

THE DUNAVERNEY AND LITTLE THETFORD FLESH-HOOKS: HISTORY, TECHNOLOGY AND THEIR POSITION WITHIN THE LATER BRONZE AGE ATLANTIC ZONE FEASTING COMPLEX

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Discovered in County Antrim and Cambridgeshire respectively, the Dunaverney and Little Thetford flesh-hooks are two of only thirty-six currently known examples from the Bronze Age of the Atlantic seaboard of Europe. Both are impressive and enigmatic objects and are among the most elaborate of later-series flesh-hooks dating to c 1100–800 BC. Not surprisingly, from the time it was found in 1829, Dunaverney was the subject of much antiquarian interest. Yet, despite their rarity and unusualness, the Dunaverney and Little Thetford flesh-hooks have never been adequately studied.

Our investigations have provided an understanding of the technology of these two flesh-hooks, as well as new chronological information for the type as a whole. They have also revealed new uses of lost-wax casting in the British Isles, where the use of this technique is otherwise rare. The bird motifs on the Dunaverney flesh-hook remain unique, although it is now possible to set them against a broader background of iconographic representations on Atlantic feasting gear. Moreover, certain recurring design features may suggest that iconographic symbols were originally more often present on flesh-hooks. The findspot of Dunaverney lies at the heart of deposits of other contemporary prestige metalwork and that of Little Thetford within the greatest concentration of finds of the innovative Wilburton-stage metalworking tradition; both re-enforce the social significance of these rare objects.

Hook-pronged implements occur widely in Bronze Age and Iron Age cultures from the Caspian Sea to the Atlantic, but they are never more than sparsely represented. The forms they take vary both geographically and temporally and different types were sometimes coexistent within a given culture-zone. In the case of the Atlantic Bronze Age examples, the weight of evidence suggests they were used to extract food from sheet-bronze cauldrons, or possibly buckets, as part of a feasting ritual. The defining characteristics of such flesh-hooks are that they have one, two or exceptionally three prongs that are triangular, square or diamond-shaped in section. They can be single or multi-component depending in part on the material from which the shaft was made: most were made of wood which rarely survives; a few were of bronze and thus integral to

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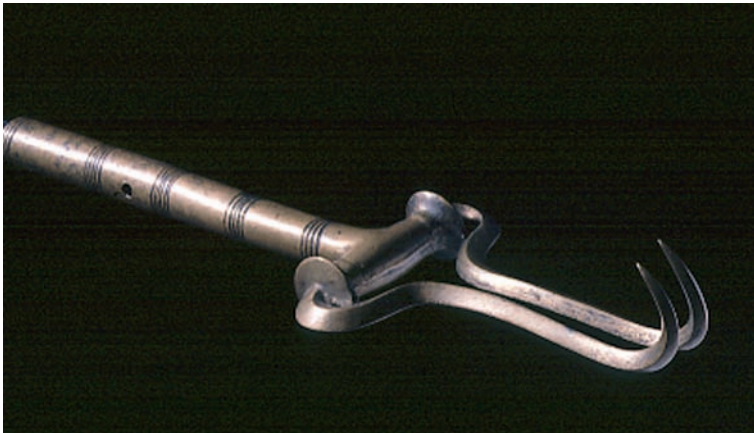
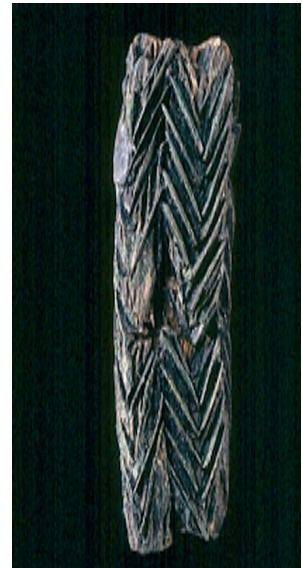


Fig 1. The Dunaverney flesh-hook, comprising three metal ferrules and a surviving fragment of oak shaft inlaid with strips of bronze (British Museum registration number: 1856, 12-22 1). *Photograph:* © the Trustees of the British Museum.

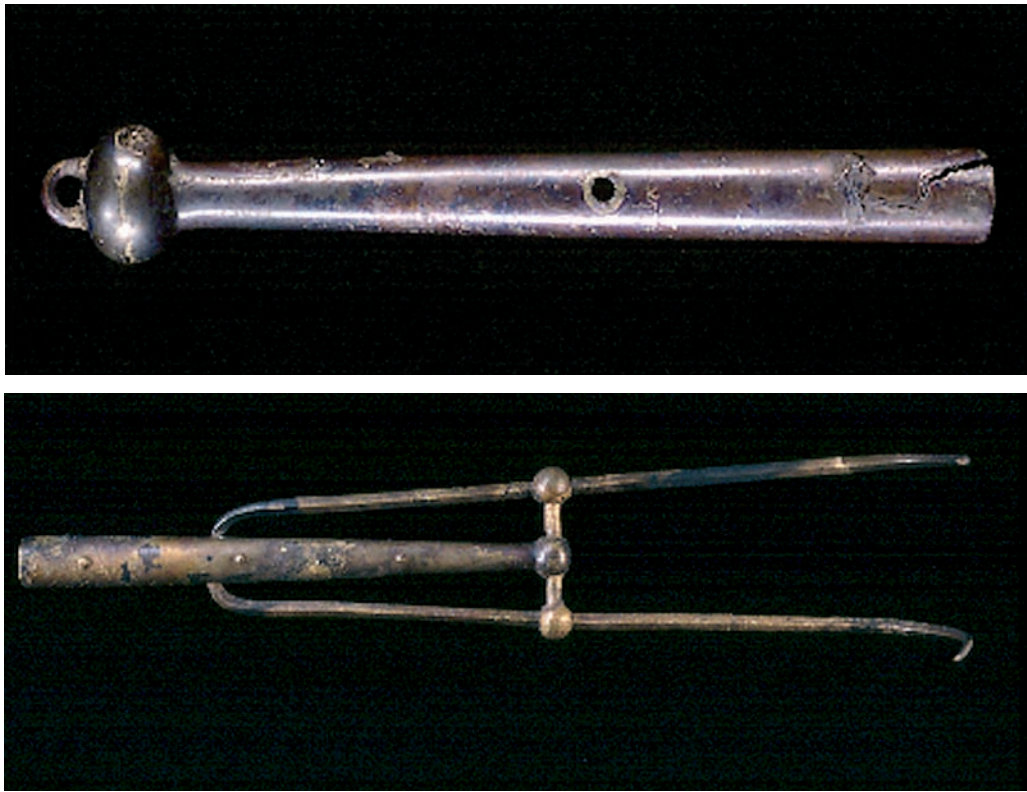


Fig 2. The Little Thetford flesh-hook, comprising two metal ferrules: butt- and hook-end (British Museum registration number: 1929, 4-15 1). *Photograph:* © the Trustees of the British Museum.

the object along with the hook-end and the butt-end. Occasionally wooden-hafted flesh-hooks also have an intermediate bronze ferrule, each connected to the next component by an unknown length of wooden shaft. To add to this variety, some flesh-hooks have decorative elements such as hanging rings, twisted metal shafts or even zoomorphic imagery.¹

Not surprisingly these impressive and diverse examples peculiar to the Atlantic world have been the subject of interest over many years.² However, there has been little by way of overview of the distinctive Atlantic series as a whole and relatively few technological studies of individual implements, even of some of the most impressive examples such as the two examples in the collections of the British Museum (figs 1 and 2). That neither had previously been researched in any detail is all the more surprising in the case of the Dunaverney example, given the unparalleled degree of zoomorphism displayed and the unique decoration on the wooden shaft, a small section of which survives.

Atlantic flesh-hooks occur in Britain, Ireland, western France and Iberia and have a long currency from about 1300 to 800 BC. At their simplest, they are double-pronged, made from a single bent bar and attached to a wooden shaft using an organic binding (Class 1: fig 3), or single-pronged with a socket to receive the shaft (Class 2: fig 4a). Classes 1 and 2 are the earliest – starting around the thirteenth century BC – but are not

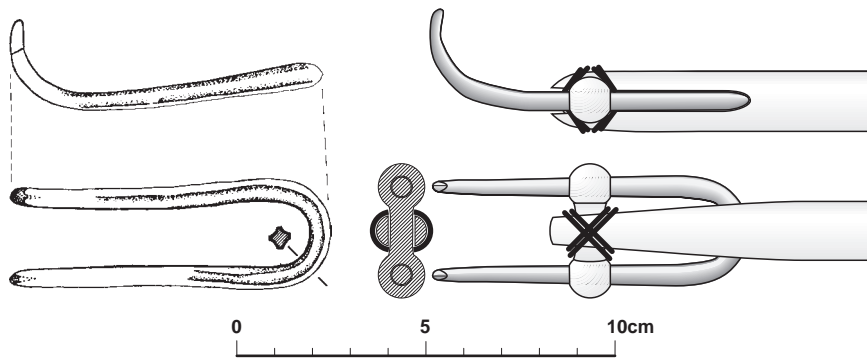


Fig 3. An example of a Class 1 flesh-hook: Bishopsland hoard, Co Kildare, Ireland (after Eogan 1983), and suggested reconstruction of its hafting. *Illustration: Stephen Crummy.*

necessarily restricted to this early date; flesh-hooks also appear in central Europe and in Sicily at about the same date. The more elaborate flesh-hooks, Classes 3 and 4 (figs 1, 2 and 4b), are distinguished from one another by having wooden and metal shafts respectively. They are all double-pronged, except for one triple-pronged example (from Baiões, Portugal). Class 5 comprises individual hooked prongs with rivet holes; no intact flesh-hooks with riveted prongs have been found, so we do not know whether such implements were originally single- or multi-pronged.

After careful scrutiny of fragmentary and incomplete objects that might be flesh-hooks, we have been able to list and classify only thirty-six finds from Atlantic Europe and a further five stylistically related examples from Sicily.³ Several of these, including the Sicilian examples, are objects not previously recognized as being flesh-hooks or parts thereof; other examples will undoubtedly emerge.

Dunaverney and Little Thetford are both Class 3 flesh-hooks. While some similarities in style can be found among the elaborate flesh-hooks – for example, the bobbin-like head from which the prongs emerge seen on several flesh-hooks including Dunaverney (see fig 1) – there is considerable individuality. In general terms, the more complex and elaborate flesh-hooks of Classes 3 and 4 can be seen as evolving from the simpler forms as early as *c* 1100 BC.⁴

EARLY DOCUMENTATION

The Dunaverney flesh-hook

The Dunaverney flesh-hook was found in the course of peat cutting at the Dunaverney Bog (fig 5) to the north of Ballymoney, County Antrim, in 1829. The earliest published account of its discovery appears in the *Dublin Penny Journal* of 6 April 1833 (fig 6).⁵ The author, given only as ‘P.’, is later identified as Dr Petrie.⁶ In response to his entreaty for a possible function for the object, a very brief letter to the editor appeared in the *Dublin Penny Journal* of 22 June 1833 where the author, one ‘T.A.’, suggested that it might have

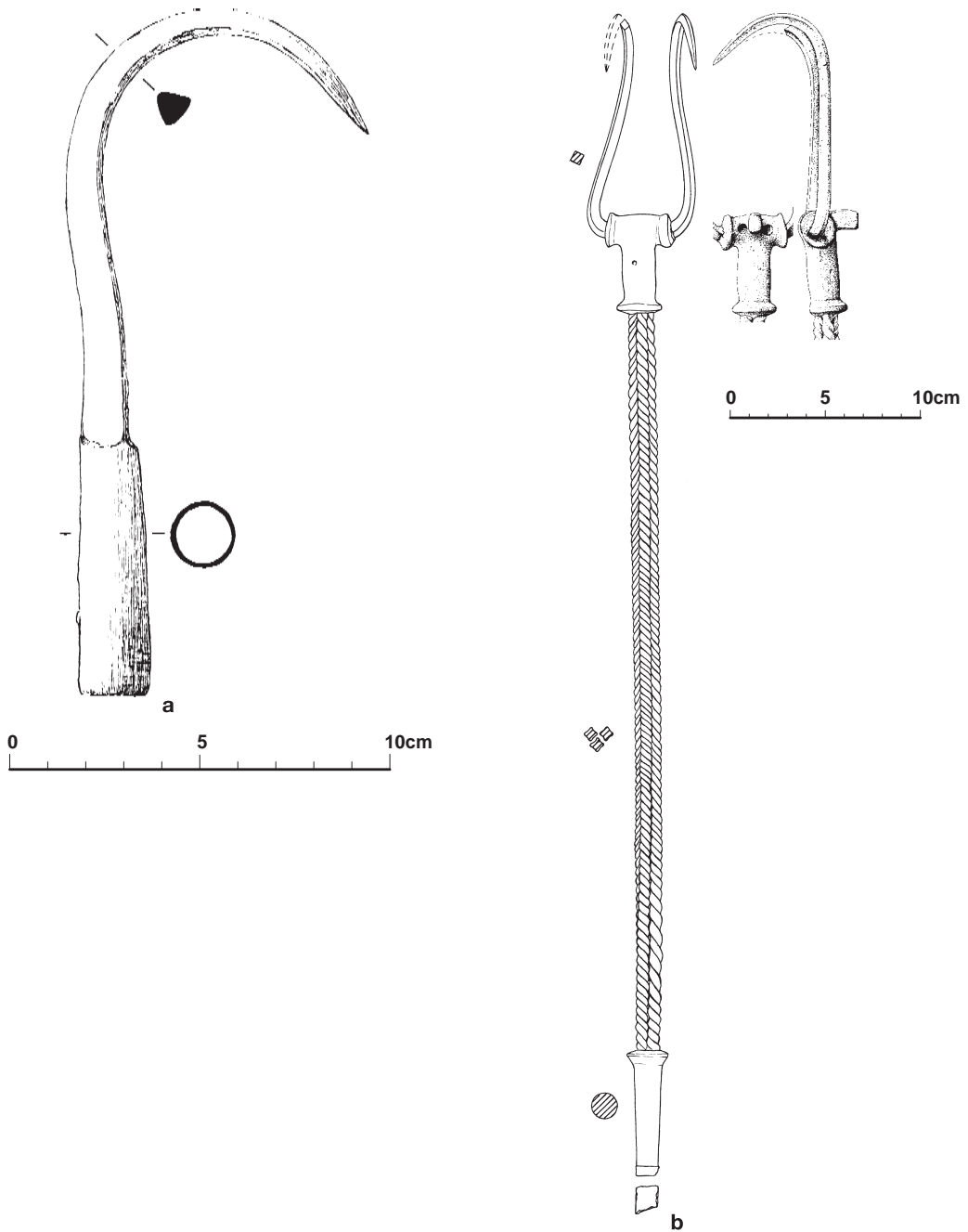


Fig 4. Examples of (a) a Class 2 flesh-hook: Feltwell hoard, Norfolk, England (after Norfolk Museums Service 1977, cat. no. 87); and (b) a Class 4 flesh-hook: Cantabrana, Burgos, Spain (after Delibes de Castro *et al* 1999).

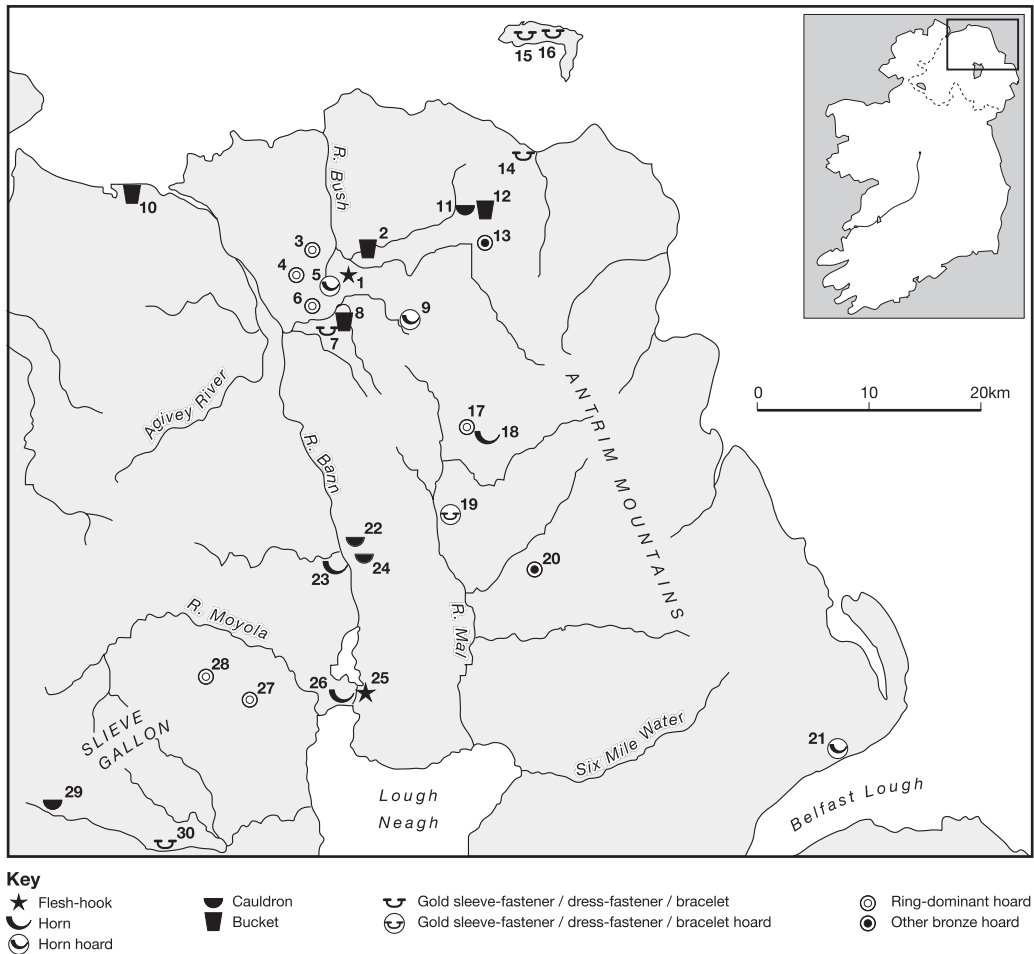


Fig 5. Location map for the Dunaverney flesh-hook. Also shown are Late Bronze Age hoards and other prestige metalwork types of bronze or gold (after Briggs 1987; Coles 1963; Eogan 1983 and 1994; Gerloff 1986): 1 Dunaverney; 2 Dervock; 3 Bootown Moss; 4 Seacon More; 5 Drunkendult; 6, 7 and 8 Ballymoney area; 9 Drumbest; 10 Downhill; 11 and 12 Cape Castle Bog; 13 Cromaghs; 14 Portnagh, Ballycastle; 15 Rathlin Island; 16 Ballynagard, Rathlin Island; 17 and 18 Clough; 19 Craighilly; 20 Crevilly valley; 21 near Carrickfergus; 22, 23 and 24 Portglenone; 25 River Bann, Toome; 26 Toome; 27 Lackagh; 28 Annagh; 29 Tulnacross; 30 Killymoon Desmesne.

