig 6.
10. Fenwick 1975.
11. Ibid, fig 213; Bruce-Mitford 1975, figs 190–2.

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Ship-burial practicalities

The ship is likely to have been dragged from the river by the closest route. Two combes provided smoother gradients and the ship was buried on the edge of the plateau close to their head (fig 1a). Taking it out of the water would have presented no special difficulty.[12] Wooden craft required to be regularly beached and laid up every winter. Moving even large vessels was an intrinsic part of construction and maintenance. However, portage to the burial site 700m distant was different and a big operation. There are slight reasons for supposing that Mound 2 antedated Mound 1.[13] If so, experience would have been gained in living memory when a ship only a few metres shorter was transported there. Cables, skids and advance preparation of the 1:20 incline would have facilitated the move. Extra hands could be summoned from their work. For this task, manpower was more efficient than oxen – draught horses were not then in use.[14]

Forward planning is evident. On the plateau the shape of the hull was carefully excavated by the Anglo-Saxon burial team. We found their sandy spoil dumped well back, showing space for manoeuvre.[15] However, a large pit indicated on the 1939 plans did not exist (fig 1b). The confusion appears to have been caused when a reduced level area was created to facilitate Hutchison's survey of both extremities.[16] In 1967 we found undisturbed banded sand close to both ends of the hull, proof that the trench was not wider at one end, as would have been the case if the ship had been dragged into it. A revised plan was published to show the close-fitting trench.[17]

The ship was probably hauled across halved logs over the trench, pegged to planks protecting the edges of the trench. Once in position, the labour force could have supported the ship on ropes while the logs were removed and then, coffin-style, lowered it.[18] Paul Ashbee found no post-settings beneath the remaining portions of the mound, evidence that a direct lift had been used. In the trench two halved logs were identified as well as the lack of room to backfill. Had the vessel tilted at that stage, there was certainly manpower present to right it and install props. Furthermore, it appears unfeasible for carpenters to have erected a heavy construction on an unstable and lopsided hull (fig 2). It seems more likely that the movement occurred after the funeral. The crowd who contributed more than 300 tonnes of topsoil may have been unaware that the ship was tilting beneath their feet.[19]

12. Oxen were used within living memory to launch and beach Portuguese double-ended fishing boats known as *xavegas* (Johnstone and Tilley 1976). The church bell was rung to summon teams from the fields.
13. Carver 1998, 132–4; fig 85 places Mound 1 with the secondary group to the south. Mound 2 also occupies the highest point on the site.
14. Ameen *et al* 2021.
15. Ashbee 1975, 306–8, figs 220, 230.
16. Bruce-Mitford 1975, fig 6; Fenwick 1975, 289.
17. Bruce-Mitford 1975, fig 230. Unfortunately, the figure was not used when a new combined plan was redrawn (Carver 1998, fig 25). In consequence, the actual shape of the trench is not generally known.
18. This slightly modified Phillips' reconstruction of the operation (Phillips 1940, 12)
19. The volume of its perimeter ditch could be used to reconstruct Mound 2 with a height of 4m and diameter of 24m (Carver 1998, 121, 2005, fig 80). Mound 1 lacked a ditch and had been denuded. Its original size and height are likely to have exceeded Mound 2. Ashbee (1975, figs 217–18) shows Mound 1 reduced by later substantial losses to the east, so that the ship was no longer equally disposed below it.

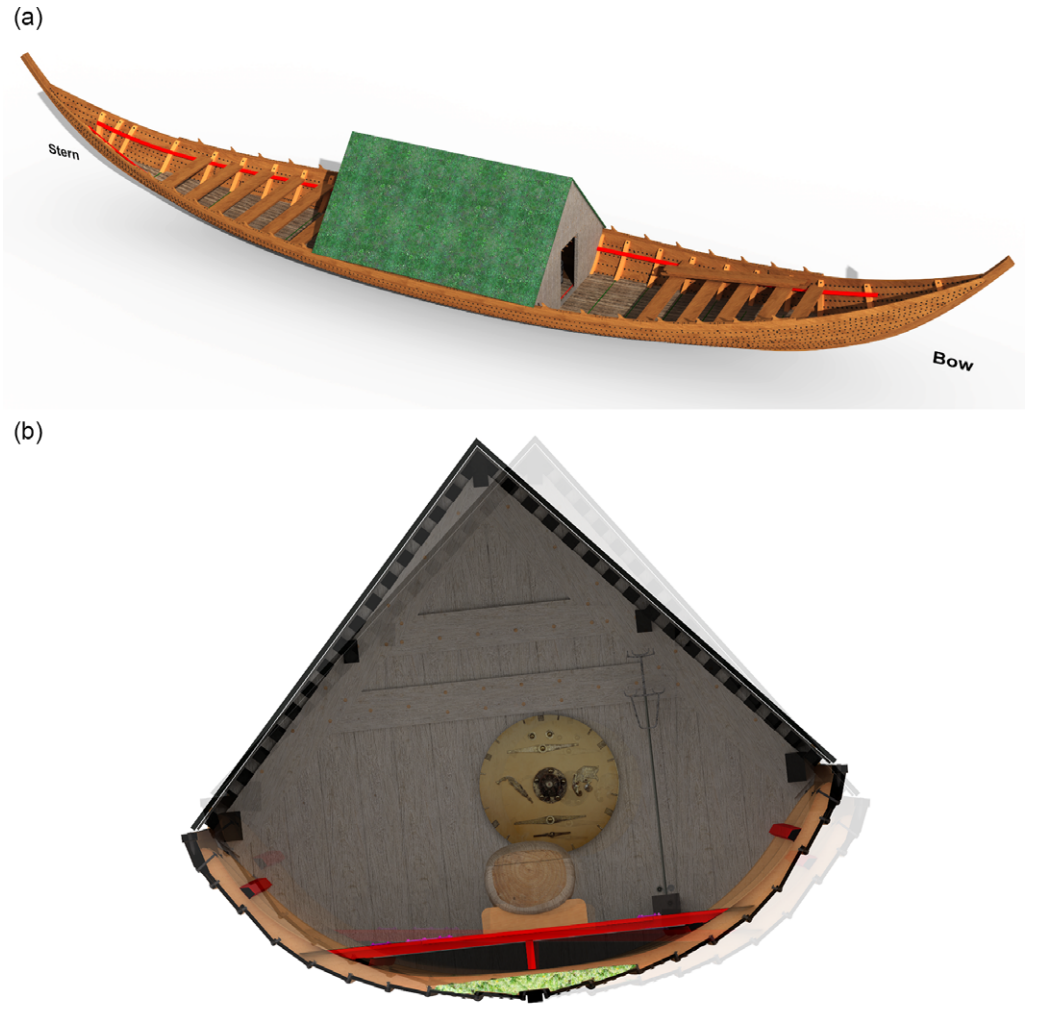

Fig 2. a) the ship as reconstructed with a turf-covered chamber accessed from the foredeck; b) section of the chamber reconstructed to show the subsequent tilt. *Images*: © Pat Tanner.

THE SPACE AMIDSHIPS

Deck or no deck?

Amidships there was either a continuous deck, or gangways, or an undecked area. Evidence of the latter is suggested, not only by the absence of holes, but also by the considerable traces of decayed vegetable matter underlying the chamber deposit.[20] A pollen sample contained a

20. Photographs show a reduced room (space) between frames 13 and 14 starboard and the 1939 plan is 'flipped'; however, plans show the wider room on the opposite side substantiated in our re-excavation (Bruce-Mitford 1975, card 4). It may be evidence of a starboard futtock replacement and renders a thwart here less likely.