been used 'as a beam or steel yard for weighing, and that for this purpose the different modifications of weight were determined by moving the birds inserted in it according to a scale', or 'that it might have been used as an Ounce!'.⁷

Later that same year (1833) the discovery was also noted in the *Ordnance Survey Memoirs of Ireland*. In volume 16, under the parish of Ballymoney, there is a 'Memoir on Ancient Topography' by J Stokes, dated October to December 1833 which includes a small section on 'Miscellaneous Brass Objects' that says:

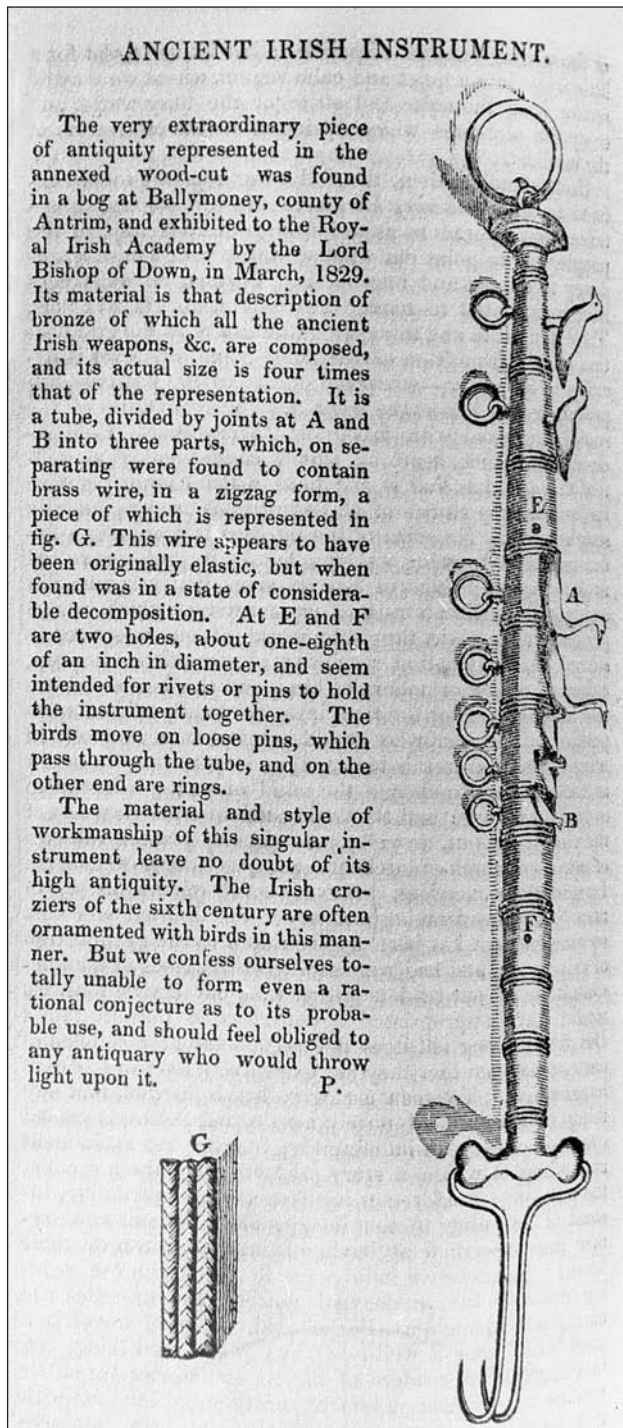


Fig 6. Woodcut of the Dunaverney flesh-hook from the *Dublin Penny Journal* of 6 April 1833, together with the description by Dr Petrie. Photograph: Society of Antiquaries of London.

About the year 1832 a curious brass instrument 2 and a half feet long ornamented with birds graven on its surface and in shape like a large flesh fork, was found in Dunaverny [*sic*]. It was sold to Mr Mant, then rector of Ballymoney, and is said to be now in a Dublin museum.⁸

Certain details in this account suggest that Stokes relied on orally transmitted information and had not seen the object itself – notably the description of the birds as being ‘graven on its surface’. The length recorded is somewhat longer than the combined lengths of the surviving pieces, but equally it is not clear that the account accurately reports the full hafted length as found. Stokes was certainly not correct about the date of discovery as the flesh-hook was exhibited to the Royal Irish Academy in March 1829.⁹

A further survey of County Antrim a little later, in 1837–8, again noted the discovery, this time with additional information on the circumstances:

Instrument of Brass. About six years ago Benjamin Spear¹⁰ of Dunaverny [*sic*] found a curious brass instrument about 2 and a half feet long and as thick as a walking stick, and ornamented with birds engraven on it. On one end was [*sic*] prongs like a flesh fork, but turned up at the point like a drag. It was discovered in a flow bog in the same townland and was sold to the Reverend Mr Mant (then rector of Ballymoney) for 1 pound, and is said to be deposited in the Dublin museum. 25 December 1837.¹¹

In 1849, ownership of the flesh-hook passed to James Carruthers. In a letter dated 4 July 1849 to John Windele, a fellow collector in Cork, Carruthers wrote: ‘A few weeks since after severe competition with the Royal Irish Academy I became the owner of a curious Irish bronze antique purchased at the sale of the effects of Dr Mant Bishop of Down & Connor & Dromore’.¹² The ‘antique’ in question was the Dunaverny flesh-hook and the letter might be taken to imply that James Carruthers himself bid for it at the auction. However, his son, George, in a letter to the British Museum in 1888, says that it was he who bought it at the sale for his father.¹³ The acquisition of the Dunaverny flesh-hook by the British Museum is recorded in the register for December 1856 as being from H O Cureton, who would have acted as buyer on behalf of the Museum at the Carruthers sale, at Sotheby’s.

In 1852 the flesh-hook, along with many other antiquities belonging to Carruthers, was exhibited in Belfast Museum at the twenty-second meeting of the British Association for the Advancement of Science; the catalogue entry states that ‘no satisfactory use has been assigned to this instrument’.¹⁴ By the end of the same year Carruthers had managed to track down a man who was present when the flesh-hook was discovered and who told him that ‘each piece was joined together by an ornamented oak rod about a foot long. This would make the thing about four foot in length’.¹⁵ This is much longer than the length quoted in the *Ordnance Survey Memoirs of Ireland* (‘about 2 and one half feet’) and does not specify whether the quoted shaft lengths included the parts inserted into the bronze ferrules. It should not be taken as a wholly reliable recollection after such a passage of time, and we present evidence below that the shorter length is more likely.

While the flesh-hook was in his possession, James Carruthers wrote to the Kilkenny and South-East Ireland Archaeological Society on 15 March 1854, and this communication was printed in the *Proceedings and Transactions* (which later became the

Journal of the Royal Society of Ireland).¹⁶ He summarized the circumstances of the find thus: 'it was discovered in 1829 in the bog of Dunnaverny [*sic*], in the townland of the same name, within two miles of Ballymoney, county of Antrim'.¹⁷ He also stated that he had had a full-size lithograph made of the flesh-hook which he had 'widely circulated, in the hope of discovering its use, but without effect; there have been many opinions offered regarding it, but all at variance with each other'.¹⁸ Carruthers himself was of the opinion that the object was used for divination or for sacrificial purposes. Despite the existence of the new lithograph, however, the article was illustrated with a reprint of the 1833 *Dublin Penny Journal* woodcut, which had also been used in the meantime in *Annaler fur Nordisk Oldkyndighed* (1836–7), in a section about minor discoveries of strange artefacts.¹⁹

It was clearly desirable to track down a copy of the Carruthers lithograph. Enquiries of the Society of Antiquaries of London and the Royal Society of Ireland, as well as a search through the archives in the British Museum, brought no success. However, the archives of the Royal Irish Academy bore fruit and a hand-coloured lithograph was located thanks to Siobhan Fitzpatrick, the librarian (fig 7).²⁰ An inscription around the butt ring states that the drawing was by James Moore, MD; the lithographs were produced by Lamont Brothers. No date is given, but the legend makes it clear that the object was at the time in the possession of James Carruthers and suggests that the birds are swans, ducks and ravens.²¹

The letter dated 9 April 1888 from George Carruthers, James's son, to the British Museum drew our attention to the existence of yet another early illustration. In the letter he seeks information about the Dunaverney flesh-hook and states 'my sister in Belfast has a large book of drawings made by herself of all the leading gems of Irish Archaeology, both in the Royal Irish Academy, and in private collections, and she gives them local habitation as close as possible'. This refers to Rose Carruthers's book of watercoloured drawings, now in the National Museum of Ireland, containing drawings from life of many of the objects in her father's collection, as well as copies of drawings of a number of other antiquities.²² Comparison of the full-size lithograph with Rose's half-size and less accomplished watercolour is revealing. Not only is the orientation of the birds, their rings and the hooks identical, but so too is the legend, saving only minor changes such as 'County' for 'Co'. This strongly suggests that she copied the lithograph rather than drawing the object afresh.

The object was only mentioned briefly by John Evans in his seminal work on Bronze Age metalwork for, at that time, he thought it to be of later date; he ventured no suggestion as to function, but curiously referred to the object as a 'rod', with no mention of the hooks, and gives an approximate length ('18 inches') significantly shorter than the combined length of the three extant bronze components (*c.* 0.57m, or 22.4in.).²³ Evans may thus not have seen the entire object. However, in a publication four years later by Boyd Dawkins on the subject of the newly found Late Bronze Age Eaton hoard, Evans is credited with drawing a parallel between the Dunaverney flesh-hook and the fragmentary example in that hoard.²⁴ Evans clearly knew the object better by this stage and we may presume that he also realized that it was Bronze Age on the strength of the Eaton association.

Boyd Dawkins also credited John Evans with the suggestion 'that it was used in religious ceremonial, after the fashion of the flesh-hooks of the Levites'²⁵ and this functional identification was consolidated in the first edition of the *British Museum Guide*: 'The implement ... is probably a flesh-hook, used ceremonially like that of the



Fig 7. Colour lithograph of the Dunaverney flesh-hook which James Carruthers 'widely circulated, in the hope of discovering its use' in about 1852. *Photograph*: © the Trustees of the British Museum.

priests in Eli's time'.²⁶ There are in fact a number of Biblical references to flesh-hooks, one of which is to flesh-hooks with three teeth.²⁷ It was also the *British Museum Guide* that first explicitly ventured a Bronze Age date for the flesh-hook. Even so, Armstrong and Macalister²⁸ preferred a more conservative dating, to the Iron Age. Indeed, even the *British Museum Guide* saw it belonging at the very end of the Bronze Age: confronted with bird images that were unique in the insular context, Hallstatt (ie Ha C and D) influences were invoked, thereby tying the flesh-hook to what was regarded as the Bronze Age/Iron Age transition – then dated to around 500 BC. As late as the middle of the last century, leading scholars were placing the find in the 'sixth to fifth century BC'.²⁹ In the meantime, the Bronze Age/Iron Age transition has been backdated by up to three centuries.

The *British Museum Guide* introduced a new illustration of the Dunaverney flesh-hook, the first new published drawing since the original 1833 woodcut. Both Armstrong and Macalister also included new illustrations of the implement, but they are rather crude depictions apparently copied (independently) from the lithograph or (less likely) from Rose Carruthers' watercolour.³⁰ All of these early depictions are important in showing the object with a ring at the end of the knob at the butt: the ring has since gone missing and the loop that would have held it is torn open at one end. Archival photographs show that this damage had occurred before the middle of the twentieth century as the ring is missing in the 1953 *Guide to the Later Prehistoric Antiquities of the British Isles*.³¹ The most likely context for the damage would have been the mass movement of objects that took place during the Second World War, although no damage to the flesh-hook is actually recorded for that period. Our recent investigation found another alteration that must have post-dated discovery but probably pre-dated even the 1833 illustration:³² to each of the rods below the swans a simple loop is attached using modern solder; these loops and two of the suspended rings are of modern metal (see below).

The Little Thetford flesh-hook

The history of the Little Thetford flesh-hook (see fig 2) is altogether simpler. It was discovered in 1929 in a bog in Cambridgeshire (fig 8), a century after the Dunaverney flesh-hook was found in Ireland. Reginald Smith outlines briefly the circumstances of this find, the first complete one in England: 'It was found this year about 9ft. from the surface in digging a dyke on reclaimed fen-land at Little Thetford, Isle of Ely'.³³ It was purchased by the British Museum the same year. Smith remarked on remnants of a wooden shaft 'in the lower socket or ferrule, with a wooden peg through it', but they are not referred to in the acquisition register for 1929 and only minute corrosion-impregnated fragments of this wood now survive attached to the socket interior. It is frustrating that insufficient material remains to radiocarbon date the Little Thetford flesh-hook. As with Dunaverney, study has brought to light evidence of some modern repairs (to be discussed below), but no documentation relating to these repairs has been found.

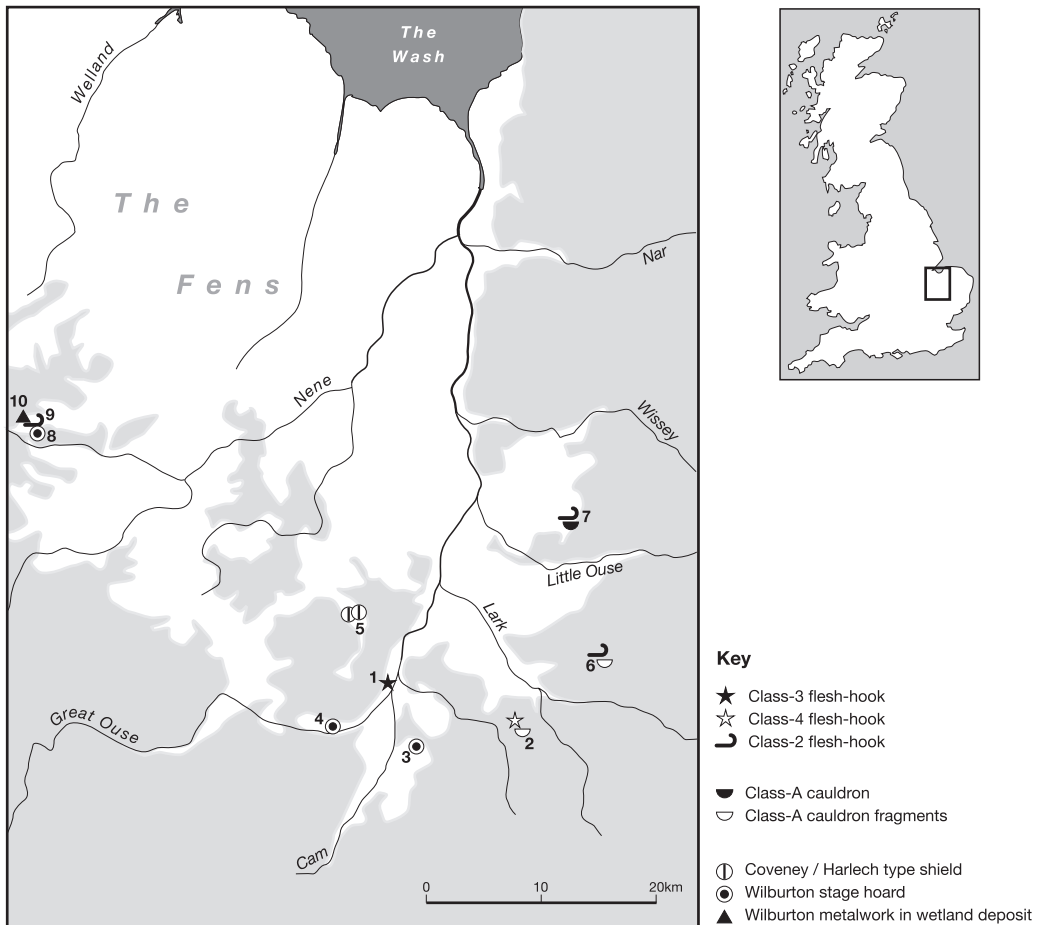


Fig 8. Location map for Little Thetford and other Fenland flesh-hooks (fen edge after Waller 1994). Also shown are later Bronze Age cauldrons and Wilburton-stage hoards: 1 Little Thetford; 2 Isleham hoard; 3 Wicken Fen hoard; 4 Wilburton Fen hoard; 5 Coveney Fen hoard; 6 Eriswell hoard (Penard stage); 7 Feltwell hoard (Penard stage); 8 Bradley Fen hoard; 9 Flag Fen timber platform; 10 Fengate Power Station wetland deposit.

DESCRIPTIONS

Dunaverney

The Dunaverney flesh-hook comprises three tubular stretches of bronze which will be referred to as the 'hook ferrule', 'central ferrule' and 'butt ferrule' (figs 9 to 11).³⁴ Of the two sections of wooden shaft that would have connected the ferrules, only one fragment had survived by 1833;³⁵ its current length is 66mm (see figs 1 and 10). It is densely inlaid with strips of bronze in a herringbone arrangement and thus presumably was an exposed segment rather than one hidden within one of the sockets.³⁶

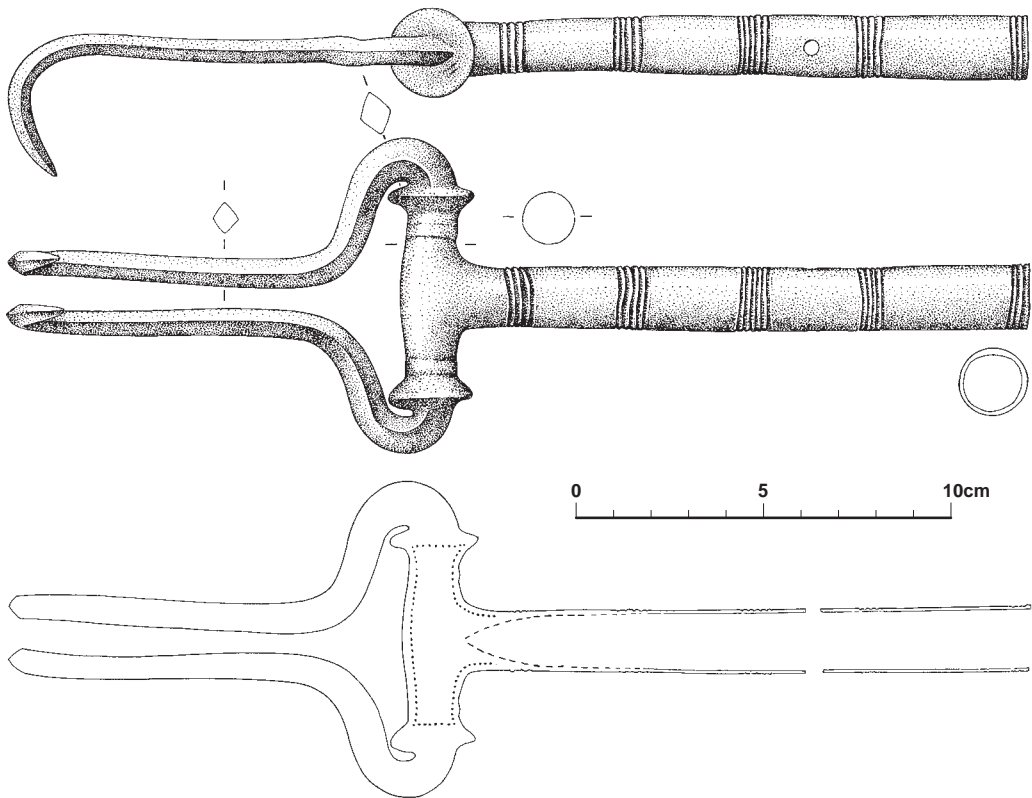


Fig 9. The hook ferrule of the Dunaverney flesh-hook (scale: 50 per cent). *Drawing:* Karen Hughes.

The long socket of the hooked end tapers steadily from the mouth to the bobbin-shaped cross-bar.³⁷ The latter has a circular section like the socket itself, but with a slightly swollen centre and marked expansion towards essentially flat ends. The constricted zone just inside either end flange carries a slight concentric moulding. This has no function and we can only think that it is a skeuomorph of a feature or component present on earlier composite flesh-hooks. The prongs are cast as one with the socket and cross-bar, emerging roughly centrally from the flat ends. They are of crisp diamond section tapering gently towards the rather rounded tips. As they emerge from the cross-bar the prongs turn in tightly through about 160 degrees until they almost meet, at which point they turn out to run almost parallel and in line with the socket. In fact, they diverge slightly before bending in the right-angled plane to form the hooks themselves. There is nothing to suggest any significant modification of prong shape since manufacture. Five rather crudely executed bands of three, five, six, five and four grooves occur at intervals between the socket mouth and a point close to the cross-bar (see fig 9). Most bands are evenly spaced, but the two closest to the mouth are more widely separated. A pair of peg holes, 4.5–4.7mm in diameter, perforate the socket transversely between the second and third groove-bands.

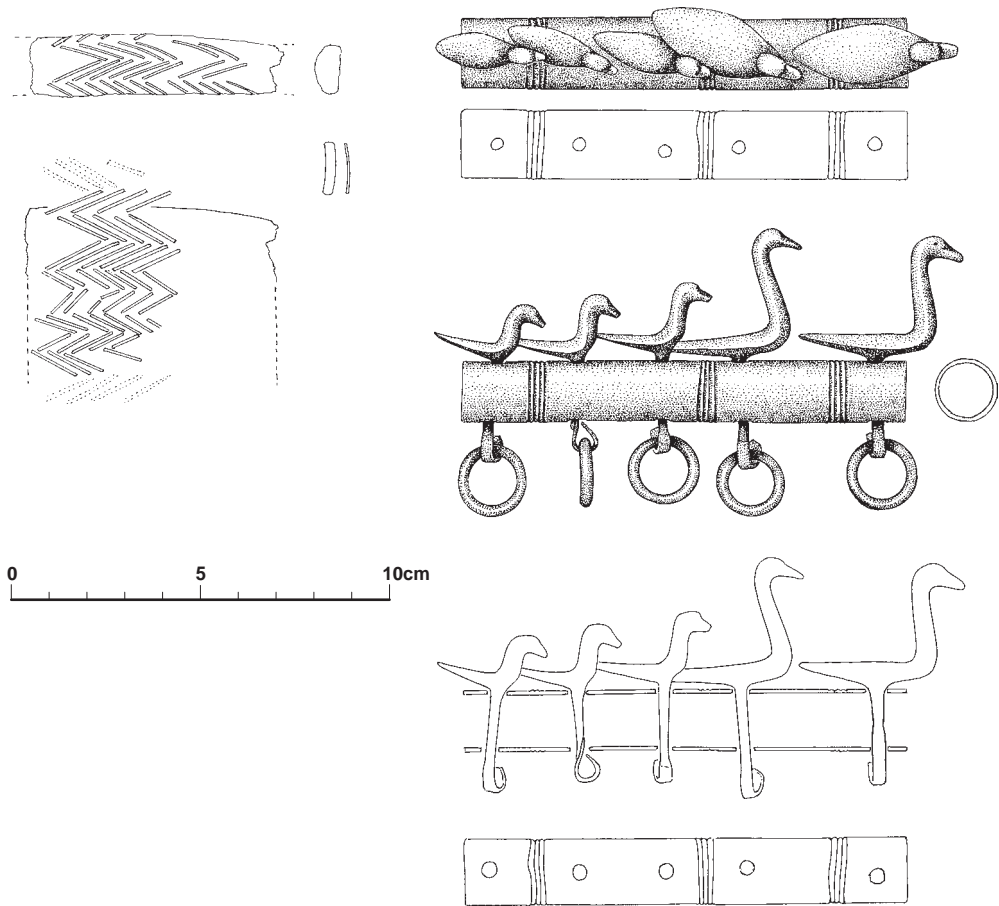


Fig 10. The central ferrule of the Dunaverney flesh-hook and the inlaid wood fragment, also shown rolled out (scale: 50 per cent). *Drawing: Karen Hughes.*

The central ferrule – that bearing a family of five water birds – is almost perfectly cylindrical, with no taper from end to end.³⁸ Three groove-bands, each of four grooves, are spaced along the tube with smaller spaces at either end than those in the middle; the latter two gaps are not equal, so the middle groove-band is not quite central (see fig 10). The birds probably represent two adults and three young, while the long necks and other features of the adults are highly suggestive of swans. The shallowness of their bodies is inconsistent with any waterbird seen out of the water and instead gives the impression of bodies partly submerged (fig 12a). Even so, the bodies are somewhat stylized with a lenticular plan view and a tendency towards an axially ridged back (fig 13a). We have called them swans 1 to 5 in sequence, starting at the end with the two adults. Their distribution along the tube at first appears without pattern, but the linking rods of swans 2 to 5 are fairly evenly spaced and apparently set in pairs symmetrically around two of the groove-bands. Swan 1 is spaced further apart, beyond the final groove-band. This allows the larger swans not to clash with one another, whereas swan 2 and each of the cygnets in turn overlap when aligned with the ferrule.

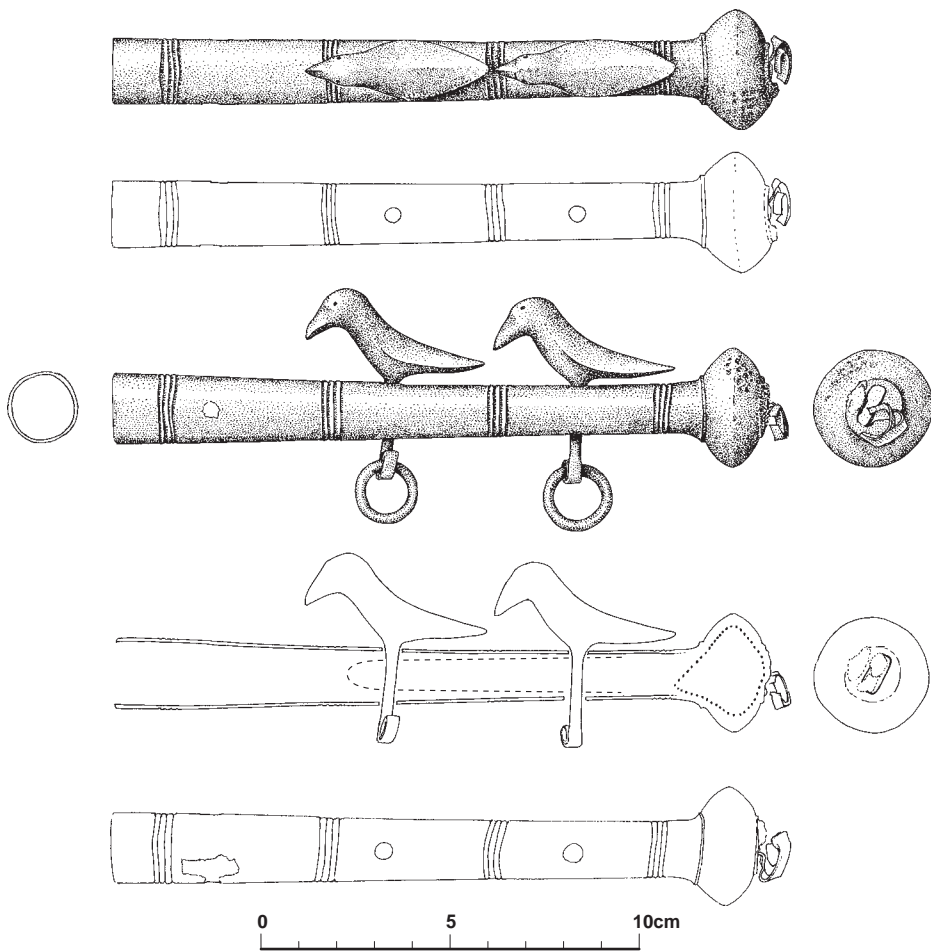


Fig 11. The butt ferrule of the Dunaverney flesh-hook: the outline of the lead-rich metal in the knob is based on radiography and of the shaft remnant in the butt-end on the use of a boroscope (scale: 50 per cent). *Drawing:* Karen Hughes.

Each swan is cast in one with a rod, or tang, projecting from the belly. The tangs are sunk through pairs of holes of 4.6–4.9mm diameter in the ferrule, below which the roughly round section is flattened to facilitate it being coiled around a free-running ring. The pairs of holes are not all perfectly aligned so that the rods pass through the ferrule slightly skew to 90 degrees. These birds and those on the butt end can now rotate through 360 degrees horizontally, but whether this was the original intention is not certain. It is rather unlikely that the wooden shaft would have passed unbroken through the whole of the central ferrule and more likely that separate lengths were inserted from either end. This would allow both to be rebated so that metal and wood met in a flush surface. In this arrangement a subsidiary function of the swans' tangs, or two of them at least, would have been to secure the shaft ends. The rings vary a little in outer diameter, from a minimum of 17.3mm to a maximum of 19.2mm, and in thickness between 2.7mm and 3.3mm. Although it has emerged that two rings, those below swans 3 and 4,

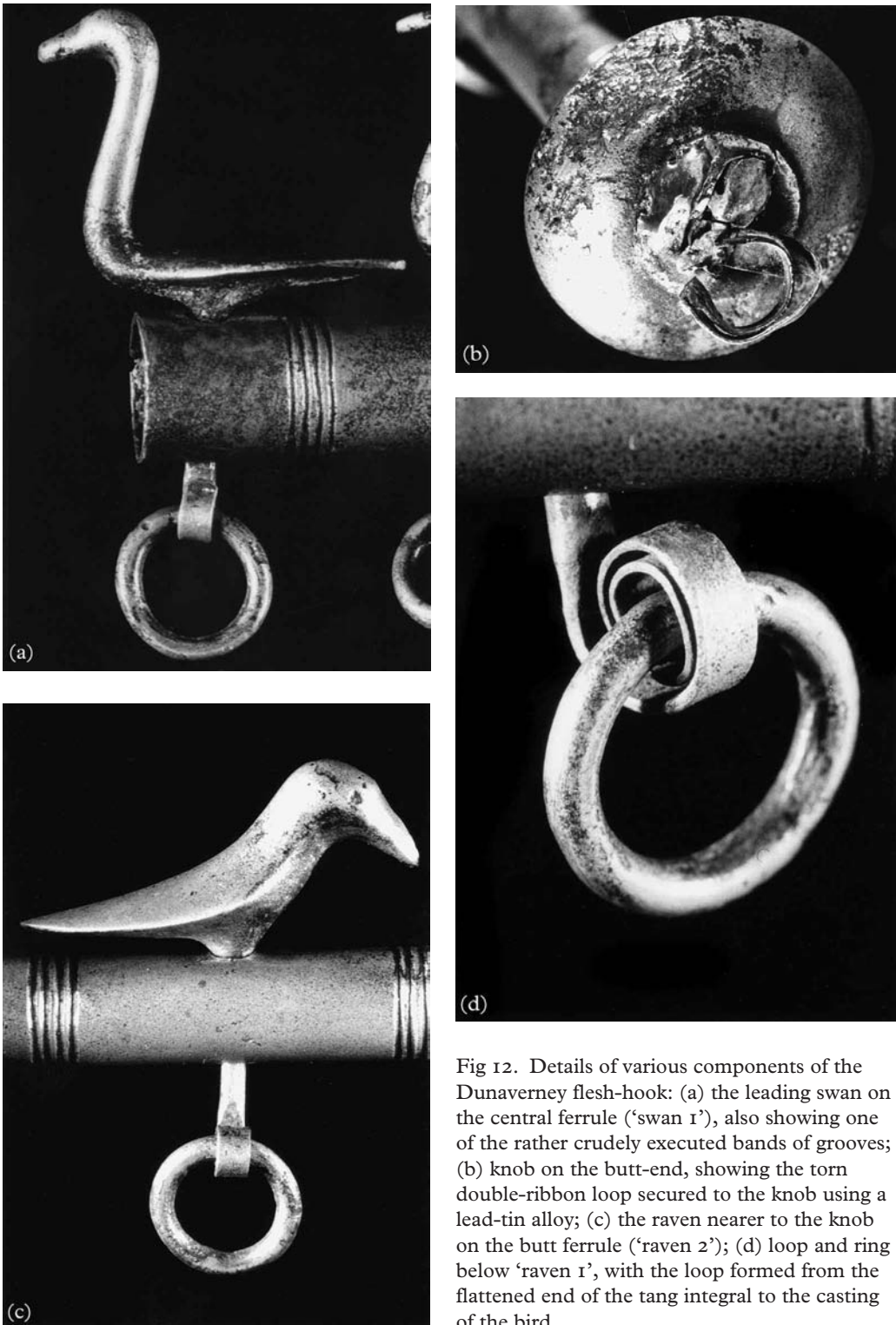


Fig 12. Details of various components of the Dunaverney flesh-hook: (a) the leading swan on the central ferrule ('swan 1'), also showing one of the rather crudely executed bands of grooves; (b) knob on the butt-end, showing the torn double-ribbon loop secured to the knob using a lead-tin alloy; (c) the raven nearer to the knob on the butt ferrule ('raven 2'); (d) loop and ring below 'raven 1', with the loop formed from the flattened end of the tang integral to the casting of the bird.