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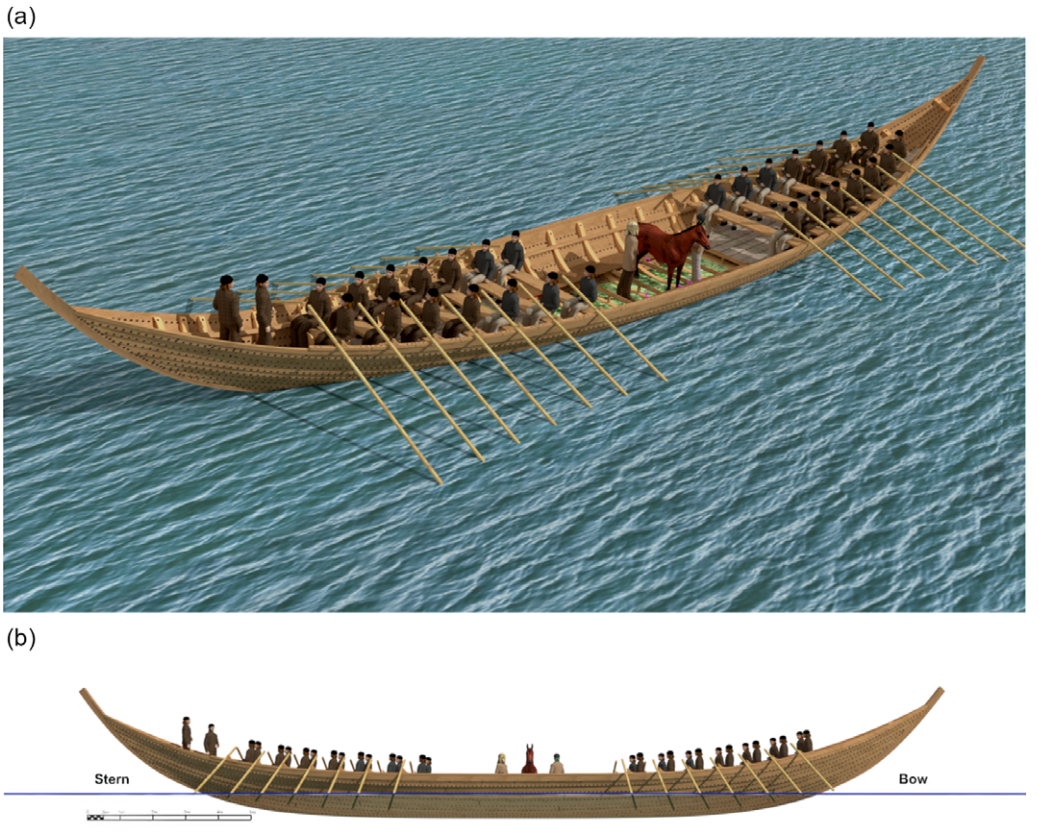

Fig 3. The Mound 1 ship reconstructed with twenty-eight oarsmen: a) the open hold here used to accommodate a rider and fourteen-hand horse standing on dunnage; b) another view. *Images*: © Pat Tanner.

higher percentage of *Calluna sp.* compared with the adjacent old ground surface.[21] This is a clue that the decayed vegetable matter may have included heather dunnage, a bedding of choice, on which passengers, gear and animals could be transported (fig 3). In addition to lowering the centre of gravity, the bottom of the vessel provided some shelter from the elements. The Bayeux Tapestry depicts horses stalled low down in galleys under sail.[22] The images remind us that there may have been similar accommodation in the Sutton Hoo galley. Flanking gangways would have facilitated the crew movement fore and aft (fig 4a).

Platform fasteners

A horizontal surface underlying the grave furnishings is presumed not to be ship structure.[23] If correct, how was it supported? Rectangular plates, or cleats, with a short nail

21. Phillips 1940, 13; Dimbleby 1975.
22. Wilson 2000, pl 4.
23. 'Platform' rather than 'floor' is used here to avoid confusion. A floor is the bottom member of a frame comprising several components.

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(b)

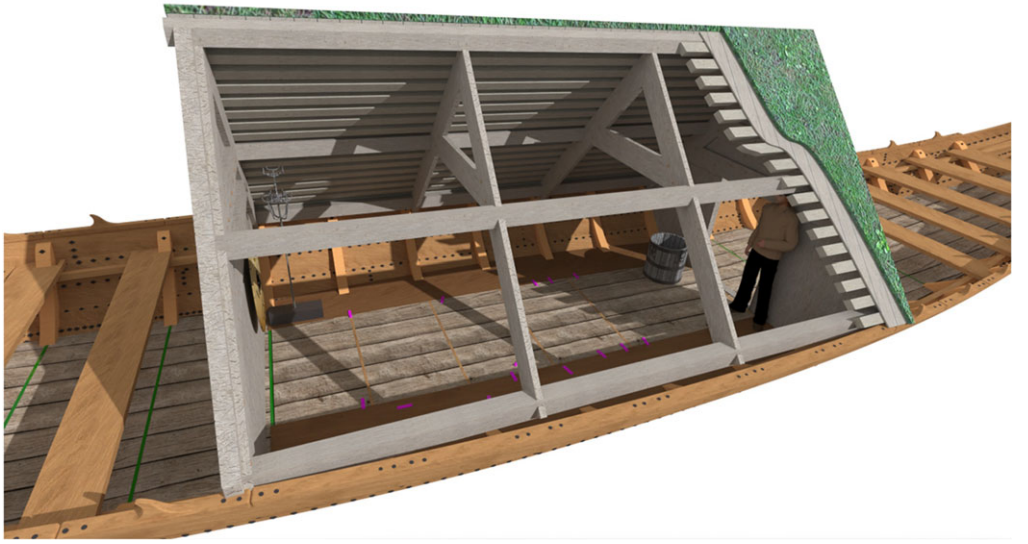

Fig 4. Tentative reconstructions amidships: a) gangways connect decks and accommodate passengers; b) cutaway of the burial chamber with a platform inserted in the open space between the gangways. *Images*: © Pat Tanner.

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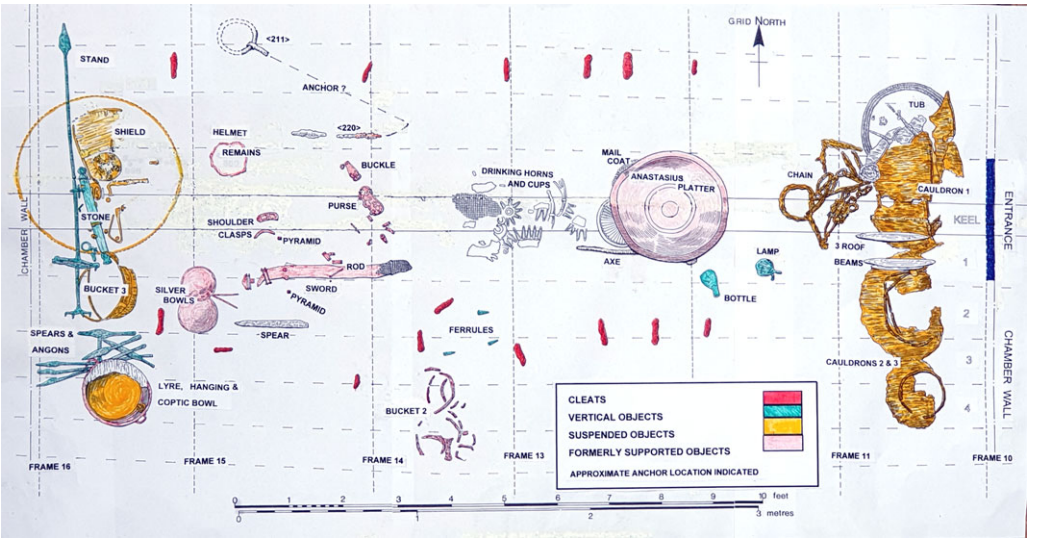

Fig 5. Plan of the burial chamber coloured to show the movement of objects. The strakes and presumed entrance are indicated. *Drawing*: Author's additions to published plans.

at each end were found unevenly disposed 700–800mm distant from the centreline of the keel (fig 4b, 5)[24] In Phillips' view they possibly fastened the platform. Varying numbers of cleats are associated with coffins or beds in Anglo-Saxon and continental cemeteries.[25] Such crude devices are at variance with the standard of contemporary joinery.[26] They are best seen as improvisations by funeral undertakers to strengthen or fasten coffins or reinforce a bed sufficiently to transport a corpse. Cleats have the obvious advantage of not requiring a burial party with carpentry skills.