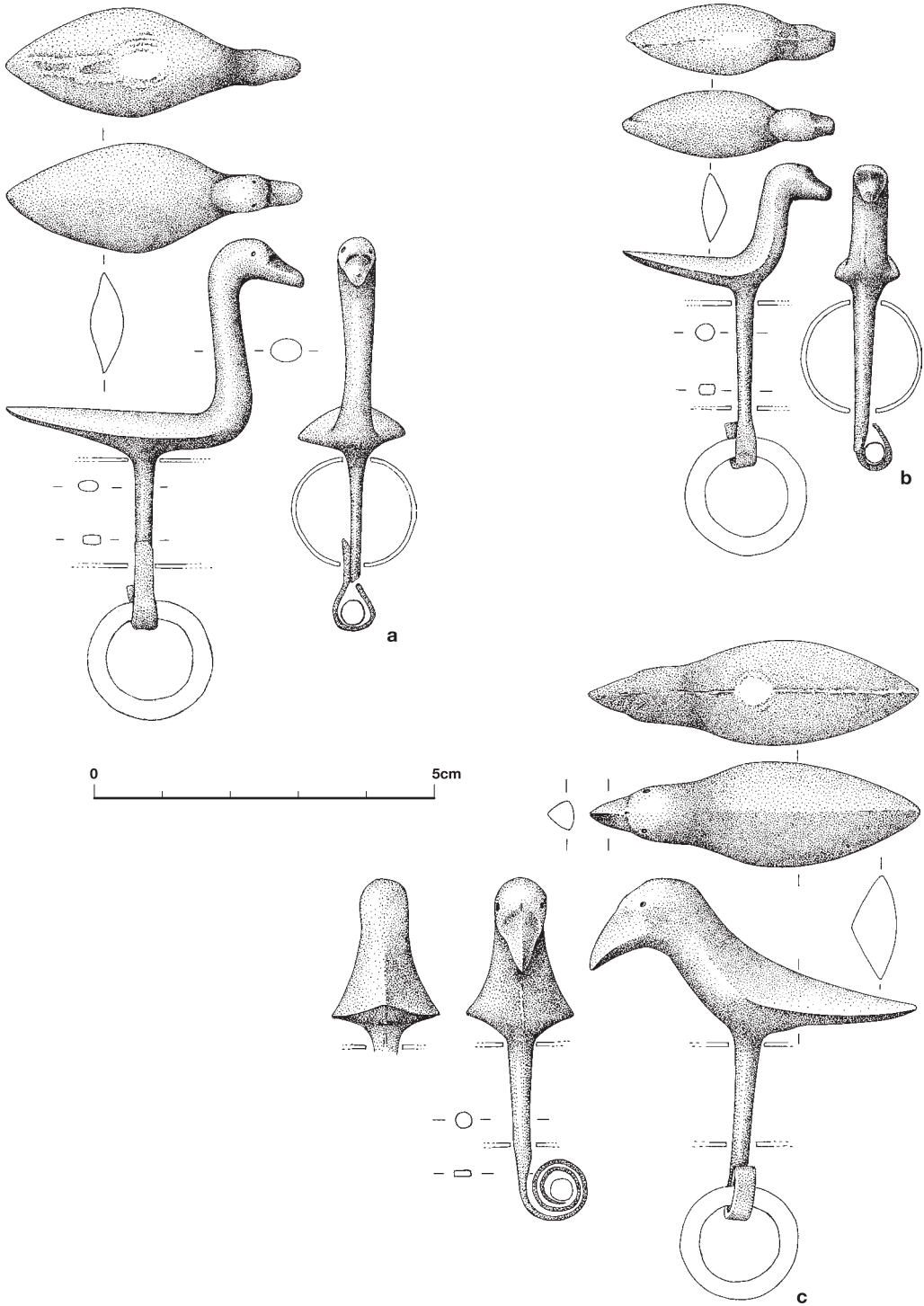


Fig 13. Dunaverney flesh-hook: drawings of (a) 'swan 1'; (b) 'swan 3'; (c) 'raven 1' (scale: 100 per cent). *Drawing: Karen Hughes.*

are modern substitutes (see below), this does not account for dimensional differences. Those two must in fact have started penannular for they are each closed with a drop of solder. The other three were cast entire. Examination of the rolled rod ends shows that all five have in fact been attached to the main shaft, or re-attached, with a soldered lap-joint (fig 13a). This may explain the rather untidy variation in the lengths of the rods, and hence the height at which the rings are suspended and, indeed, the fact that the alignment of the ring beneath swan 4 is near perpendicular to the others. Metal analysis (below) makes it clear that this is modern restoration. There are some differences in the current configuration of rings and suspension loops from that shown in the Carruthers lithograph (see fig 7), but the misalignment of the ring under swan 4 suggests that the restoration was done soon after recovery.³⁹

One technological question about the birds is whether they were all individually moulded, or whether they are repeats within each of the two sizes. The two adults have a similar slight asymmetry to the body when viewed from above (see fig 10) and are sufficiently similar in all dimensions⁴⁰ to allow the possibility that they derived from the same mould or pattern. Slight differences in their heads, as seen in elevation, are to be expected from the vagaries of metal take-up in the mould and/or post-cast finishing. Dimensions⁴¹ for the three cygnets are again similar to one another, but there are subtle differences in shape.

The butt ferrule has a long tapering socket terminating in a biconical knob. The socket is the same internal length as that of the hook ferrule and they also share similar diameters at their mouths and narrowest points.⁴² The junction between the knob and socket is encircled by a fine step moulding, while a similar step on the butt itself creates a raised flattish disc 14.5mm in diameter. The latter is perforated with a rectangular hole, c 10 × 4mm, to accommodate a loop which had held a plain ring (of larger diameter than those suspended under the birds) until the mid-twentieth century (see above). The loop is now torn, remaining only as a contorted double-strip of metal (see fig 12b). Visible through the end perforation is a mass of what appears to be 'white' metal (shown to be lead-tin alloy, below) trapped within the knob.

Four groove-bands, each comprising four grooves, have even spaces in between and much shorter gaps outside the first and last, a spacing pattern not dissimilar to that on the central ferrule. A pair of holes ranging between 4.5mm and 5.1mm diameter perforates each of the three groove-defined segments: the first is aligned horizontally for a securing peg, the second and third vertically to accommodate two further birds.

Like the swans, the bodies of the butt-end birds are stylized, pointed at the tail end and shaped with a longitudinal arris along the back (fig 13c). A thick, shortish neck leads to a round-crowned head supporting a large thick bill with a distinctly convex upper profile. The head and bill most resemble certain members of the *Corvidae* family, notably ravens and rooks (fig 12c). We will refer to the bird nearest the socket mouth as raven 1 and that towards the butt as raven 2. As with the swans, their feet are substituted by a tapering tang which, after passing through the tube, is flattened and rolled to hold a free-running ring; in these tangs, however, there is no solder joint between bird and rolled loop (fig 12d). Ring diameters (17.4–18.4mm) and thicknesses (2.6–3.2mm) are in the same range as those under the swans. The ring under raven 2 is suspended lower than under bird 1 (ie the rod is longer) and this may be accounted for by the fact that the latter is rolled 2.25 turns compared to only 1.33 on the former. They are also rolled to different sides of the tube if the ravens are faced in the same direction.

The dimensions⁴³ and postures of the two ravens are in most respects very similar, again making it possible that they were cast-siblings. Pricked depressions representing the eyes are in different positions, but these could have been punched in after casting.

Little Thetford

The Little Thetford flesh-hook has a butt-end weighing 111g in addition to the hooked part which weighs 264g, but no middle portion in either metal or wood survives (fig 14). The account of discovery is brief, but Smith⁴⁴ did remark that a piece of wooden shaft with a securing peg had originally survived in the butt-end (as noted above). The hook-end employs a cross-bar element, as is present on Dunaverney, and there are also similarities in the presence of a bulbous knob and an end loop on the butt ferrule. However, in other respects the two deviate significantly in design and, moreover, in construction. On Little Thetford, the styling of the cross-bar is different and the long, largely straight prongs continue behind it, extending right back to a point low on the socket.

The hook-end

The hook-end in particular transpires to be a complex, composite object involving as many as seven components, three of them being the main structural elements – the ferrule, the cross-bar and the prongs; the components are individually described (see fig 17 for an exploded view of the flesh-hook where the components are numbered as below).

1. HOOK FERRULE

The ferrule is 193.5mm long,⁴⁵ tapering gently from the mouth (diameter 18.2–19mm) towards the closed end (minimum diameter 9.8mm), which terminates in a bulbous knob (diameter 15.6mm) perforated laterally to accommodate the cross-bar. Two smaller pairs of opposed perforations, both in the same plane as those through the knob, occur towards the mouth end, one for the prong bases to pass into, the other allowing the socket to be secured to the shaft by means of a peg. Those accommodating the prong bases tend to be diamond-shaped, in keeping with the prong-bar section, but they are not a tight fit. The socket is smooth and well finished and three neat, evenly spaced projections, apparently cast in one with the socket, are set in a line and point upwards when the hooks are upwards. Two of these (fig 14: projections a and b) are rod-like and project 4.8mm, while the third (fig 14: c) is a less prominent circular protuberance, 1.2mm high; all have a similar basal diameter. Radiography⁴⁶ and visual inspection show that neither (a) nor (c) has a corresponding internal projection; hence neither is the remains of a chaplet used to hold the clay core in place during casting; the internal block (component 7) prevents this being ascertained for projection (b). The distance between projection (a) and the centre of the terminal knob is about the same as that between the projections themselves. They are smooth-profiled and may thus have had some secondary working. The two longer projections show a very slight expansion at their ends.

2. PRONGS

The prongs are rods of square cross-section (orientated diagonally relative to the axis of the socket) which taper around the curved hooks; close to the points the outer angle of

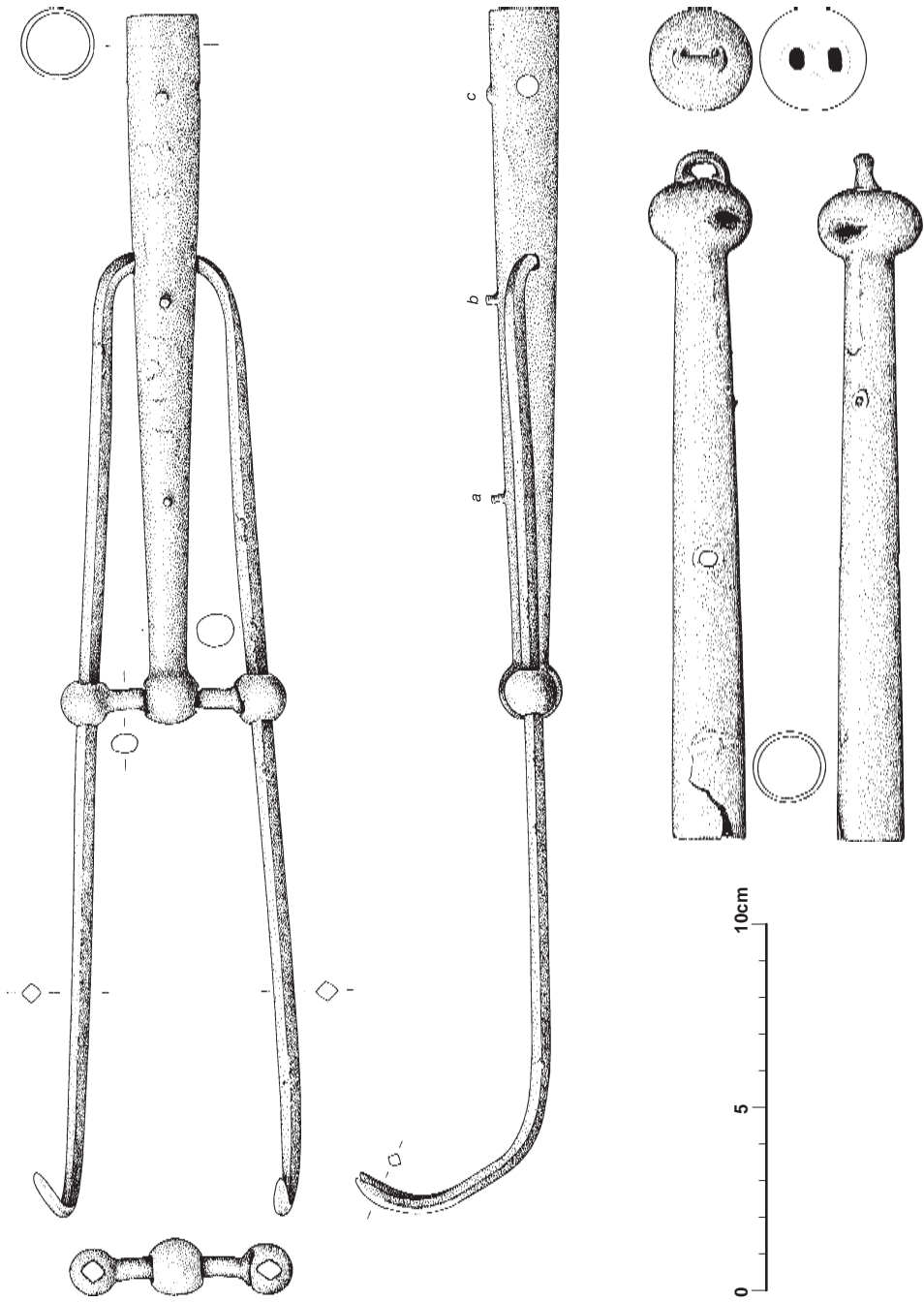


Fig 14. The Little Thetford flesh-hook (scale: 50 per cent). *Drawing: Karen Hughes.*

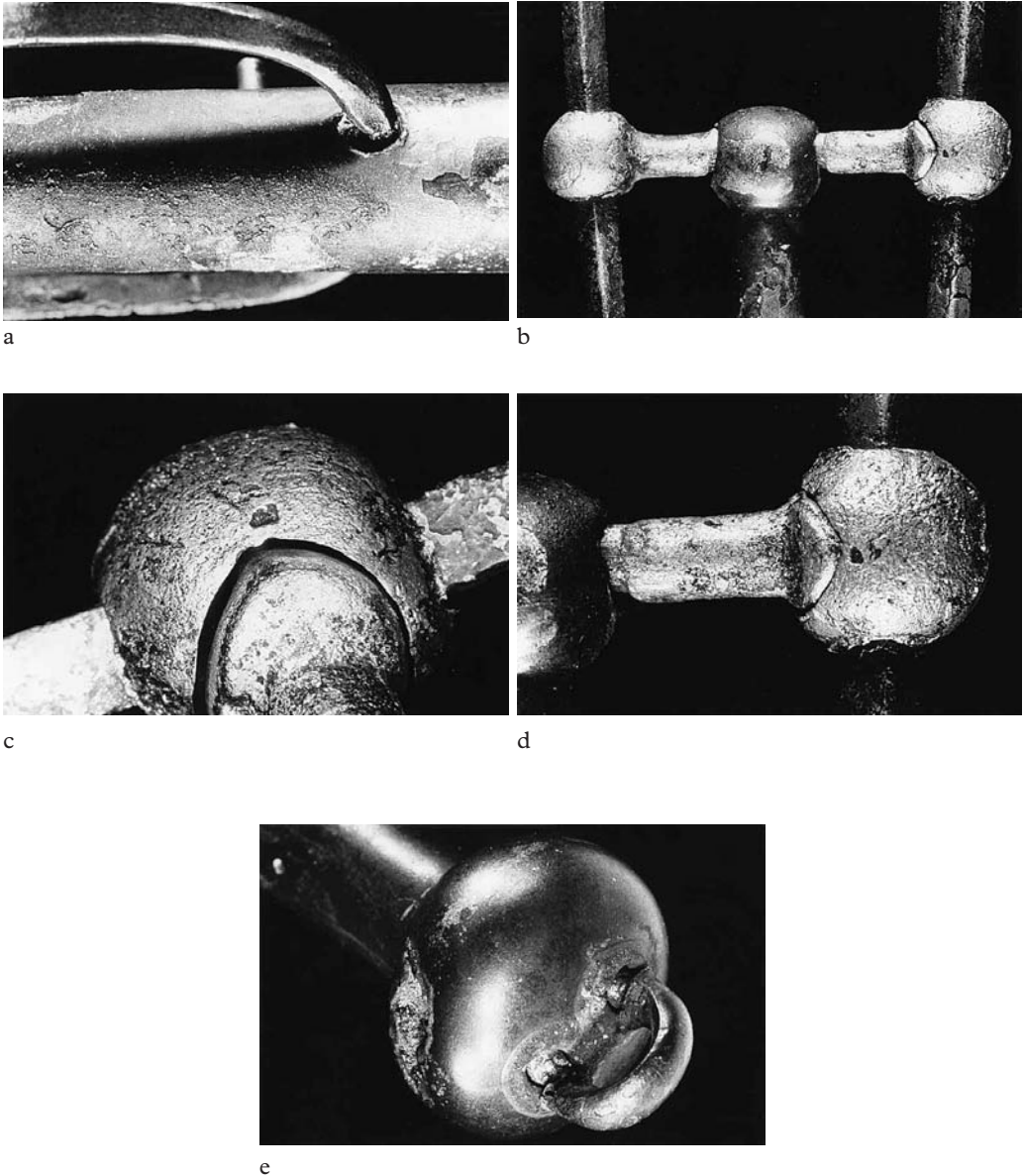


Fig 15. Details of various components of the Little Thetford flesh-hook: (a) rod of the prongs where it passes through the ferrule; (b) cross-bar passing through the terminal of the hook ferrule with integral end-collar for one prong and subsequently added cap-end for the other; (c) detail of the cap-end showing the loose joint; (d) section of the cross-bar narrowing as it enters socket terminal; (e) knob and loop on the butt-end showing the gape in the knob and beyond it the repair on the ferrule itself (the bright spot is a drill hole for analytical sampling). Note the rough flanges on the loop and the expansion once inside the knob. *Photograph*: © the Trustees of the British Museum.

the cross-section becomes more rounded. The general thickness is between 4.2 and 5mm, but one prong also thins to 3.5mm, as it turns in tightly to enter the socket. The perforations in the walls of the socket are larger than the rods, as already noted (*c* 5.8mm). In plan view the prongs diverge gradually from the base, passing through the cross-bar ends *en route*. In side view they remain in line with the socket until almost 80mm from the tips, from which point they begin to bend to form the hooks. Overall they are turned through about 120 degrees, but the curvature is not even, nor identical from one to the other. However, both exhibit two points of stronger curvature at about 60mm and 20mm from the tips.

Owing to the density of the internal block (component 7), it was difficult using radiography to ascertain the form of the prongs within the ferrule. However, eventually an exposure was achieved which showed the prongs apparently linking together as a single bent rod. Nevertheless, due to the small movement of one relative to the other, there is reason to believe that they are now broken within the socket. Use of a single rod satisfactorily explains the difference in the way the two prongs were secured by the cross-bar ends (see below), but it would seem that it broke into two at a later stage, and this could account for the internal block, to re-secure the broken ends. Small differences in the rod cross-sections and thicknesses to either side of the socket do not contradict the initial single-rod hypothesis, since some working would have been necessary to thread and tightly bend the rod through the perforations (fig 15a). In addition to the internal block, resinous material – presumably adhesive – was also noted at the perforations. Analysis by gas chromatography-mass spectrometry (GC/MS) showed the material to be shellac, and thus very likely to be the result of conservation since discovery, perhaps in an attempt to reduce the movement noted above.⁴⁷

3. CROSS-BAR AND 4. CAP-END

The cross-piece (fig 15b) at the socket head comprises two parts and serves as a stay for the prongs by means of a collar at either end, although neither is a close fit. The main piece comprising the arms and one end-collar is 56.5mm long (based on radiographs). The arms are of slightly oval section (5.2 × 6.4mm) but the central portion, where it passes through the aperture in the ferrule terminal, is thickened, to judge from the radiographs. The end-collars are visually similar spheres 13.4–13.7mm in diameter, which also match in style the ferrule terminal in between, but while one is entirely integral with the cross member, the other involves a separate ‘cap-end’. A small gap between the cap-end and the prong allows a small amount of free movement. It would appear from the radiographs that the arm ends in a fork, to which the corresponding prong was butted up before the cap-end could be attached. The cap-end itself, in addition to the recess to receive the forked end, has square perforations top and bottom to accommodate the prong. The forked end of the cross-bar would not have passed through the terminal of the ferrule in its current form since it is too broad (11 × 8.3mm or more, based on the radiographs, compared to the apertures of *c* 8.7 × 7.5mm). In addition to being loose on the prong, the cap-end is also loose on the cross-bar (fig 15c). The technology of fitting cross-bar and cap-end is discussed below.