In the ship the cleats have been interpreted as evidence for a giant coffin, or 'body-bearer'.[27] However, the sixteen located specimens, and a further four with no individual find-spot, resist identification as coffin fittings because all were lying horizontally. Additionally, the evidence of textiles on the upper surfaces of three shows that their nails pointed downwards.[28] Phillips' and Bruce-Mitford's original idea of a platform still stands. However, they were unable to suggest a part of the ship to which it was secured. As no internal structural elements survived, the minimum is suggested here, namely, planks resting on deck-beams (which incidentally would have strengthened the framing) with thwart risers and stringers (longitudinal elements), which would help to resist racking (twisting) in a hull without a backbone (fig 6).[29] On this hypothesis, partial decks, or gang-ways, could provide a function for cleats securing the infilling planks (figs 4b, 6).

24. Bruce-Mitford 1975, fig 363.
25. Blair 2019, 104–12.
26. Evison 1980, 357; Blair and Goodburn 2019.
27. Evison 1980; Carver 2005, fig 92.
28. East 1984.
29. For example, Hedeby I (McKee 1983, 68; Crumlin-Pedersen 1997, fig 4.13). Risers do not resist racking to the same degree.

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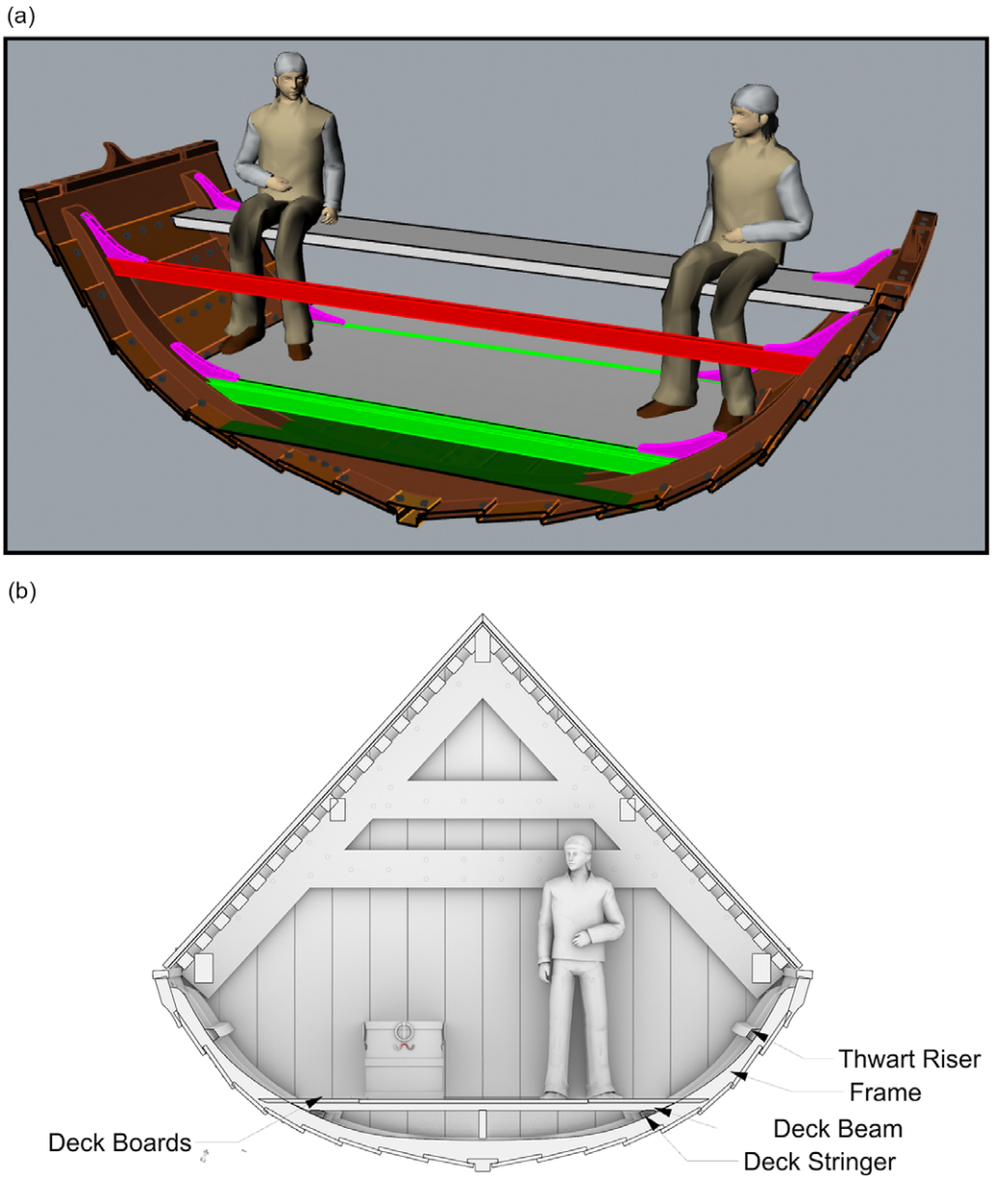

Fig 6. a) the rowing positions of seated oarsmen can be used to determine the height of thwarts and deck, variously supported; b) the deduced deck level is a clue to the height of the burial chamber platform. *Images*: © Pat Tanner.

THE BURIAL CHAMBER

There is evidence that a wooden structure the size of a modern garage was built over frames 10 to 16 (fig 5) with the apex of a pitched roof about 2.95m above the keel. The height of presumed vertical objects precludes a horizontal roof (fig 7). The tiny portion of remaining

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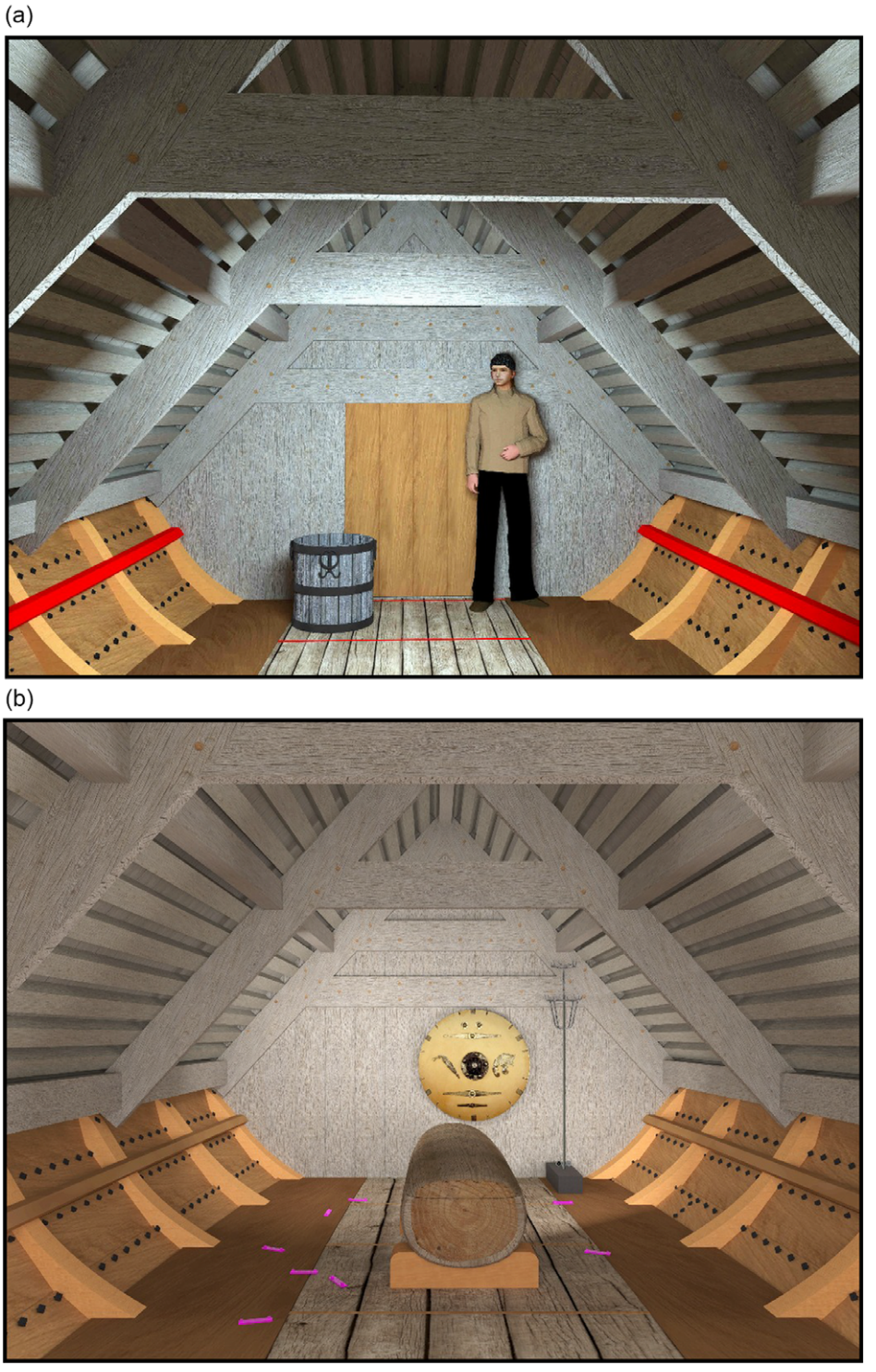

Fig 7. Two views of the reconstructed interior of the burial chamber showing: a) proposed opening in the east wall and thwart supports (red); b) relative positions of cleats (purple). *Images*: © Pat Tanner.