5. INTERNAL COLLAR SUPPORT AND 6. PIN

The cross-bar is not a tight fit within the aperture of the terminal of the ferrule (fig 15d) and is secured by an internal ‘pin’ which permits a small degree of rotation about the long axis of the socket. The pin proves to be of brass and is therefore recent, and not of

Bronze Age date. It is about 2.5mm in diameter and 13mm long, the exposed end being flush with the socket end and covered by a false patina. Radiographs show that internally the pin passes right through and a little beyond the terminal (towards the socket mouth) where it has a domed end no broader than its 'head'.

Radiography shows that there is another component within the socket terminal knob which the cross-bar also passes through. It is just visible through the apertures in the socket terminal, but is not now in direct contact with the cross-bar, as demonstrated by a tunnel of clear vision virtually encircling the latter as it passes through. This internal component, seen as barrel-shaped in face view in the radiographs, can therefore be visualized as an almost spherical tube, or collar, of about 11mm diameter and 9mm width. The density seen in the radiographs implied a heavy metal such as lead and this is confirmed by analysis (below). It seems possible that deterioration of the surfaces of the lead collar resulted in a gap developing between it and the bronze cross-bar. This would explain the later insertion of the brass pin to limit movement and its concealment with a mixture of Paris green pigment and barium sulphate to simulate corrosion.⁴⁸

7. INTERNAL BLOCK

It was clear from initial inspection down the socket that it was blocked where the prong rod passed through. Radiographs showed this blocking not to have a particularly regular shape and to be confined to a 43mm stretch straddling the prong bases; it was therefore almost certainly designed to secure them. Moreover, they indicated a very dense material, later confirmed to be lead with some tin (below). It cannot be assumed that this is ancient, especially in the light of the adjacent adhesive and the brass pin in the cross-bar, but analysis supports the case for contemporaneity or near contemporaneity. Once in place, this block would have limited the length of wooden shaft that could be inserted into the socket to 58mm.

The butt-end

The butt-end comprises two obvious surviving metal components – the ferrule and an end loop – but there is also clay material in the ferrule end, as well as apparent repair patches of bronze on the socket wall.

8. BUTT FERRULE

The ferrule is 180mm long (excluding the loop), tapering gently and steadily towards a spheroid knobbed terminal. The socket mouth is slightly oval – 18.1 × 18.9mm – partly because of distortion caused by an open crack (see fig 14), but the narrower end is also oval – 13.1 × 13.5mm. There is an apparent repair at the inner end of the crack. The maximum depth of the socket internally is 132.5mm and there is a 'ledge' on one side at 124.5mm, ending presumably at the remnant clay core visible through a gape in the knob (fig 15e). A short distance up the socket from this gape, on the same side, there is the faint outline of what appears to be a patch in the socket wall. The possibility that this was a repair patch to infill a perforation owing to mis-casting is supported by the metal analysis (below). The gape in the knob may itself thus be due to over-thin casting on this side, being either cast intact but prone to later wear and corrosion, or mis-cast and, if patched at the time, not durably repaired.

Continuing on the same line, shortly above the repair patch there is a small circle of golden colour which, using surface x-ray fluorescence (see below), was higher in tin than

most analyses, then a 'blister' which has less tin than normal. It is not clear how these patches were formed, but they seem to be integral to the ancient object. The alignment through the peg-holes is a little off 90 degrees relative to the axis of the ferrule; the holes have diameters between 4.55 and 4.8mm. The knob is a squashed sphere, the shortest axis in line with the socket and 28.5mm in diameter transverse to it. On its end there are two rather ragged perforations to accommodate the end loop (no. 9; see below). Each is encircled by a ring of differentiated patination about 11mm across, the two conjoining as a 'figure-of-eight' (fig 15e).

9. END LOOP

The exposed part of the end loop has a neat 'C' shape with less regular expansions at either end where it butts up to the ferrule knob (fig 15e). Its cross-section approximates to a pointed oval, but with a more bi-faceted inside relative to a bowed outside. There is no obvious wear on the loop, which might suggest that it had attached a soft material such as a leather thong rather than a metal ring as seen on Dunaverney. The maximum width is 14.3mm, the minimum thickness in the centre 3mm and the maximum breadth (end view) 5.65mm. Beyond each expanded terminal, the loop continues as narrower rods which penetrate the perforations in the knob before swelling again inside to prevent detachment of the loop even though it is a loose fit. Radiographs in fact show that the swollen ends link up inside the terminal so that the loop is the visible part of a continuous annulus, the hidden part of which is much less regular in shape than the visible section (see fig 20.6).

SCIENTIFIC ANALYSES

Metal analysis

Having multi-components, the two flesh-hooks warranted extensive metal analyses to check whether or not the various parts were cast from the same melt of metal. Variations in metal composition could, when linked to other evidence, help clarify the sequence of construction and whether any parts were later repairs, modifications or additions. This could include both ancient alterations and any that have occurred since discovery.

It was not thought necessary to conduct fully quantitative analyses on every component, particularly in the case of Dunaverney with its twenty-five components. A strategy was therefore adopted whereby comprehensive x-ray fluorescence (XRF) analyses were undertaken on uncleaned surfaces; given surface corrosion and the potential for relative leaching in a bog environment, these data are qualitative and are therefore discussed in general terms only.⁴⁹ In a small number of cases, a drilled sample was analysed by XRF after discarding unrepresentative surface metal; in these instances the data are quantitative. The benefit of surface XRF was that it rapidly identified modern repairs and replacements and aided the selection of samples for fully quantitative analysis by inductively coupled plasma atomic emission spectrometry (ICP-AES). ICP-AES is capable of giving accurate and precise quantitative results for a range of major, minor and trace elements.⁵⁰

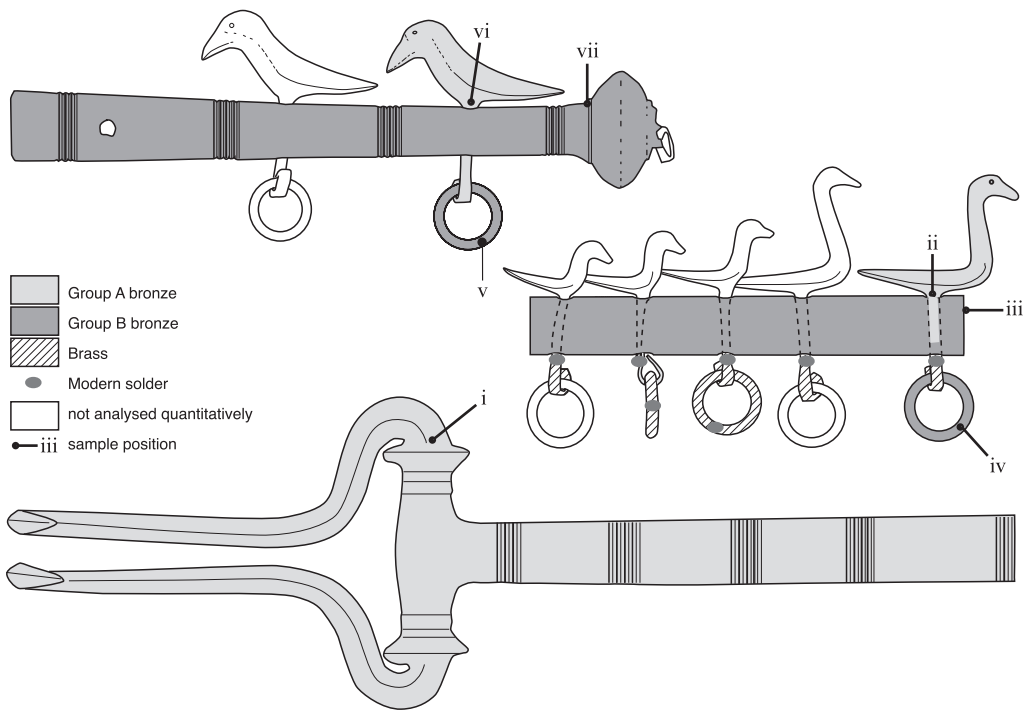


Fig 16. Outline drawing of the Dunaverney flesh-hook showing the ICP-AES sample positions and the metal groups used. The same low-lead alloy was used for the hook ferrule as for two of the birds, but not for the other two ferrules. The flesh-hook was therefore a single design concept.

Dunaverney

All components were analysed non-destructively by XRF, and a representative set of seven were drilled for ICP-AES analysis (table 1 and fig 16). The XRF results immediately clarified that all five looped ends on the tangs under the swans, and two of the rings thereby attached, were of brass and therefore are from post-recovery restoration. That the looped ends are brass while the swans themselves are of bronze is readily explained by the joints visible on each tang at around the point of exit from the ferrule itself (fig 13a). Analysis of the joint revealed varied solder compositions, but all having significant zinc which is incompatible with a Bronze Age date. On the other hand, the lead-dominant metal inside the butt terminal where the loop is attached contained about 10 per cent tin and only impurity level zinc, which is consistent with Bronze Age lead alloys. Tin levels in the bronze components typically fall around 10 per cent and lead is also present at fairly high levels (up to 8 per cent) on account of its deliberate addition to the bronze.

The ICP-AES results provide detailed compositional characterization and break down into two groups. Bimodality in lead (Pb) values (as plotted logarithmically) is supported by bimodality in silver (Ag) and exclusive ranges in antimony (Sb), nickel (Ni) and arsenic (As). Tin (Sn) shows a tendency to be higher in the group with the lower lead levels. The lower lead composition group, which we define as group A,

Table 1. Analytical results using inductively coupled plasma atomic emission spectrometry (ICP-AES)

	Ag	Al	As	Au	Bi	Cd	Co	Cu	Fe	Mn	Ni	P	Pb	S	Sb	Sn	Zn	Total Weight (mg)	
Little Thetford flesh-hook																			
i	0.040	<0.01	0.06	<0.006	<0.02	<0.002	0.003	82.2	0.077	<0.001	0.039	<0.03	6.66	0.13	0.09	8.76	<0.02	98.1	8.30
ii	0.039	<0.01	0.06	<0.006	<0.02	<0.002	<0.003	84.5	0.142	<0.001	0.040	<0.03	6.38	0.14	0.10	9.34	<0.02	100.7	5.76
iii	0.018	<0.01	0.07	<0.003	<0.02	<0.002	0.002	87.2	<0.01	<0.0005	0.031	<0.03	1.62	0.23	0.05	10.7	<0.01	99.9	11.28
iv	0.037	<0.01	0.05	<0.003	<0.01	<0.002	0.002	83.1	<0.01	<0.0005	0.037	<0.03	5.73	0.07	0.09	9.49	<0.01	98.6	13.89
v	0.010	<0.01	0.03	<0.006	<0.02	<0.002	<0.003	85.5	0.019	<0.001	0.014	<0.03	1.29	0.15	0.03	14.1	<0.02	101.2	6.43
vi	0.031	<0.01	0.04	<0.006	<0.02	<0.002	<0.003	87.4	<0.01	<0.001	0.033	0.03	4.55	0.12	0.07	8.90	<0.02	101.2	8.43
vii	0.010	<0.01	0.04	<0.006	<0.02	<0.002	<0.003	75.9	2.164	0.002	0.018	0.07	1.02	1.59	0.04	12.9	<0.02	93.8	6.54
Dunaverny flesh-hook																			
i	0.061	<0.01	0.06	<0.003	<0.01	<0.002	0.003	86.3	0.020	<0.0005	0.074	<0.03	2.39	0.13	0.08	11.1	<0.01	100.2	14.38
ii	0.038	<0.01	0.04	<0.006	<0.02	<0.002	<0.003	88.9	<0.01	<0.001	0.069	<0.03	1.13	0.29	0.04	11.9	<0.02	102.3	6.92
iii	0.141	<0.03	0.11	<0.02	<0.06	<0.007	<0.01	88.0	<0.04	<0.002	0.105	<0.09	8.00	0.10	0.22	9.43	<0.05	106.1	2.30
iv	0.149	<0.01	0.13	<0.006	<0.02	<0.002	<0.003	83.2	<0.01	<0.001	0.110	<0.03	7.88	0.08	0.23	9.56	<0.02	101.4	7.48
v	0.149	<0.01	0.12	<0.006	<0.02	<0.002	<0.003	84.2	<0.01	<0.001	0.109	<0.03	7.62	0.09	0.23	9.41	<0.02	101.9	7.99
vi	0.064	<0.01	0.05	<0.006	<0.02	<0.002	<0.003	88.5	<0.01	<0.0005	0.074	0.04	2.08	0.08	0.08	9.27	<0.01	100.3	9.91
vii	0.125	<0.03	0.13	<0.02	<0.06	<0.007	<0.01	89.5	<0.04	<0.002	0.090	<0.09	5.98	0.10	0.17	10.3	<0.05	106.3	2.07

Notes

- Results are quoted as weight per cent.
- Bismuth (Bi) was analysed using atomic absorption (Hughes *et al* 1976).
- '<' denotes less than the quoted detection limit.
- For samples of 10–15mg, the precision is $c \pm 1-2$ per cent for the major elements, $c \pm 5-10$ per cent for the minor elements, deteriorating to ± 50 per cent at the detection limit.
- For sample weights of 6–9mg, the precision is $\pm 2-3$ per cent for the major elements, $c \pm 10$ per cent for the minor elements.
- See figs 16 and 17 for approximate sample positions.

occurs in the hook ferrule, swan 1 and raven 2 (fig 16). On the other hand, two rings beneath the birds join the other two stretches of ferrule as group B metal (higher lead).

The fact that six elements, being a mixture of impurities and alloy constituents, are so highly correlated is significant in terms of the metals employed, even though the gross difference in the chemical signatures of the two groups is not marked by comparison with the variation encountered in Bronze Age metalwork at large.⁵¹ At the very least it can be argued that two metal composition variants were involved in the manufacture of the flesh-hook. At the most basic level it is possible to interpret this as deriving from two separate melts of bronze.⁵² In theory it is possible that there could have been some time between the castings based on the two melts, but given the integral nature of the design of the flesh-hook and the distribution of the two metal groups across the various components it is far more likely that very little time elapsed.

Although no systematic programme of analysis has been undertaken on Irish Late Bronze Age metalwork, there are a number of published analyses.⁵³ Among these some three dozen results for Late Bronze Age types are very close to the impurity composition seen for Dunaverney and others are sufficiently similar to be potentially part of a single pool of metal in circulation. This comparative material typically has lead in the 1 to 8 per cent range, another point of correspondence with the Dunaverney metals.

Little Thetford

Eight drilled samples were taken (fig 17), seven from copper-alloy components for ICP-AES analysis, while the eighth, the block inside the socket, was analysed by XRF and proved to be lead (the block had to be sampled as it is not accessible by XRF *in situ*). A further twenty-one XRF analyses were done to investigate a range of surface features as well as the obvious components. Many of the XRF analyses showed high levels of iron from the burial environment.

The seven ICP results on copper alloys are fairly consistent (see table 1). Each of five diagnostic impurities – arsenic (As), antimony (Sb), silver (Ag), nickel (Ni) and bismuth (Bi) – falls within a narrow range and only iron (Fe) – which is prone to great variation because of its inhomogeneity in bronze – shows a wide spread of values. Tin (Sn) levels fall around 10 per cent and lead (Pb) is also present at fairly high levels (1 to 7 per cent) owing to its deliberate addition. All the analysed copper-alloy components are therefore of leaded bronze, which is almost universally the composition of Late Bronze Age copper-based objects in Britain.

The lead values are of further interest, however, since they again show a bimodal distribution when plotted logarithmically with three results in the range 1–1.7 per cent (denoted group C) and four from 4.5–6.7 per cent (group D). It transpires that these two groups may also be separated on the basis of four impurities in a very similar fashion to the division seen for Dunaverney. Moreover, tin values are all higher in group C, although there is no break from the group D range. Similar mutually exclusive but touching ranges are seen in antimony, nickel and sulphur, while silver tends towards a bimodal separation.