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overburden sectioned by Phillips had traces of a roof that 'came down to the gunwales on each side, resting just inside them'.[30] Roofing was laid in at least two directions and was probably turfed.[31] The gunwales were not badly deformed amidships, so they cannot have borne the weight of the structure. Similarly, the localised pressure of conventional end-posts taking the weight of a ridge would have destroyed the keel-plank in two places. The same objection applies to Carver's choice of Oseberg-style external end-posts, for which he admits evidence is lacking.[32] Rather, sagging lines of the rivets mark localised deformation of the strakes in the vicinity of the chamber walls.

These factors point to a massive roof distributing weight evenly along robust end walls. Unfortunately, in the Sutton Hoo soil the stoutest timbers left only traces and Brown did not section the overburden. Further, he had dug away the east wall when, contrary to instructions, he continued to excavate in the interval before Phillips took over. His diary for 14 June 1939 makes this patent: 'No signs yet of the burial but a large rib or timber where a rib should be has come to light with some long vertical rivets.'[33] The loss of this evidence and the long rivets meant that Phillips was uncertain of the original length of the chamber and the wall construction.[34]

The roof

Brown had also probed the deposit, removing wood traces. Three pieces of oak were left in place (fig 5). They were recorded as 'pegs' by Stuart Piggott. Later termed 'stakes', their function remained opaque. However, <230a–c> are patently neither pegs nor stakes, but eroded portions of substantial oak timbers locally preserved by proximity to the corroded cauldrons. Their elevated position suggests close-set purlins and key evidence for the roof. Fig 7, proposed here, is based on the need for any reconstruction to conform with the recorded evidence. The unsophisticated digital images are intended to indicate the structure, but joints and scantlings are open to debate.

The curvature of the hull precluded conventional corner-posts supporting horizontal beams. A solution proposed is that the beams were morticed into stout transverse walls and a strong roof was created by rebating numerous purlins into them. In other words, along each side a longitudinal beam independent of the gunwale was a possible means of supporting the weight of the roof trusses. Within the chamber the gap created between the straight beams and the curvature of the gunwales is calculated as 150mm at its maximum. To provide a close fit and prevent ingress of sand, a small adjustment of the length of individual roof boards would be sufficient. The structure needed to withstand

30. Phillips 1940, 12. Phillips (Bruce-Mitford 1975, 176), an experienced archaeologist, observed that the eaves rested inside the upper part of the gunwale as in the Oseberg ship; 'the roof of the Gokstad ship similarly did not project over the gunwales' (Sjøvold 1969, 57). Bruce-Mitford, however, disagreed (1975, 178–9).
31. Bruce-Mitford 1975, 172, fig 112 n 27; Carver 2005, 127. Turf or bracken would reduce ingress of sand through small gaps.
32. Carver 2005, 187, fig 89.
33. Bruce-Mitford 1974, 163; Carver 1998, 12.
34. Bruce-Mitford 1975, 485: 'the line drawn by Phillips is taken just far enough west to clear the furthermost piece of bronze. However, rib 10 shows clear textile impressions ... suggesting it may have been inside the chamber.'

the weight of the mound. The closely spaced oak timbers suggested are similar in size to those proposed for the Prittlewell roof, which also had to support a mound.[35]

Based on the evidence of the recorded bulge of the west wall, Carver's commitment to horizontally planked end walls was taken by him to preclude an entrance, 'the continuity of the planking argues against a door in the east or west wall so the chamber would have been furnished before the roof planking was laid in position'.[36] However, battened, or rebated, vertical planks could have created the coherent bulge of the west wall. The disposition of the most important grave goods at this end in any case precluded an opening.

It was different at the east end of the chamber. Brown's diary entry, quoted above, records that forward of frame 10 he found a member parallel to it. Together they may have created a slot in which the stout bottoms of vertical planks lodged. This would avoid the difficulty of direct attachment to the hull. Unfortunately, Phillips had no opportunity to examine and record this area himself. An opening at the east end must remain a possibility.

Disposition of the grave goods

Superb excavation of another royal grave, close both geographically and temporally, has refreshed interpretation of Mound 1.[37] The Prittlewell burial chamber confirms a practice of suspending bowls and other items on the walls, and the provision of boxes and furniture. It prompts renewed scrutiny of the missing evidence at Sutton Hoo.

The tilt is patent in the photographic coverage, measured during the Science Museum survey and recorded in our re-excavation. It was sufficient to impact the grave goods (fig 2b and 5). It caused some objects to slip southwards. Others appear to have slid or toppled from furniture or supports. Examples of tipped items are: the inverted pile of silver bowls and pair of spoons; bucket 2; the gold and garnet rod; the iron stand; the Coptic bowl with the angons gripped by one of its handles; the pottery bottle; and the lamp. This was the first of three movements that can be detected.

Some time later, pressure from the soil filling the ship both fore and aft would explain the inward bulge of the chamber walls. Such lateral movement can be detected in the collapse of items hung, or propped, against the walls. At the west end a nail by which the large hanging bowl had been suspended had become cemented by corrosion products to one of its handles. A bag containing the lyre ended up partly overlying the tilted Coptic bowl. Then the fragile hanging bowl clearly crashed on top of both, as it forced part of the lyre up through its bottom. Along with the tumble of bucket 3, an adjacent group of spears collapsed like spillikins. Evidence that the propped shield was pushed violently into the 'body space' is the deformation of part of its metal rim-binding. The 'whetstone' and iron 'stand', if not previously toppled when the ship tilted, were now dislodged. At the other end the smashed remains of three suspended cauldrons and a chain were to mask a possible entrance.[38]

35. 20–5cm thick: Blair and Goodburn 2019, 320, fig 79.
36. Carver 2005, 183. Note that graves SH2 and SH14 had overlapping vertical timbers on their long sides.
37. Blackmore *et al* 2019.
38. Evidence was found for the suspension of cauldrons 1 and 3 (Evans 1983, 485–7). If not suspended, cauldron 2 may have been the last item positioned in the chamber.

After a lapse of time the catastrophic collapse of the roof impacted the objects. This is evident in the corroded fragments of helmet, the bent shaft of the stand and its broken cage, the fractured Coptic bowl, the misshapen purse frame and the 'wet towel' deformation of the Anastasius platter. The latter's cracked foot was driven deep into a silver bowl crumpled by the impact.

THE BODY SPACE: PUTREFACTION AND DISORDER

Temporary burial during preparations for interment could not significantly retard the rapid decomposition of a corpse. Today funeral operators combine chemical injections with cold storage to spare us the grim reality of which our forebears were only too aware. Forensic websites provide data on the rate of decomposition initiated by stomach acids – within minutes of death. After thirty-six hours the body's enzymes begin a meltdown known as putrefaction. After two or three days, internal bacteria activate autolysis. The most dramatic decay occurs within the first month. Low temperatures slow the impact of blowflies, humidity and oxygen. Body size, clothing and cause of death are factors. Purge fluid drains from the corpse and the body becomes a black green. Tissues begin to break open. If death is from a septic wound, decay is faster.[39]

In ancient Egypt successful preservation necessitated evisceration and desiccation. A 'black goo' external sealant in a dozen British Museum mummy cases has been identified as a combination of plant oil, animal fat, tree resin, beeswax and bitumen poured while warm over the mummy within.[40] Elsewhere, among people who did not practice evisceration and lacked a dry climate, similar measures could be taken to retard decomposition.