As with Dunaverney, the two impurity compositions defined (excluding the lead-tin components) are not so disparate that they imply major differences in the origins of the metal stock. More likely they result from more random variations from melt to melt, based on either freshly won metal or a not entirely homogenized pool of metal in circulation. Group C metal is associated with the hook ferrule, the butt ferrule and the

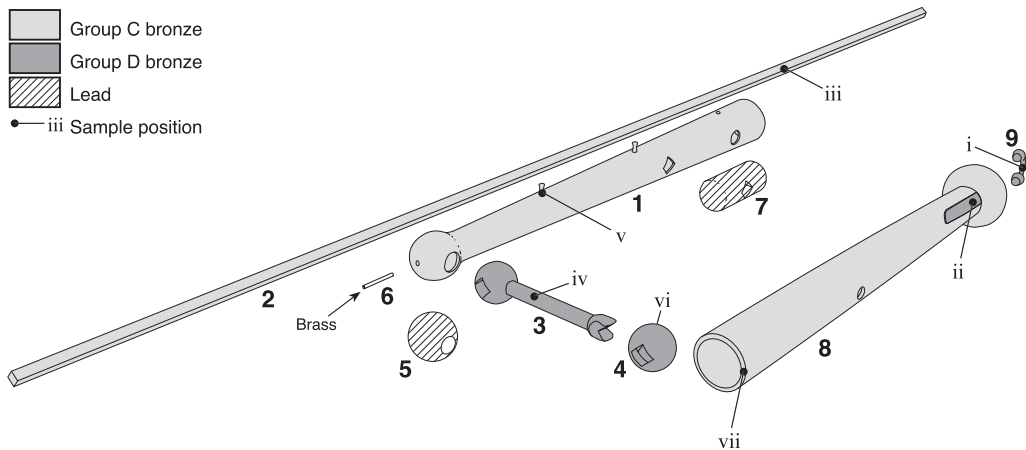


Fig 17. Outline drawing of the Little Thetford flesh-hook components showing the ICP-AES sample positions and the metal groups used.

analysed prong, whereas group D is associated with the cross-bar, its cap-end, the end loop and a repair in the butt ferrule (see fig 17). Since in one case a group C component had to exist prior to a group D component being added – the ferrule and its repair patch – we may infer that the group C objects were the first cast. This has implications for the construction sequence outlined below.

The characteristics of the chemical compositions point to a date in the Late Bronze Age (LBA) which is divided into a series of stages (fig 18). High lead (>1 per cent) is rare in Britain prior to the LBA and only significantly associated with some Acton assemblage metalwork⁵⁴ at a date too early for any flesh-hooks (sixteenth to fifteenth century BC). The impurity pattern, with three diagnostic elements in the low range – arsenic (As), silver (Ag) and nickel (Ni) – and antimony (Sb) in the low/medium range, compares at a general level with a number of analysed LBA objects of both the Wilburton and the Ewart stages, but few close matches have been found. There is much in common with compositions found in Wilburton assemblage H-metal,⁵⁵ although arsenic tends to be higher in H-metal (up to 0.75 per cent). For example, nineteen objects in the Cambridgeshire hoard of Isleham show arsenic focused between 0.08 and 0.4 per cent, but on the other hand two objects from Taplow compare closely to the Little Thetford composition.⁵⁶ A few analyses for Blackmoor hoard objects (early Ewart) are similar, but again arsenic tends to be greater than antimony, which is not the case for our results.⁵⁷ There are many Ewart objects with these diagnostic impurities at low/medium levels; again, few if any are the same as Little Thetford in all respects.

The internal block (component no. 7) is predominantly of lead, as was suspected from its density on the radiographs, but also contains approximately 13 per cent tin and 1 per cent copper (in this case, XRF was done on a drilled sample and hence is quantitative).⁵⁸ The internal ‘collar’ (component no. 5) in the bulbous terminal of the hook ferrule is very difficult to access for sampling, but a tiny scraping was obtained. Again, by XRF, it was predominantly of lead, but with only a small amount of tin (the result is qualitative as the sample extracted was very small and included some corrosion products). Lead-tin alloys have been discovered in other Bronze Age objects;⁵⁹ lead is

Date BC	Period	British metalworking assemblage	Irish metalworking assemblage
1300	MBA ↑↑		
1250		FELTWELL Penard	BISHOPSLAND Bishopsland
1200			
1150	LBA	Wilburton	Roscommon
1100		LITTLE THETFORD	
1050			
1000		Ewart-Blackmoor	
950			DUNAVERNEY Dowris
900		mature Ewart	
850	LULWORTH	DOOMORE	
800	Earliest Iron Age	Llyn Fawr (bronze, plus iron)	
750			
700			
650			
600	Early Iron Age ↓↓	Halstatt D ↓↓	

Fig 18. Chronology of the Late Bronze Age in Britain and Ireland, with its associated metalwork stages and suggested dating of the key flesh-hooks discussed.

always the major component and the tin may be accidental since no advantage is apparent and these alloys are not being used as soft solders.

Lead isotope ratios were measured by the Isotracer Laboratory, Oxford, for the internal lead block (table 2). They fall within the tightly clustered distribution established for the lead in Wilburton metalwork,⁶⁰ but this is not unique to the Wilburton stage. Some Ewart metalwork ‘inherited’ this signature, probably owing to both the carrying of metal stocks across the transition through extensive recycling and the continued exploitation of the same lead source, possibly one in the Mendips.⁶¹

A final component needs to be dealt with: the pin penetrating the hook ferrule from the top of the bulbous terminal. Surface XRF indicated in excess of 10 per cent of zinc

Table 2. The results of lead isotope analysis for the internal block in the hook-end socket of the Little Thetford flesh-hook

Lead 208/206	Lead 207/206	Lead 206/204
2.0873	0.8500	18.417

The quoted standard error (%) across 60 measurements was 0.01–0.003 lead 206/204

and some 20 per cent of arsenic; the latter will be from the Paris green applied to disguise the pin which, given the zinc content, is a modern addition to secure the other components at this junction.

Radiocarbon dating

In the mid-1990s, an attempt was made to radiocarbon date the Dunaverney flesh-hook using a small sample from the surviving segment of inlaid shaft, but the sample proved to be too saturated with consolidants from former conservation treatments.⁶² However, during later examination with a boroscope and an optical microscope, it became clear that more of the original shaft survives in the butt-end being trapped by the rods beneath the two ravens. Since the coils formed at the end of these rods are still intact (see fig 12d), the wood must be ancient. It was possible to obtain two independent radiocarbon measurements which were consistent with one another and could therefore be combined to give the weighted average in table 3; the calibrations⁶³ are based on that average.

Being oak, the wood has the potential, if heart wood was used, of having been of some considerable age prior to use. However, the likelihood of a shaft of roughly 16mm diameter being fashioned from particularly mature wood seems small and the date is therefore likely to be close to the date of manufacture of the flesh-hook.

Table 3. Radiocarbon measurements for the Dunaverney flesh-hook

	Wood id.	Lab. ref.	Date BP	Combined date BP	Cal BC (1 sigma)	Cal BC (2 sigma)
Dunaverney	<i>Quercus</i> sp. (oak)	OxA-10004 OxA-10005	2839±37 2818±37	2828±26	1005–925	1050–910

THE MANUFACTURE AND CONSTRUCTION OF THE FLESH-HOOKS

Dunaverney

While both the flesh-hooks under consideration are multi-component, the mode of assembly of the Dunaverney example was fairly conventional relative to that of Little Thetford. Its three main segments, the ferrules, were each most likely cast in a bivalve mould. The hooks at one end, and the butt knob at the other, were cast as part of their respective ferrules, but the former would have been cast straight, then curved round in post-cast working. The forging required to bend them would have added both hardness and elasticity, a point made by Armbruster in the context of her study of the Baiões flesh-hook.⁶⁴ The decorative grooves are not very neatly executed but are fairly deep, suggesting they were present in the casting, even if tidied up during finishing. Similarly, the various perforations to accommodate pegs and the under-bird rods could have been created easily in the casting, at the same time providing an excellent opportunity for supporting the core relative to the mould valves. Once finished the ferrules would next have to be mounted on two lengths of wooden shaft. Insetting the latter with, probably, hundreds of small slivers of bronze would have been time-consuming and fiddly. Even

with the cutting of neatly fitting slots in the wood, it can be assumed that adhesive would be essential to prevent loss during use (consolidants used in conservation treatment prevent this from being verified). The overall pattern created was very regular (see figs 1 and 10). We know of no other example of such inlaying – however, survival of wooden shafts is rare.⁶⁵

If the birds were also produced in bivalve moulds, residual traces of casting flashes have been carefully removed in the finishing. It is possible that they were each individually modelled in wax then cast in single-piece investment moulds, but correspondence between the alike birds (ie the two ravens, the two adult swans and the three cygnets) favours a common pattern having been used, therefore implying part-moulds at some stage of the process. Once produced, the rods projecting beneath each bird were passed through the pre-formed holes in the ferrules, but the latter would need to have been already mounted on the oak shafts. To judge from the unrestored rods, the ends projecting beyond the base of the ferrule were flattened, thereby enabling each to be coiled around a separately cast ring. Even so, this coiling operation – involving up to 2¼ tight turns – would have been tricky, and would probably have required the use of fine tongs to turn the strip while hot.

The final component to discuss is the end loop and ring. The earlier twentieth-century damage precludes certainty on the arrangement here. However, the ribbon-like nature of the torn loop suggests that a double thickness ribbon was doubled round the pre-formed ring and its ends inserted into the pre-cast slot in the butt. If the ribbon ends could have been turned outwards once inside the terminal, this may have held the ring adequately. However, the composition of the lead-tin infill there allows it to be ancient, suggesting additional securing of loop to terminal by filling the cavity with this low-melting-point alloy. Holmes has shown that similar ribbon loops on some of the Irish Bronze Age horns were secured by lead alloy.⁶⁶

The compositional analysis shows there were at least two phases of casting in the manufacture of Dunaverney. The two birds analysed, one swan and one raven, are not of the same metal group as their respective ferrules, but are of the same group as the hook ferrule (see fig 16 and table 1). This clearly demonstrates that the flesh-hook was a single design concept.

Little Thetford

In the case of the Little Thetford instrument, there was less, if any, need to construct the object from so many components; the whole of the hook-end and the whole of the butt-end (except for the missing, free-running ring if such originally existed) could each have been cast in one without compromising the desired design. The possible reasons for the complex mode of construction are discussed below.

We can assume that the three components of metal group C were the first cast – the two ferrules again most likely, as traditionally, in cored-bivalve moulds. The rod for the prongs is, however, very long and thin for direct casting, at 610mm. It is therefore more likely that it was initially cast as a shorter, thicker bar, and painstakingly hammered out into a longer rod. The neat square section could have been created, if not present at the outset, during this process. Once stretched to the desired dimensions it would need to have been bent in a tight curve just off-centre to preform one of the prong base angles (fig 19.2). However, before assembly could progress further, the cross-bar needed to be made, and this was certainly cast from a different melt of metal, group D. The

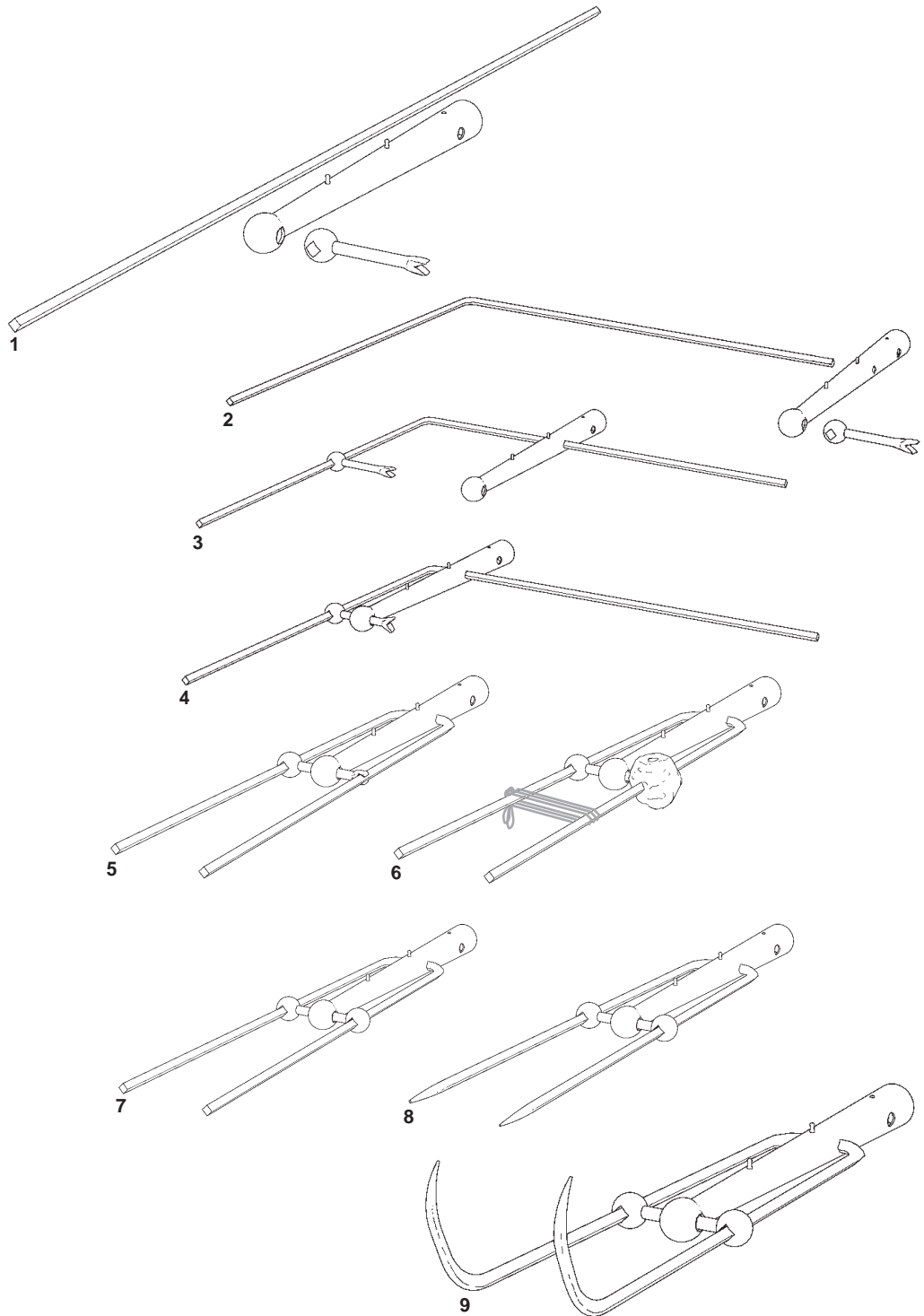


Fig 19. The sequence of steps in the construction of the Little Thetford flesh-hook.

perforation through its complete end needed to be cast ready to provide a close fit for the rod, whereas the forked end was not cast in its final form. It must initially have been more slender to pass through the perforations in the ferrule terminal. Only after it and the right-angled rod were united and passed through their respective perforations in the ferrule (fig 19.3 and 4) could the end be worked to expand the fork and create an appropriately shaped recess to accommodate one side of the square section of the second prong.

Having reached this point, the second prong could be brought round to its correct alignment, butting up against the fork (fig 19.5). This involved making a complementary tight turn where the prong-rod exited the ferrule. This could readily be achieved by placing a narrow mandrel in the angle between the rod and the ferrule and bending the rod around it. The bending would not have required intermediate annealing,⁶⁷ but might explain why this bend is not quite symmetrical with that opposite, as well as why the rod was preferentially thinned there, this being a way of encouraging it to bend at the right place. Once drawn up to its final position, the cap-end could be fixed around its union with the cross-bar. At first, because of the gap between the cap-end and the forked end, it was assumed that this had been pre-cast, then slid down the second prong, slotted over the forked end and partially closed around it by forging. However, inspection under the microscope by Paul Craddock points instead to it having been cast on. Numerous gas bubbles in the casting show no evidence for deformation such as would have been caused by final-stage forging.

Normally one would expect cast-on metal (bronze on to bronze) to have acted like a hard solder, binding everything together tightly, so the looseness of the fit is a puzzle. There is no sign of excessive wear and tear to account for it. The prongs would probably have been bound together to ensure that the fork and abutting prong did not spring apart during creation of the cap-end. A wax model of the cap-end would then be built around the junction, invested with refractory clay then fired to melt out the model and preheat the clay (fig 19.6). Obviously a gate had to be formed in the mould to allow the wax to drain out and the bronze to be poured in. On the basis of current evidence, this is an extremely unusual use of the lost-wax casting technique in Bronze Age Britain (see discussion below).⁶⁸

By this stage, the hook-end was essentially assembled, but two main operations remained: forming the hooks themselves and securing two crucial loose unions. There may have been some advantage to giving the whole assembly more rigidity before forging the prongs; this concerned the slack joints where the cross-bar and prong base passed through over-large perforations in the ferrule. Both had a plug of lead-rich alloy cast into them – components 5 and 7 – but while the former would have been necessary from the outset, it is possible that the latter was a secondary feature, for the prong base could initially have been clamped tight by the insertion of a wooden shaft with a specially cut split end. If this was the case, it was only later, perhaps after the prongs snapped within the ferrule, that the lead block was cast in to secure the broken ends.

The orientation of the object would have been different for the two lead-rich castings. Component 7 in the middle of the socket would have been most easily formed by pouring molten lead into the socket mouth. Since it is clear from the radiographs that the block stopped abruptly a little beyond the prong base, there must have been something still filling the lower end of the socket, either original clay core, or material subsequently inserted. The radiographs also show a roughly conical outer end to the block, presumably the result of pouring in a viscous and rapidly cooling metal. The gaps

around the prongs at the side perforations would have acted as vents and any lead flowing out of them could easily be cut away after cooling.

At the ferrule terminal the original clay core had been scraped out to form a tubular hole for the cross-bar to pass through, but once the latter was in place, there was a lot of slack around it. The lead-rich alloy poured in to fill the void therefore took the form of a barrel-shaped collar trapped inside the shell of the bulbous terminal and enveloping the centre shaft of the cross-bar. For this infilling, the assembled hook-end would have been set on its side, though not quite at 90 degrees. Although it would have been difficult to flow the molten lead into the small gap around the shaft at the upper perforation, there does not seem to be any practical alternative to this mode of creation. Again, the opposing gap would serve as a vent and, indeed might be largely blocked with clay to prevent too much metal running straight through. Any excess lead would have been cut away at the openings. The seemingly neat shape of the collar as indicated in the radiographs is thus entirely the product of the void that needed to be filled. Presumably this collar would initially have succeeded in making the union rigid and the current small movement is due to later wear or deterioration. In particular, the collar's surfaces where exposed to the peat of the burial environment would have been more vulnerable to corrosion than the associated bronze. The freedom of movement here, probably including side-to-side movement, would have made it desirable to secure the junction after discovery. A simple narrow hole was evidently drilled from the end of the terminal right through the lead collar and cross-bar to accommodate a brass pin.