In the Anglo-Saxon period Christian authors record incorrupt saintly corpses, but are unforthcoming about methods used. The lack of written and archaeological evidence has resulted in a factor absent from cemetery studies.[41] A recent exception is Lyn Blackmore and Christopher Scull's computation of the person days required to construct the Prittlewell burial chamber with implications for the decomposition of the corpse. During this time it would have bloated, the tongue protruded and the eyes bulged. It seems that gold foil crosses were placed over the eyes and a cloth covered the face. Meticulous excavation and the presence of experts failed to identify embalming substances. Only two fragments of tooth enamel were retrieved from the sieved soil.[42]

At Sutton Hoo, while preparations for interment in the great ship were completed, it is likely that internal and external treatments were applied to the corpse and it was kept cool and fly-free. Temporary burial is a possibility. However, those responsible for the organisation had only two options: the body had to be either cremated or embalmed. Elsewhere in the cemetery delayed interment may be marked by the choice of a cremation or a dugout coffin. The advantage of monoxylous constructions is that they are robust and, importantly, do not leak purge fluid.

39. For instance, https://www.exploreforensics.co.uk the rate of decay in a corpse (accessed 24 April 2023).
40. Fulcher and Taylor 2020.
41. For example, Lucy and Reynolds 2002; Semple and Williams 2007. Exceptionally, two anecdotes show Wulfstan's interest in corpse preservation (Lund 1984).
42. Blackmore *et al* 2019, 305, table 18.

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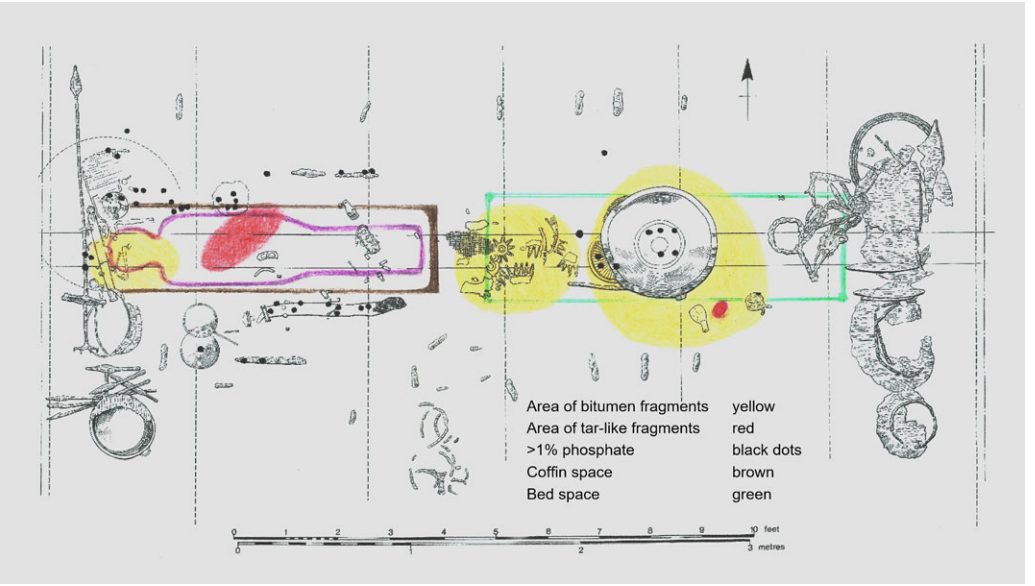

Fig 8. Plan of the burial chamber coloured to show the distribution of residual phosphate, bitumen and 'tar', and proposed positions of a coffin and bed. *Drawing*: © Author, based on Burger *et al* 2016 and Bruce-Mitford 1975.

Any trace of a body beneath Mound 1 eluded the excavators, and Phillips only sieved a small quantity of the chamber soil. For years a cenotaph was suspected.[43] With respect to the possibility of cremation, insufficient forensic evidence survived to identify the burnt bone on the elevated silver platter.[44] However, ferric phosphate readings obtained in the vicinity of the 'body space', including the shield and scabbard, indicated the presence of bone or ivory (fig 8).[45] In the re-excavation we carried out an extensive programme of soil sampling within, outside, and below the burial chamber, but failed to find evidence of other burials or sacrifices.

EVIDENCE OF EMBALMING: WAS A MUMMY BURIED IN THE SHIP?

Cloth tapes

A profusion of textiles furnished the chamber, covering and underlying items. It is an effort to imagine that the replaced fibres represent sumptuous fabrics cushioning the inorganic objects lying in improbable positions. In addition to large coverings and cloaks, an

43. Bruce-Mitford 1975, 684.
44. Barker *et al* 1975, 550–64; Vierck 1980b. Mrs Pretty independently commissioned analysis of fragments retrieved by her chauffeur on 29 July, 'it appeared that an embalmed body had been crushed flat within the deposit' (Markham 2002, 46). Phillips makes no mention of this extraordinary intervention, which happened 'after hours' (Bruce-Mitford 1975, 742).
45. The sword scabbard was cleaned at an early stage, but ferric phosphate was identified in 1971 (Bruce-Mitford 1975, fig 402).

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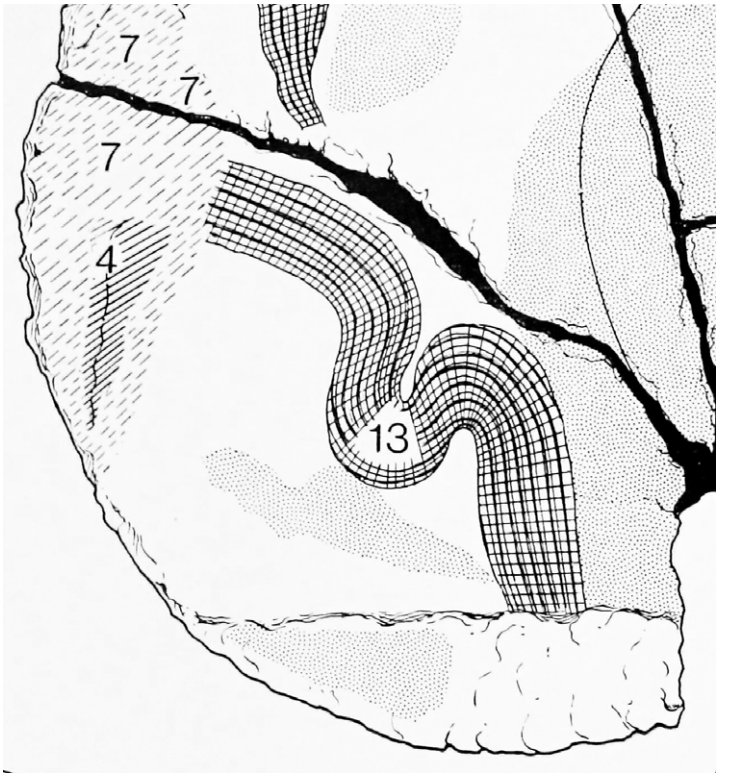

Fig 9. Tape <13>. Impression of parallel lengths preserved on the corroded mail coat. *Drawing*: Eric Eden © Trustees of the British Museum.

extraordinary quantity of linen tape was found. Its occurrence as a functional binding of the sword scabbard is expected, as are wool tape fastenings for shoes and clothing. However, beneath the sword lay a box containing more than 16m of unused tape in two separate coils, 'two tightly-wound rolls of tape, replaced by iron oxide, apparently the same very fine tape used to bind the scabbard'.[46]

In contrast to the unused coils, apparently used tape was mineralised by proximity to the rusted mail coat where two types occurred.[47] There was estimated to have been as much as 10m of tape <13> (fig 9). It had no obvious function and appeared to be parallel or folded lengths. The same tape was recorded elsewhere with the comment, 'appearances suggest a spare supply for various purposes'.

Elizabeth Crowfoot provided a clue when she opined that the group of tiny walnut cups <128–34> may have had a medicinal purpose.[48] Pathology has made large strides in identifying evidence of disease in human remains, but the use of medicinal potions remains speculative. It can safely be assumed that, if death did not occur instantaneously, treatments thought appropriate would have been applied to the patient. For instance, wortcunning lore included a poultice of vinegar stewed with honey and meal bound on

46. Ibid, 465.
47. Significantly, bitumen fragments were identified in the vicinity (Burger *et al* 2016, fig 2).
48. Bruce-Mitford 1983, 374.