With the whole assembly rigid, the smith could have set about finishing the hooks. The tips would logically be formed at this stage by forging and grinding, giving an opportunity to make final adjustments to their lengths to ensure symmetry before turning the prongs (fig 19.7 and 8). The matching double-inflection curve of both prongs also shows a concern for symmetry and may have been achieved by turning them simultaneously over a single long mandrel (fig 19.9).

The butt ferrule also needed additions, one planned – the loop to attach a ring or thong, the other due to a casting flaw which left an elongate hole in the socket wall. The repair infilling this hole and the loop were probably made of the same stock of metal (group D) as the cross-bar and its cap-end, but since the latter two had to be produced on separate occasions from one another, these group D components were not necessarily simultaneous castings.

The loop is a continuous annulus partly inside and partly outside the terminal as described above. This can be achieved by pre-casting the loop and then setting it carefully in position in the bivalve mould for the ferrule. This is a method suggested by Holmes for some of the loops attached to Irish horns.⁶⁹ However, certain details of the loop on the Little Thetford flesh-hook argue against this method having been used; while the greater part of the loop is neatly fashioned, the flanges to either side are relatively ragged and, moreover, abut the outer surface of the knob. Had this loop been pre-formed it is likely that the flanges would have been finished neatly, if intended to be visible, or otherwise to have been concealed in the process of casting the ferrule. Instead, it is possible to suggest that the flanges are a by-product of pressing a wax model of the loop into the two perforations in the end of the pre-cast ferrule (fig 20). A second relevant feature is the form of the internal part of the loop. The radiographs indicate that it was not particularly regular and this is more likely to have been the incidental result of casting into a scraped out hole, rather than into a mould made for the purpose of casting the loop in isolation. A final piece of relevant evidence is the deduction

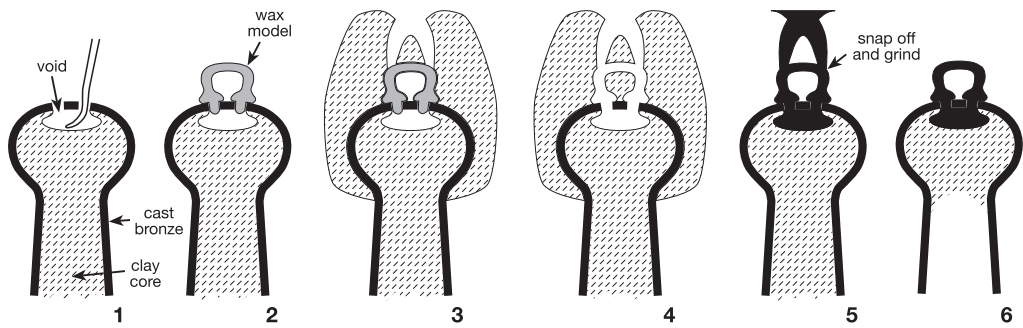


Fig 20. Illustration of the manufacture of the Little Thetford butt-end loop using lost-wax casting: (1) void carved out of clay core of cast ferrule. The shape of the internal cavity made in the knob is schematic, but is based on radiographic evidence; (2) loop modelled in wax and plugged into the two perforations; (3) clay investment mould constructed around loop and knob; (4) mould fired and wax melted out; (5) bronze cast-in; mould broken away; (6) bronze casting jet detached.

(above) that the group D metal seen in the end loop was a *later* melt than group C used for the ferrule.

Before putting the wax model in place it was necessary to scrape out cavities in the clay core just inside the two perforations. These cavities were extended towards one another to link up beneath the bronze shell. The ends of the wax loop need only have been long enough to plug into the two cavity entrances, thus preventing the invested clay getting inside. Clay would have been invested around the wax in the usual lost-wax process, but, after the wax had been melted out, the inflowing bronze would have occupied the full cavity, providing no gas was trapped.

Alloy composition

For each of the flesh-hooks, two distinct compositions of leaded bronze were used. The different impurity compositions could simply be a function of variations in the stock of metal available. However, the compositional difference in terms of the *alloy* used may have been a deliberate choice on the part of the smith: for both objects the lower lead alloy has been used for the prongs. Lead does not dissolve in bronze and it will segregate, especially if the metal cools slowly; this causes problems for subsequent cold working of the bronze even with periods of annealing. However, experiments with rolling ingots of leaded bronze have shown that it would have been possible to produce sheet from a 10 per cent lead bronze if the ingots were cast in metal moulds and therefore cooled relatively quickly.⁷⁰ While it may therefore have been possible to use a higher lead alloy for the prongs, particularly if the metal had cooled quickly and the lead had remained distributed,⁷¹ it appears that neither smith took the risk.

Such deliberate choice of a low-lead bronze (once leaded bronze was the norm in Britain) is most pronounced in the manufacture of cauldrons. In the Wilburton and Ewart periods, the sheet bronze, made by repeated hammering to thin the metal, are fairly lead-free (<1 per cent), whereas the cast fittings contain around 10 per cent or more of lead; later in the Llyn Fawr period (fig 18), however, the lead level in cauldrons

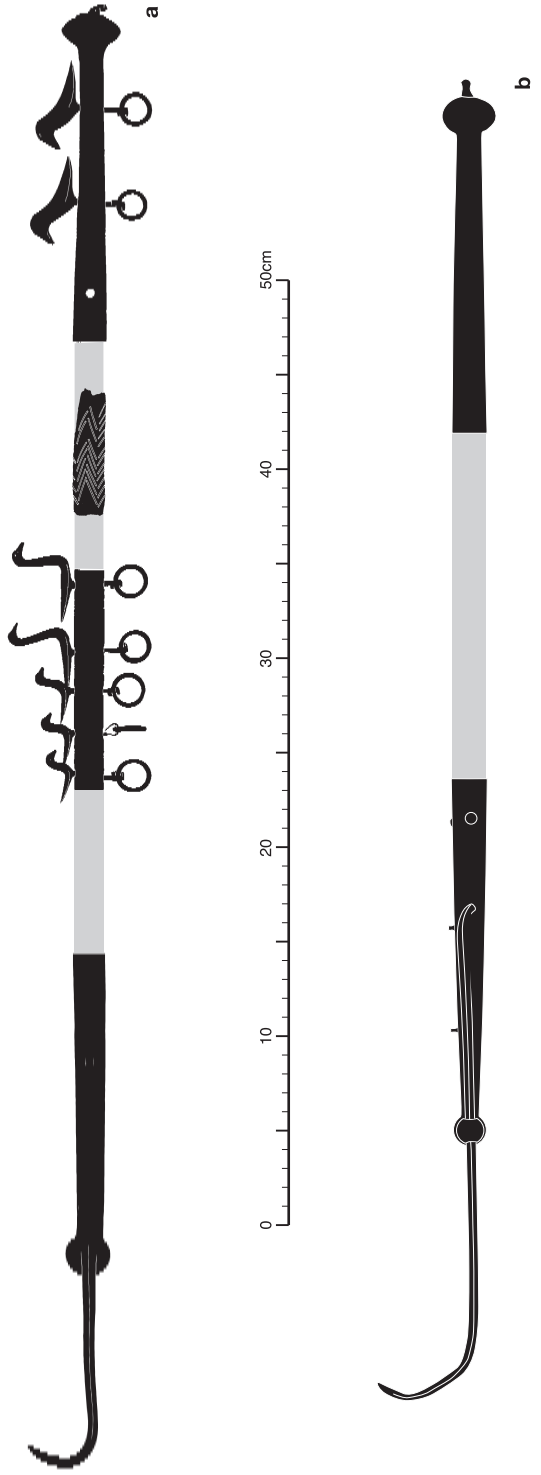


Fig 21. Outline reconstruction of (a) the Dunaverney and (b) the Little Thetford flesh-hooks.

increases and there is less differentiation between the sheet bronze and other components.⁷²

Original length

While we have discovered a great deal about the Dunaverney and Little Thetford flesh-hooks, one fundamental fact is missing – their original lengths. Dunaverney was apparently discovered intact, but did not survive in that state for long. As we have already seen, there are two accounts of its original length. The one of 1832, three years after the flesh-hook was found, has it at about 2½ft (about 0.76m), while the later account of 1852 has it measuring a hugely impressive 4ft (about 1.22m); one cannot help but wonder if the tale had grown in the telling over the intervening twenty years.

We believe that the evidence of other Class 3 and 4 flesh-hooks would favour the shorter length (as reconstructed in fig 21). Table 4 shows the lengths of the most intact of these elaborate flesh-hooks.⁷³ For the multi-piece flesh-hooks, the minimum length given is the total of the lengths of the metal segments; for Dunaverney, however, it includes the length of the extant wooden shaft segment (66mm) plus a second shaft of similar length.

Table 4. Lengths of the most intact of the elaborate flesh-hooks

Condition	Flesh-hook	Class	Length (mm)
Intact	Thorigné	4	750
Found intact, but now lost	Lurgy	3	c 740
Nearly intact?	Cantabrana	4	>620
Incomplete shaft	Dunaverney	3	>700
Shaft missing	Little Thetford	3	>520
Shaft missing	Baiões	3	>550

The elaborate flesh-hooks are quite individual, but nevertheless share a number of features. The correspondence in length of the Thorigné and lost Lurgy flesh-hooks suggests that length might have been relatively standardized, possibly even for practical reasons.⁷⁴ If so, then the exposed sections of shaft on the Dunaverney flesh-hook, if equal in length, were only about 90mm long – not much longer than the extant piece. An overall length for Dunaverney similar to that of Thorigné would correspond well with the earlier account of its discovery in the *Ordnance Survey Memoirs of Ireland*.⁷⁵ The implication of a ‘standard’ length for Little Thetford would imply an exposed length of shaft 180–230mm long (minimum length reconstructed in fig 21).⁷⁶

It is noteworthy that the majority of Class 3 and 4 flesh-hooks have prong lengths that are between 100 and 130mm, measured from the point of emergence from the cross-bar. The shortest is Doomore (65mm) and the longest is Little Thetford (142mm), while the overall length of the Little Thetford prongs from the U-bend in the ferrule is 261mm. In contrast, the double-pronged Class 1 flesh-hooks (see fig 3) are surprisingly short: their *entire* lengths measured from the U-bend range from a maximum of only 100mm for the example from Ballinderry, County Offaly, Ireland, down to as little as 57mm for that from Barrios de Luna, León, Spain.⁷⁷

Table 5. Class 3: elaborate socketed flesh-hooks, double-/triple-prong

No.	Provenance	Ferrules present	Head style	Key references
1	Dunaverney, Co Antrim, Ireland	Hook-end (double-prong) Central Butt	Bobbin	This paper
2	Lurg, Co Tyrone, Ireland <i>Now lost</i>	Hook-end (double-prong) Butt	Simple U-form	Carruthers 1854–5; Armstrong 1924, 117, fig 12
3	Doomore, Co Sligo, Ireland	Hook-end (double-prong)	Double-prongs from rectangular head; cross-bar is bilateral extension of head into loop for ring	Unpublished; National Museum of Ireland registration number: 1944, 265
4	Killeonan II, Argyllshire, Scotland	Hook-end (double-prong) Butt	Bobbin	Coles 1959–60, 25; fig 3; Jockenhövel 1974, Abb. 1, no. 13; RCAHMS 1971, 12, 14; pl 6; Colquhoun and Burgess 1988, no. 537
5	Little Thetford, Cambridgeshire, England	Hook-end (double-prong) Butt	Bobbin-like cross-bar	This paper
6	Eaton, Norfolk, England	Hook-end	Bobbin	Dawkins 1885; Norfolk Museums Service 1977, 33–4, fig 78
7	Lulworth (Winfrith Newburgh), Dorset, England	Hook-end (double-prong, one missing) Butt	Bobbin	Drew 1935; Jockenhövel 1974, Abb. 1, no. 12
8	Solveira, Trás-os-Montes, Portugal	Hook-end (double-prong)	U-form with perforated ‘webbing’ in crook	Kalb 1980, 42, Abb. 6, no. 29; Coffyn 1985, 178; Delibes de Castro <i>et al</i> 1992–3, 421
9	Senhora da Guia, Baiões, Portugal	Hook-end (triple-prong) Central Butt	Triple prong from pyramidal head	Armbruster 1998; Armbruster 2000; Armbruster 2002–3; this paper (see note 79)
Unaccompanied butt ferrules				
10	Monalty Lough, Co Monaghan, Ireland	Butt	–	Anon 1968, 93; Jockenhövel 1974, Abb. 1, no. 16
11	River Bann near Toome, Co Antrim, Ireland	Butt	–	Unpublished; Ulster Museum, Belfast Richard Warner, pers comm
Possible example				
12	Plouguerneau, Finistère, France	Central, with single ring	–	Le Roux 1985; Briard 1991, 128–30, 133, fig 4.10; Armada Pita and López Palomo 2003, 176; this paper (see note 106)

DISCUSSION

Having fully described the Dunaverney and Little Thetford flesh-hooks, one is left in no doubt that, relative to most Bronze Age metalwork, these are ‘complex’ objects. The various forms of analysis we have been able to apply have both improved our dating of the instruments and helped clarify the particular technologies employed. In some respects, their technological features, just as much as the features of their design, are idiosyncratic. In each case, the resulting combination is an object with individuality and complexity, bordering on the unique, even though belonging to the family of elaborate flesh-hooks (Classes 3 and 4: tables 5 and 6).

We have previously highlighted the fact that individuality and complexity are characteristics of the most elaborate flesh-hooks and have suggested that the significance of *individuality* lies in the expression of the elevated – indeed, totemic – role they held for their respective communities.⁷⁸ *Complexity* is multi-faceted in the context of this object type. There is undeniable complexity in the design of Dunaverney in particular, as well as in that of several other elaborate flesh-hooks. Complexity is also expressed strongly, albeit in different ways, in the respective technologies of Dunaverney and Little Thetford, in terms of assembly techniques and the use of different casting methods and metals for different components.

Technological and design complexity, and the use of *cire perdue* (lost wax) casting

The Dunaverney and Little Thetford flesh-hooks are both multi-component objects. While the construction of the Dunaverney flesh-hook is less unusual than that of Little Thetford, it is the more visually striking of the two. Its design, which we know from the compositional analysis was a single original concept (see fig 16), arguably incorporates more of the unusual elements of the elaborate series of flesh-hooks than any other single example: notably a central ferrule, an unprecedented degree of zoomorphism, an unusually large number of rings and an inlaid shaft.⁷⁹ However, the surviving fragment of shaft from Dunaverney has received little attention. As discussed above, it is meticulously inlaid, with small strips of bronze set in a herringbone pattern. Looking to the Class 4 flesh-hooks on the Continent, the two with extant hook-ends have bobbin cross-bars like Dunaverney, indicative of the interchange of design ideas. However, the Continental ones have shafts made from alternately twisted metal rods (see fig 4b).⁸⁰ This suggests that the inspiration for the herringbone design inlaid into the Dunaverney wooden shaft was the Continental twisted metal shaft: it is far more likely that the decorative expression in the former is a skeuomorphic imitation of the structural form than *vice versa*. This means that the Continental version of the bobbin flesh-hooks existed at least as early as Dunaverney, thus perhaps as early as the eleventh century BC or the beginning of the tenth.⁸¹

While complex in design, technologically Dunaverney is among the simpler of the later-series flesh-hooks. With the exception of the inlaying of the wood, it employs a range of production techniques largely standard in the Late Bronze Age, albeit requiring skill and dexterity. Little Thetford instead uses a particularly unconventional constructional method. There is no practical reason why Little Thetford should have been made in so many pieces and in such a complex way. However, progression in style from the simpler Class 1 and 2 flesh-hooks to the elaborate Class 3 and 4 examples is

Table 6. Class 4: elaborate metal-shafted flesh-hooks, double-prong

No.	Provenance	Shaft form	Head style	Key references
1	Thorigné, Deux-Sèvres, France	Triple twisted rods	Bobbin	Gomez de Soto and Pautreau 1988; Pautreau and Gomez de Soto nd
2	Cantabrana, Burgos, Spain	Triple twisted rods	Bobbin, in form of bull's head (fig 4b)	Delibes de Castro <i>et al</i> 1992–3; Delibes de Castro <i>et al</i> 1999
Possible examples				
3	River Genil, Seville, Spain	Double twisted rods	–	Armada Pita and López Palomo 2003 <i>Comment</i> : shaft fragment, including butt
4	Isleham, Cambridgeshire, England	Single smooth thick rod	–	Burgess and O'Connor 2004, 188, fig 22.5; Needham and Bowman 2005, fig 4 <i>Comment</i> : possible example lacking head/prongs

instructive for comprehending the seemingly bizarre nature of this construction; it makes more sense if seen as a fairly literal copy of a hafted Class 1 flesh-hook. In our suggested reconstruction of the hafting of Class 1, as illustrated by the Bishopsland example (see fig 3), the cross-bar would have been necessary to prevent rotational motion of the hooks relative to the shaft. The most coherent explanation of the construction of Little Thetford is that it is a skeuomorph of the earlier metal-and-organic hafting arrangement.⁸² The true 'bobbin' cross-bar seen on many of the Class 3 and 4 flesh-hooks could then be a stylized development of the Little Thetford form.

The construction of the Little Thetford flesh-hook employs *cire perdue* (lost wax) in highly innovative ways to add the end loop to the butt ferrule and the end cap on to the cross-bar to secure the prong (see figs 19 and 20). Loops had been cast as one with spearheads and axes for centuries before, but on these types the loops were high in the mould or appended to thick metal bodies.⁸³ The problem for the Little Thetford butt may have been the position of the loop at the bottom end of a long, thin-walled casting; there might have been a high risk of the rapidly cooling molten metal not filling the thicker loop void.