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a 'swarthened and deadened body' which was first scarified.[49] Conceivably, the coils of tape in the chamber had been supplied for the application of salves contained in the little cups. Against this theory, the quantity found is excessive for such a purpose.

Bitumen

No trace of tar within the lands (overlaps) of the planking was identified and no evidence of surface tarring survived.[50] In the spoil from the 1939 excavation, a single nodule was identified as 'pitch'. Amidships, the situation was different. Scattered in the chamber were found small deposits of a black substance originally described as Stockholm tar (fig 8).[51] Recorded findspots <212, 249–56> were in the area of the putative coffin. As evidence of 'black goo' derived from efforts to embalm the corpse, they were significant but inconclusive. However, recent re-identification of <252–5> as fifty-three fragments of bitumen of Middle Eastern origin strengthens support for mummification practices.[52] As the authors of the report concluded: 'The interpretation of the tarry lumps in the burial chamber as a mariner's repair kit must now be rejected.'

There is evidence in northern Europe that within Rædwald's lifetime the Merovingian elite practised embalming. The processes were unsophisticated, with oral injections including benzoic acid. They were 'essentially based on the use of oil and resin-soaked linen strips used with aromatic plants such as thyme, nettles, myrrh and aloes'.[53] Embalming knowledge may be assumed to have been widely shared in court circles, with trade or gift exchange of exotic substances such as frankincense, myrrh and bitumen via the Byzantine Empire.

The coffin in the body space

A ridge of amorphous wood grain overlying the keel in the 'body space' may be the remains of a coffin.[54] A large monoxylous coffin has previously been reconstructed by Carver and others in efforts to explain the two rows of cleats.[55] However, a smaller dugout coffin is here proposed, because the presence of tape, bitumen and 'tar' constitutes support for prior embalming in a close-fitting container. Sweet-smelling herbs would have been placed in it. The body is likely to have been given oral injections. Bandages impregnated with preservative substances, wood tar and bituminous 'goo' may survive as scattered impressions.

Coffins in this period are variously sized, presumably reflecting to an extent the stature of the deceased and the number of possessions to be placed within. Phillips' notion that the regalia were somehow suspended over the body space was never convincing. As soon as Carver envisaged a huge coffin, they could be arranged on its lid. In a further scenario,

49. Cockayne 1864, 185, 25.
50. Bruce-Mitford 1975, 351.
51. Ibid, 373.
52. Burger *et al* 2016.
53. Bianucci *et al* 2016.
54. Bruce-Mitford 1975, figs 114 and 115.
55. Evison 1980; Carver 2005, 92–4, fig 92.

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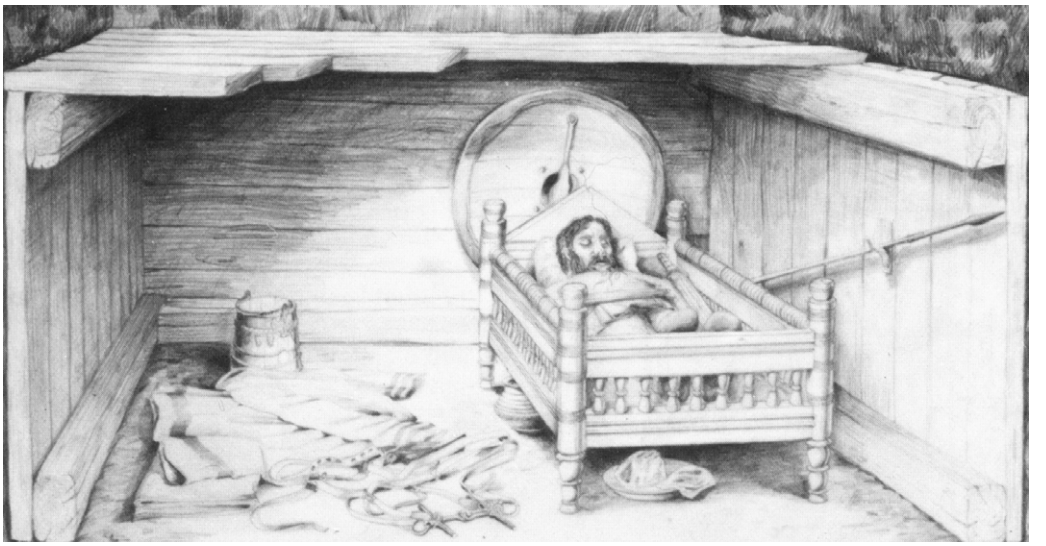

Fig 10. Basel-Bernerring grave 33. Reconstruction of the bed.
Drawing: After Moosbugger-Leu 1982.

the violent collapse of the roof smashed the lid, the regalia fell in disorder and the frame of the gold purse was deformed in the crash.

Nevertheless, with a big coffin a difficulty remained. Why were numerous objects put inside, while the most precious and personal ones were placed outside it? On the other hand, if a compact coffin and an unsuccessful embalming process are assumed, the need to arrange the regalia on the lid rather than on the decomposing body becomes explicable.

Regarding stature, the occupant was not a beefy six-footer. A shoe size 40 was identified among his belongings, and his Scandinavian-style shield was on the small side.[56] Carver characterised the Mound 1 hero as small and stocky.[57] His height is unlikely to have exceeded 1.75m. I have indicated the coffin in the space occupied by the collapsed shield and the regalia (fig 8).

We can visualise the king's magnificent shield suspended at its head before the wall bulged. Flanking it were two other accoutrements of a great warrior, namely, a sword and a helmet. It was seemly for both to rest on top of organic materials rather than lie on the floor. Underlying the sword there is evidence of a box, but the helmet was so fragmented that only a trace of replaced textile survived. One of the pyramids belonging to the sword was found in the space occupied by the putative coffin. This may be an incidental result of the collapse, or slight support for a coffin of rounded dugout form with the pyramid lying beneath it (fig 10). Interestingly, the tree-trunk coffin in Trossingen grave 66 rested on two transverse supports raising it above the bottom of the grave.[58]

56. Bruce-Mitford 1978, 94, table 2; East 1983.
57. Carver 2005, 125.
58. Theune-Grosskopf 2018, abb 15. Such supports have been used in the digital reconstructions.

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THE DAY OF THE FUNERAL

Built on any set of hypotheses about the amount of advance planning, a new possible sequence for the final preparations can be proposed. People may have been gathering for the obsequies while the ship was being installed in the 3m-deep trench and the chamber built. It was then ready to receive the body and the chosen or gifted furnishings (fig 2a). We can expect that a ceremony or procession formed a component of the funeral. Fording the wide tidal Deben from a royal manor on its west bank would have been tricky. Mourners encumbered with the coffin and offerings more probably proceeded from a convenient hall on the east bank and walked slowly along its sandy tracks. The *palatium* (palace) at Rendlesham is 6km distant upstream.[59] Wherever their point of departure, on arrival they would have perceived the roof of the finished chamber butting against the gunwale some 1.65m below their feet, while the flooring constructed for the treasure lay as much as 2.5m below.[60] However, both fore and aft, the rowing decks were visible curving upwards and approaching ground level at prow and stern. With thwarts temporarily removed, the rising foredeck could have provided a convenient position for a burial party waiting to receive the objects. The hypothesis presented here is that, from a point in the bow, the assemblage was simply carried into the chamber via a temporary opening in its east wall. Did such an opening exist?

The means of access to the Sutton Hoo burial chamber has always been problematic and, in the absence of an obvious position, it has always been assumed that it was via an unfinished roof.[61] For this to be excluded, a temporary entrance elsewhere has to be proposed.[62] The suggested position is indicated on figs 2a, 4b, 5 and 7. Access through an opening in the east wall would enable even the weighty coffin to be manhandled safely.[63] Inside the chamber a planned layout can be deduced. Against the far wall were clustered the most prestigious objects, with pegs and nails by which some were secured or suspended (fig 5). At the same 'important' end there were also spaces assigned for the upright iron stand, spears and angons. The middle of the chamber seems to have been reserved for the warrior, appropriately flanked by his weapons and helmet. Assuming access from the east, the last items positioned were practical food containers suspended on the wall or placed to one side.

The plan goes awry

If, as proposed here, the substantial roof was already completed by this time, the next part of the proceedings would not be visible to mourners ranged alongside. It could be hypothesised that the original intention of the burial party was to use the privacy the chamber

59. Described thus in an incident in Rædwald's reign (Bede 1992, I, 12).
60. Carver 2005 has misleading reconstructions. His fig 93 shows the gunwale at ground level, while fig 92 has twelve strakes rather than nine and even depicts flush, rather than overlapped, garboards.
61. Cauldrons 1 and 3 were presumably the last items to be hung on the wall. It could not be determined that cauldron 2 had also been suspended (Evans 1983).
62. In contrast with the large, unencumbered space in the middle of the Prittlewell chamber floor (Blackmore *et al* 2019, 308, fig 265).
63. The Prittlewell ash coffin and corpse are calculated to have weighed as much as 235kg (Ibid, 321).

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afforded to take the body out of its temporary coffin and remove the bandages and 'black goo' crust in order to wash and dress him, as was the custom.[64] In this case, the original plan was possibly to transfer the clothed body, complete with cuirass and regalia, to a bed positioned ready to receive it. It is presumed that traces of removed and discarded strips of congealed bandages were locally preserved beneath the chain mail (fig 9).

On this hypothesis, a stench, and the prospect of clothing a bloated body will have confronted them. Any bucket of washing water would be redundant.[65] In such a predicament, the decision might be to reseal the unclothed corpse in its temporary coffin. If so, the king's regalia and rod needed to be arranged on the lid, together with the shoulder-clasps. These we may imagine were hastily unclipped from the leather cuirass the dead man was no longer in a condition to wear.[66]

Careful organisation, evident in the items arranged along the end walls, contrasts with disorder in the middle of the chamber. It speaks of a change of plan. In my scenario there remained sufficient room to retain the coffin by placing the bed east of its intended position. On it were dumped his silverware, clothes, shoes, wash bowls, combs, knives, tiny cups and bedding. In this scenario, the difficulty was that the bed now moved into the space – probably intended for a table or a chest – on which his drinking-horns, cups and silver could be placed.[67] Instead we have an untidy heap of objects of all kinds.

Evidence for a bed

The reconstruction choice of a bed, as opposed to a bier, best explains the way the objects came to rest in the central area. The author first researched the idea in the 1960s and Carver has also envisaged a railed construction, like that in Oberflacht grave 37, as a way of stabilising the heap beneath the weighty Anastasius platter.[68] A wooden body-bearer on which the pile could be separated into three layers makes sense of their disposition. As no iron fittings were found, a rebated and dowelled construction, with raised sides resembling a baby's cot, is supposed.

Contemporary beds of this design have been found in well-preserved Alamannic male graves. Dimensions are a guide to what may be postulated in the body space. Reconstruction of Basel-Bernerring grave 33 shows that beds of this type existed in this period.[69] It demonstrates that the axe and chain mail could lie under a bed, with the hanging bowls, silver dish, clothing and other items on the bedding (fig 10). Overall, the silver platter could be supported by laths laid across the bed rails.[70]

64. Clothed burial is a defining feature of inhumation practice in 5th–7th century AD England (Ibid, 305).
65. Bucket 3 <119> is of yew wood and is in an anomalous position among the important objects. Yew (*taxus baccata*) is poisonous and contaminates liquids (Kite *et al* 2013). Its position near the 'body space' and capacity of 25 litres suggest that it held water for washing. I have found that it stains water red. Conceivably, yew was selected for that very reason.
66. The relationship of the clasps to each other was puzzling and indicated that they were not attached to a garment at the time of burial (Bruce-Mitford 1975, 541).
67. The Prittlewell chamber contained a coffin, chest, chair and shelf (Blackmore *et al* 2019, fig 265).
68. An elegant table was found in Trossingen grave 58 (Theune-Grosskopf 2018, abb 10) and should be considered here.
69. Martin 1976.
70. Moosbugger-Leu 1982, abb 34, shows this construction.

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Table 1. Weight of iron fastenings in Sutton Hoo ship 1, calculated by Pat Tanner.

Sutton Hoo
Orca3D Weight and Cost Report
3D Scanning Ireland
Report Time: 23 September 2018, 12:20:25
Model Name: F:\Dropbox\3D Scanning\Sutton Hoo\Sutton Hoo_V5.3dm

Weight Items

Object Name	Material	Weight (kgf)	LCG (m)	TCG (m)	VCG (m)	Weight Basis
Layer: 12 Keel Scarph Rivets						
SubTotal		2.030	-9.013	0.000	-0.004	
Layer: 3598 Rivets						
SubTotal		728.342	-9.030	0.000	0.270	
Layer: 64 Gunwale Spikes						
SubTotal		63.696	-8.978	0.000	0.827	
Layer: 58 Frame Bolts						
SubTotal		18.368	-10.373	-0.057	0.923	
Totals		812.436	-9.057	-0.001	0.328	

* Values with an asterisk are assigned directly and not computed from the corresponding material and geometry.
** These items are associated with Rhino block instances. See "Block Item Details" section for breakdown of these weight items.

THE SIGNIFICANCE OF THE BURIED SHIP

The quantity of gold is paralleled by the amount of iron buried at Sutton Hoo. Both metals had to be sourced outside the kingdom. Their respective values have been assessed.[71] The gold was derived from Byzantine and continental coinage. However, the source of more than 1.5 tonnes of iron used to fasten the two ships is still unknown (Table 1).[72] In the absence of substantial ore deposits, production and working in East Anglia appears to have been on a small scale.[73] The weight of iron rivets and artefacts speaks of wealth created by accessing outside sources and adding value by means of exceptional technology. The display of two enormous vessels surrendered for burial was surely a symbol of maritime power. The message may have been underscored by including with one assemblage two posited ship's fittings: a possible anchor and an iron stand here re-instated as an elevated lighting device.

Evidence for an anchor

The Science Museum team found <211> too late in 1939 for it to be planned by Piggott, while <220> was only excavated in 1967.[74] Consequently, the fragments have been overlooked in recent reviews of early anchors in northern Europe.[75]

71. Schoenfeld and Schulman 1992.
72. To this should be added the quantity of iron used for the weapons, mail coat, cresset, chain and lamp and the fittings for cauldrons and tubs in Mound 1.
73. Evidence of small-scale production in Essex also makes significant the total of around 40kg of iron in the Prittlewell burial (Starley 2019, 418).
74. Bruce-Mitford 1975, 453 and fig 199.
75. See Clagget 2017; Fleming 2020.

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Fig 5 indicates the planned position of <220> and described position of <211>. They may once have formed part of an anchor lying in the apparently emptier northern part of the chamber with space for organic materials, such as coils of rope. Part of an iron ring, <211> lay between frames 13 and 14. It was of 15mm section and approximately 200mm in diameter. A hoop of the same thickness with flattened ends was connected. The length overall was about 120mm, but the tips were broken and showed signs of flaring. It was very badly corroded, but Bruce-Mitford speculated that it represented the top of a heavy wooden anchor, 'iron fittings from the fluke or stock could well have been unrecognized amongst the mass of fragmentary pieces of iron excavated in 1939'.[76]

The anchor idea was strengthened by subsequent study of <220>, a mineralised piece of ash wood with an iron tip about 305mm long. It lay approximately one metre south of the recorded position of <211>. The initial identification as the ferrule of an over-large spear was rejected in favour of a possible fluke from the same object. If so, the gauge of iron used for the ring and its approximate distance from it may be evidence of an anchor of ash occupying the space.

Although the Bayeux Tapestry dates to the end of the period, anchors carried by the English ships are instructive.[77] In addition to those of recognisably Viking type, and light enough for one man to hump to the foreshore, a more massive anchor is propped on the gunwale of the first ship (fig 11). The needlework here is well-preserved. The shaft has twice the thickness of the others, while other details differ.

All-iron anchors were very costly in the amount of metal required. Killicks and other forms utilising wood must have been common, but have not been found. A composite wooden anchor was found in the Oseberg burial, but[78] the tentative identification of a composite wooden anchor in an Anglo-Saxon ship is of unusual interest, and must await corroborative archaeological evidence.

<161> iron stand/flambeau/form of cresset

When it was revealed in 1939, Phillips interpreted the iron stand as a flambeau. That identification was accepted until it was (erroneously) surmounted with a delicate confection of iron wire and a copper alloy stag. Thereafter any function involving intense heat was precluded. For Bruce-Mitford, prompted by Bede's account of Edwin of Northumbria's royal progress, the object was no longer a lighting device, rather a ceremonial *tuuf* or standard.[79]

In the 1960s the author's study of the stand resulted in a new reconstruction of the cage element and removal of the stag assembly for which there was no apparent means of attachment (fig 12a). Laboratory tests confirmed that it had not originally fitted there. Despite this, identification as a *tuuf* had become entrenched and alternative uses were given less weight in the definitive publication. It was assumed that the stand was carried in processions with the tip supported in a holster, or was stuck in the ground. This was patently problematic because:

76. Bruce-Mitford 1983, 912–13. Note: Bruce-Mitford 1975, 452 <111> is a typo for <211>.
77. Wilson 2000, 5.
78. Sjøvold 1969, 32.
79. Bruce-Mitford, 1975, 689–90.

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Fig 11. Composite anchor resting on the gunwale of an English ship. *Image*: Official Bayeux Tapestry digital representation, City of Bayeux, DRAC Normandie, University of Caen Normandie, CNRS, ENSICAEN.

- a lighter organic material for a shaft, and a nobler metal, befits a royal standard;
- the design incorporating a domestic griddle is singularly inappropriate;
- the point of a replica pushed into the ground proved inadequate to support the top-heavy weight.

In 1988 the author returned to the original identification by Phillips. A replica was mortised in an oak block based on the dimensions of an oak beam <231> found near it in the burial chamber.[80] Its weight served to wedge the point tightly. A rope coated with Stockholm tar was wound around the upper shaft and secured with fine wire above the grille. The clear flames lighting a dark night were, as expected, dramatic (fig 12b). The anticipated risk of burning from falling fragments did not materialise. Trials showed that it could be moved in a strong wind without becoming a fire hazard. The all-iron construction made sense in that no part was combustible.

Medieval contexts for lights relate to beacons and signalling. Flame at night and smoke by day was used to indicate a land-fall, or warn of invasion. If the flambeau identification is reinstated, when was the object used? A military purpose was recently proposed by Noel

80. Ibid, 507.

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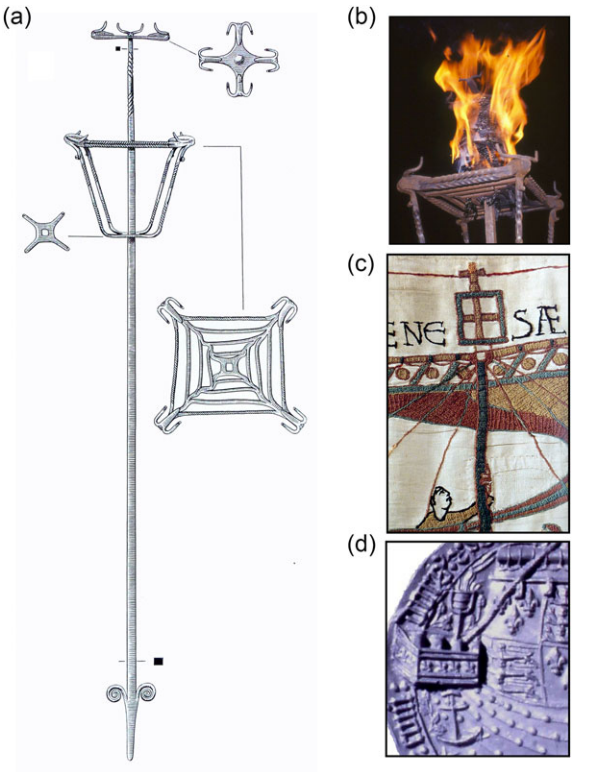

Fig 12. Possible ships' 'cressets': a) the Sutton Hoo 'stand' as restored and b) replicated and fired; c) unlit at the mast head of Duke William's flagship (Bayeux Tapestry); d) flaming on the forecastle of a Plantagenet flagship. Detail of seal impression. *Original drawing*: a) Author. *Photographs*: b) and d) © Author. *Image*: c) Official Bayeux Tapestry digital representation, City of Bayeux, DRAC Normandie, University of Caen Normandie, CNRS, ENSICAEN.

Adams.[81] It is a small step farther to argue for naval use. Throughout history there has been a need for a fleet to maintain contact by day and night in all weathers. Pennants, signal flags, smoke by day and light by night, were employed. The Bayeux Tapestry depicts Duke William's invasion. It is daylight and pennants are being flown (fig 12c). One mast head has a fitting described by David Wilson as an elaborate frame topped by a cross.[82] In the absence of an alternative identification, it seems likely to represent an unlit 'cresset' of Sutton Hoo type. Cressets, as we know them, antedated enclosed lanterns. Richard of Gloucester's seal shows that naked flames could issue from a cresset in the bow of a flagship as late as the fifteenth century (fig 12d).[83]

The context in which the iron stand was found, namely, the largest known vessel of this period, enables it to be assumed with confidence to reflect the status of the man commemorated. A naval cresset would identify a 'flagship' and the burial of its commander. For

81. Adams 2019.
82. Wilson 2000, 186.
83. Burch 1887, no. 1050 Richard Plantagenet [later Richard III], 3rd Duke of Gloucester, Admiral of England.

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Phillips, the royal character of the things deposited in it suggested that it was a state barge and contemporary with ships of a different type built for ordinary use.[84] The Deben and rivers of East Anglia were the highways of the ruling power. Control over them could regulate access to the hinterland.[85] In addition to its practical use at sea, a cresset would signal imperium closer to home. If so, it was an appropriate symbol of overlordship to place in the ship of the man commemorated.

SYMBOLS OF POWER AND BELIEF

A few scholars remain hesitant in the absence of a personal ring to associate a specific person with Mound 1.[86] However, the cumulative evidence of wealth, rank and regalia is incontrovertible. Can the greatest assemblage of riches placed in an enormous ship, together with a profusion of emblems of power and status, be ascribed to anyone other than a king in commemoration of an exceptional reign? As Steven Plunkett observed, Rædwald, despite Bede's disapproval, emerges as a towering figure transforming the English political scene. He continues to be the most likely person commemorated.[87]

Clues to the identification, sources and choice of emblems buried in the ship warrant further analysis and are discussed in a forthcoming article.

CONCLUSION

Evidence for a closely tailored ship trench, tilted ship and mechanisms of collapse are elucidated in the light of personal participation in the re-excavation of Mound 1. A new unpublished digital reconstruction of the ship with twenty-eight oars and an open space amidships provides a basis for discussion. No remains of the ship's internal structure survived, so this article aims to initiate debate by positing missing elements. Rowing geometry is used to calculate the level of a deck on which oarsmen rested their feet. This level is deduced to equate with the platform on which the burial deposit was laid out amidships.

The new reconstruction of the chamber was developed to conform with the comparative lack of damage to the ship structure. It combines the possible identification of three purlins with an overlooked record. To furnish the chamber and manhandle heavy and bulky items, access via the roof is ruled out. A hitherto unsuspected position for a temporary opening in the east wall seems more likely.

The ship is the focus of this article. If fragments found on the south side of the chamber amidships derived from a composite anchor, it is unique evidence for this period. A second object was originally identified as a lighting device and that identification is revisited. A possible unlit device of Sutton Hoo type is identified at a mast head in the Norman invading fleet on the Bayeux Tapestry. A replica of the 'stand' was found to function as a cresset when coils of tarred rope were ignited. Carried on a leading vessel, a raised light

84. Phillips 1940, 24.
85. Signalling points forming networks of communication in the later Anglo-Saxon period are the subject of research (Baker and Brookes 2017).
86. A stray find near Saffron Walden, Essex, of a massive gold Anglo-Saxon ring with syncretic imagery bears no name (Blackmore *et al* 2019, fig 269).
87. Carver 1992, 348; Werner 1992, 1; Plunkett 2005, 70.

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and flags traditionally enabled ships to keep company by night or day. Whether or not this 'cresset' was carried on board, the extraordinary quantity of iron used in the construction of the ships below Mounds 1 and 2, and surrendered for burial, shows that both had the status of capital ships. From the full-size vessel being created in Woodbridge, we can anticipate increased understanding of the structure and performance of these precursors of Viking longships.

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