The use of *cire perdue* to cast the cap-end on to the cross-bar would seem to be an ingenious solution to a technical problem resulting from the desire to imitate the style of Class 1 flesh-hooks. From finds to date, there are no Class 1 flesh-hooks in the east of England, where instead the predecessors are the Class 2 socketed single-prong versions (see figs 4a and 22a).⁸⁴ It is possible therefore that production of a double-pronged hook was something new for the craftsman who made the Little Thetford piece, and this may explain not only why the translation to predominantly metal was achieved in an extraordinary way, but also why this piece ended up with considerably longer prongs than other flesh-hooks, as noted above.

The use of *cire perdue* is rare in the Bronze Age of the British Isles. We do know, however, that this technology was already in use concurrently with early flesh-hooks. On cauldrons of Type A, the base of the handle, known as the staple, is tubular in form and was cast using *cire perdue* over the rim and on to the body of the cauldron;⁸⁵ Leeds comments on the difficulty of casting these on to thin sheet bronze and the potential for

burning through the body of the vessel.⁸⁶ A number of Class A cauldrons have been found in the east of England and that from Feltwell⁸⁷ is one of very few cauldrons anywhere in the Atlantic zone that was found in direct association with a flesh-hook – in this case a Class 2 example.⁸⁸ Cauldron handles were completed by casting rings with a diameter in excess of 100mm into the staple;⁸⁹ these may have been lost-wax cast in the same operation as the staples, as suggested by Leeds,⁹⁰ or rather more easily as a separate exercise.

We can now point to other cases of the use of *cire perdue*. The unpublished flesh-hook from Doomore has a free-running ring through a loop that is an integral part of the casting of the hook-end: this ring must have been cast on to the loop using the lost-wax method.⁹¹ We also suspect that some Irish horns may have similarly cast-on rings,⁹² and it has more recently been suggested that *cire perdue* was used for the manufacture of some gold tress rings.⁹³ In addition, cast-on rings appear to be a feature on the neck-rings in the hoard from Braes of Gight, Aberdeenshire, and possibly they existed on neck-rings from two other Scottish hoards.⁹⁴ A final enigmatic example is seen in Irish hoards containing rings interlocking with other rings,⁹⁵ and which can only have been cast-on. The recognition of these uses of *cire perdue* in the British Isles adds important new examples to the limited set of highly specialized applications of this technique.⁹⁶

Birds, rings and other special features: iconography and symbolism

The birds on the Dunaverney flesh-hook have always attracted special interest and have now been shown by analysis to be integral to the design. In seeking parallels, attention was drawn long ago to the extensive use of avian models in the later prehistoric cultures of central Europe.⁹⁷ The rarity of zoomorphic images in the British, Irish and more generally the Atlantic Bronze Age seemed to leave the Urnfield world as the main contender as the source of inspiration. However, we have discussed elsewhere not only the fact that the Urnfield use of birds involves different species and different arrangements, but also that there was an undercurrent of zoomorphism running through specialized Late Bronze Age Atlantic feasting gear, notably on the Iberian and French articulating spits.⁹⁸ The character of the zoomorphic representations is quite different from that in central Europe and its stimulus may lie rather in the central Mediterranean.⁹⁹

Identifying the ultimate source of influence for zoomorphism on the Dunaverney flesh-hook does not of course provide any insight into its specific symbolism. The birds sitting, or floating, atop the shaft are charming characterizations, only slightly stylized. The rods beneath them would have gone through wood as well as the metal ferrules and we cannot be sure whether they would originally have rotated as they now do. Moreover, it is not possible to ascertain the original positions of the birds on the central ferrule with certainty as they could all have been moved around after their original loops were severed. We have already noted that there is some logic in the spacing of the perforations for the two adults being adjacent, but we still cannot know the original orientation of the middle ferrule and, thus, whether the larger water-birds were nearest to or furthest from the birds on the butt ferrule. Certainly, the two sets of birds could not be more different from one another and this suggests to us a deliberate opposition.

The two birds on the butt end are presumably an adult pair and are best identified as corvids, perhaps ravens, as realized long ago by Carruthers.¹⁰⁰ The group of five was once described as consisting of swans and ducks, but is surely a family of swans – two

adults and three cygnets gliding along in an overlapping row. Instantly they invoke opposites: birds of water versus birds of the air; white ranged against black; fecundity as implied by offspring, death as implied by predatory character; birds of the home territory versus those of wild places. It is easy with modern eyes to equate these qualities overall with the forces of good and evil; at the very least they should represent quite distinct supernatural forces in Late Bronze Age cosmology.

It is striking that these two species recur as prominent players among the gods of the early medieval Ulster myths.¹⁰¹ This is particularly intriguing in the context of George Eogan's observations that some distributions of prestige Late Bronze Age objects seem to foreshadow the emergence of the early medieval provinces of Ireland, particularly Ulster and Munster.¹⁰² In the Irish myths ravens are associated with the war goddesses, Macha, Badbh and Morrigan, while swans are beautiful but sometimes destructive creatures with supernatural powers; the stories include frequent transmutation between swans and humans, with pairs of swans often linked together by chains of precious metal.¹⁰³ However, given the long passage of time between (some seventeen centuries), it seems unlikely that the mythological connotations of the bird species concerned would have remained unchanged.

We have suggested that in the Atlantic zone, zoomorphism on prestige feasting equipment – that is, on both the elaborate flesh-hooks and on the articulating spits – might have been a manifestation of clan identity.¹⁰⁴ Little Thetford has no zoomorphic imagery as such, but there are the three unexplained projections on the hook-end which are not the remains of chaplets for positioning the core during casting. To judge from the ring on the hook-end of the Baiōes flesh-hook, for it to hang downwards the hooks must have been upturned when in use which would also be the more practical orientation for retrieving food from a cauldron. By analogy, the projections on Little Thetford are on its uppermost surface (see fig 21). Reginald Smith wondered whether they might have supported bird images,¹⁰⁵ but they are very slight and would not provide a good footing for models. The two longer ones show minimal expansion at their ends, just sufficient to have held in place a thin perforated object, the rods in effect functioning as rivets. The third is stumpier but has a similar basal diameter and thus may originally have been of the same height as the other two. If the three were designed to hold a perforated object of some sort, they would have been cast as slightly tapering rods over which the object was slotted. Given the extant length of the two longest projections, the object would have been a relatively thin plaque (or plaques), the rod ends then being hammered to expand them minimally and thus hold it in place. If subsequently during use the attached plaque broke off or became redundant, its removal could have damaged the third rod, which then required grinding down to remove irregularities. Any sharp lips on the other two could also have been smoothed off. In this scenario, the initial phase plaque, perhaps of bone or wood, could have provided a field for decoration or symbolic notation.

In total there are sixteen Atlantic elaborate flesh-hooks – whole or fragmentary (see tables 5 and 6). One (Baiōes) is unique in having spiral motifs cast into the hook-end. Only two, representing 12.5 per cent, display zoomorphism (Dunaverney and Cantabrana), in contrast with 41 per cent (nine out of twenty-two) of articulating spits. However, Little Thetford, with its remnants of what could have been fixings for a plaque, may suggest that other modes of displaying symbols were part of the flesh-hook tradition. Some flesh-hooks have rings attached to the knob of the butt ferrule, that on Dunaverney having been lost. Such end rings can be seen as having a practical function

as suspension mechanisms for the object when not in use. However, Baiões, like the unpublished piece from Doomore, also has a free-running ring cast on to a loop on its hook-end. The central ferrule on the Baiões flesh-hook also has a ring,¹⁰⁶ and both the central and butt ferrules of Dunaverney seemingly have a surfeit of rings, although attached quite differently from those on other flesh-hooks.¹⁰⁷ It might be argued that such rings would have allowed these implements to be suspended horizontally when not in use, allowing the implements to continue to have potency beyond the feasting ritual. Dunaverney argues against this as the birds would be upside down if the flesh-hook were to be suspended in this way (see fig 21).

Free-running rings are rare on other types of contemporary metalwork, but where they do feature they are most often part of prestige or unusual objects, most notably cauldrons and Irish horns (as discussed above).¹⁰⁸ Many flesh-hook finds are too fragmentary to ascertain whether or not rings, or some other device for attachment, were originally present. However, two finds, Eaton and Lulworth, were in hoards that also contained rings of about the same size as those found on other flesh-hooks. In isolation, such rings are not uncommon in the Late Bronze Age, and probably had a variety of functions. However, the Eaton and Lulworth flesh-hooks share another feature: cast perforations in the bobbin of the hook-end. Both have a perforation set between the prongs and the latter also has one running through the bobbin from one end to the other. Such perforations were not necessary for the success of the casting process and serve no obvious practical purpose. Comparison with Doomore is instructive in considering the lateral perforation in the Lulworth example, since their hook-ends are stylistically similar. The Lulworth bobbin perforation may have served as a conduit for a separate component, such as a rod of an organic material which could have held end rings in the fashion seen in the Doomore piece (see table 5). The end-on perforations on Eaton and Lulworth are harder to explain.

Bronze rings are not of course necessary for suspending something from a flesh-hook, nor for suspending such an instrument: any form of organic binding attached to the shaft or one of the metal components would serve. Nor are cast-in perforations or rivet-like pins essential as fixing mechanisms. Whether or not they carried a symbol of clan identity is unknowable, and it must be said that the rings on the hook-ends of Baiões and Doomore, as well as the perforations on Lulworth and Eaton, would have been immersed in the cauldron when the flesh-hook was in use. Even the rings on the Dunaverney central ferrule would have caught the edge of the cauldron. Perhaps, practicality as seen from our perspective, may not have been the issue, or perhaps the elaborate flesh-hooks had become largely symbolic – still a part of the feasting ritual but no longer serving their original utilitarian role to retrieve food from the cauldron. However, the fact remains that these various attachment mechanisms were integral to the design of at least seven of the Class 3 and 4 flesh-hooks, suggesting that, in addition to a limited use of zoomorphism and more abstract motifs, they were part of the prestigious qualities of these objects.

Little Thetford and Dunaverney in their respective metalwork traditions

For Little Thetford, the impurity pattern of the bronze is not wholly diagnostic as to which phase of the Late Bronze Age this flesh-hook belongs. However, taken together with the argument (above) for its typological development, a strong case can be made for Little Thetford being a rather experimental piece made by smiths working within the

Wilburton tradition (see fig 18). It is possible that at least one other unusual flesh-hook emerged from this tradition: some otherwise unidentified fragments of shaft in the Isleham hoard, found not far from Little Thetford (see fig 8), are now suggested to be from a solid-shaft flesh-hook.¹⁰⁹ The immediate environs were clearly well served by Wilburton metalworkers – the Wilburton hoard itself is also nearby, a point of some significance given the highly innovative nature of that metalworking tradition. It produced a range of new and fancy types, including extremely long and thin-cast tongue chapes, hollow-bladed spearheads, cauldrons and varied accoutrements.¹¹⁰ The last include a number of short ferrules with beaded bulbous terminals – some with end rings – that are stylistically related,¹¹¹ but that are not regarded by us as being from flesh-hooks.¹¹²

Another radical innovation of the Wilburton smiths was their extensive use of lead as an additive to bronze. This produced alloy compositions contrasting completely with the preceding Penard phase of metallurgy and at times with rather excessive proportions of lead.¹¹³ Clearly lead was coming into circulation much more widely and this provides the background to more frequent use of lead alone or in lead-tin mixes¹¹⁴ for specialized purposes such as seen in the construction of the Little Thetford flesh-hook.

In addition to the Isleham and Wilburton hoards already mentioned, two more contemporary hoards lie within 10km of Little Thetford – that with broken up weapons from Wicken Fen and the pair of sheet-bronze shields from Coveney Fen (see fig 8).¹¹⁵ This represents an astonishing concentration of Wilburton stage metalwork incorporating the most prestigious of objects, much weaponry, and the largest hoard yet found on British soil (Isleham – *c* 6,500 fragments); it is a concentration unrivalled anywhere in the country. Among its vast haul, Isleham contains fragments of Class A cauldrons, a class first developed in the previous Penard phase. Two cauldrons of this date occur just a short distance to the east and north east, at Eriswell and Feltwell, both of course associated with a Class 2 flesh-hook.¹¹⁶ The third flesh-hook of this class in the east of England lies on the other side of the Fens, amidst the mass of timbers comprising the Flag Fen platform (see fig 8).¹¹⁷ Close by is the extraordinary Fengate Power Station ritual assemblage of marsh-deposited metalwork and other material, and a Wilburton stage hoard only recently excavated from Bradley Fen by the Cambridge Archaeological Unit.¹¹⁸

In contrast with eastern England, where the early-series flesh-hooks are all single-pronged Class 2 examples, in Ireland the only two early examples known (from Bishopsland, County Kildare – see fig 3 – and Ballinderry, County Offaly¹¹⁹) are both of the double-pronged Class 1 type which, as argued above, may have been the inspiration for the Little Thetford piece. Whereas Little Thetford is the only Class 3 flesh-hook in eastern England, Ireland boasts five examples including Dunaverney; however, two are represented only by unaccompanied butt ferrules (see table 5). Of the five, only the butt ferrule from Monalty Lough is published, and a fuller consideration of the group as a whole is merited elsewhere.¹²⁰

Establishing an independent relative chronology for Irish metalwork has always been thwarted by the poverty of associated finds for much of the sequence. Indeed, after the Early Bronze Age, despite the richness of single finds of metalwork, hoards only become fairly common in the final phase of full bronze use – the Dowris phase. This bias is very apparent in George Eogan's corpus of hoards.¹²¹ Much reliance has therefore traditionally had to be placed on cross-correlating with the British and Continental sequences, a procedure that has in-built uncertainties. However, those uncertainties are

now beginning to be mitigated by independent radiocarbon dating of singly found bronzes.¹²²

Eogan's Bishopsland phase is only represented by at most four bronze hoards,¹²³ and not all are secure associations or securely dated. Bishopsland is equated to Penard in Britain (see fig 18) and there are some closely parallel types in the two islands – notably weapons. Three triangular basal-looped spearheads from Menlough, County Galway, have been radiocarbon dated to 3015 ± 35 , 2990 ± 35 and 2930 ± 35 BP (GrN-16879–16881) on samples from their shafts, measurements which correspond very well with those for British Penard metalwork.¹²⁴

Irish associated finds contemporary with the Wilburton tradition are even harder to identify, though again certain types of sword and weapon accoutrement seem to run in parallel. By comparison, the hoard record for the succeeding Dowris phase – broadly equivalent to Ewart in Britain (see fig 18) – is relatively rich. The recent radiocarbon dates either closely or loosely associated with types found in these hoards range from 2795 ± 35 to 2650 ± 80 BP.¹²⁵ These accord well with the established span for Ewart metalwork, broadly the tenth to the ninth centuries cal BC.¹²⁶ Perhaps more tightly dated still is a Class IV sword¹²⁷ found among timbers comprising the repair of an earlier trackway at Leigh, County Tipperary. The felling/last ring dendrochronology dates of the associated repair timbers spanned 912–871 BC.¹²⁸

This relatively new dating evidence for Irish metalwork therefore reinforces the traditional chronological correlations made with the British sequence (see fig 18). More pertinently for Dunaverney, it suggests that the Dowris metalwork phase could have emerged by, or during, the tenth century BC. Although more independent dating is required to confirm this point, as well as more intensive study to characterize the putative early Dowris phase, it is possible to see the Dunaverney flesh-hook in the context of new metalwork innovations, in particular the elaborate casting of horns and the further development of sheet vessels. Horns, buckets and Class A cauldrons are well documented in the north-eastern quadrant of Ireland¹²⁹ and more specifically in Antrim and neighbouring Derry (see fig 5). But of considerable interest is that prestige Late Bronze Age types and contemporary hoards are strongly clustered around the Bush river system in northern Antrim; Dunaverney lies at the heart of this cluster (see fig 5).¹³⁰ We have speculated that elaborate flesh-hooks were a symbol of clan identity (see above); it could thus be that this distribution gives a graphic indication of the core of a polity for which the Dunaverney instrument – with its particular iconography – was emblematic.

Sequence and importance for Atlantic society

On our analysis, the Little Thetford flesh-hook is probably one of the earliest 'elaborate' flesh-hooks appearing during the currency of Wilburton metalwork. Dunaverney followed shortly after in the late eleventh or tenth centuries BC, by which time the true bobbin style had been developed (see fig 18).¹³¹ These two very differently conceived and constructed flesh-hooks thus have a central position in the overall sequence spanning the thirteenth to the ninth centuries. Their chronological position assumes particular interest because there appear to be key changes associated with the transition from early-series to late-series flesh-hooks. Most changes are intrinsic to the instruments themselves, but at the same time as elaborate flesh-hooks appeared, cauldrons, which we have accepted as having a functional relationship with flesh-hooks, *diminished* in size. This might suggest the earlier larger ones were impractical, as suggested by

Gerloff;¹³² alternatively, it might signal greater exclusivity in those privileged to eat at the feast.

Notwithstanding the fact that occasional examples of the simpler flesh-hooks could have been made or deposited later, the overall impression gained is that Atlantic societies felt some compulsion to elaborate their feasting gear from the eleventh century onwards. Our concern in this paper has been with the flesh-hook series, but the appearance of articulating spits in some Atlantic regions is another manifestation of the same phenomenon.¹³³ The elaboration process, as we have seen, was not itself uni-directional, but instead followed many individual paths of creativity. It inspired design flare in bronze production traditions that were essentially highly conservative, even when producing the most elite forms of metalwork of the time – shields and early cauldrons.¹³⁴ It led to ingenious fabrication techniques, such as had rarely, if ever, been employed together on a single artefact. These elaborations produced, perhaps inevitably, quite new and visually striking images, not only larger in scale, but also more varied in their elements, which might even have included decorative organic appendages that have not survived.

Paradoxically, however, the period of transformation of Atlantic flesh-hooks also led to virtual standardization on double-pronged instruments – Baiões being the one exception. Why double-prongs should become essential across a wide geographical zone, parts of which had previously been content with elegant single-pronged examples, is a matter for speculation. But the need to conform in this respect may be part of the background for the extraordinary fabrication contortions seen in the Little Thetford flesh-hook, a piece that also stands out for the extreme overall length of its prongs. One has to regard Little Thetford as in part an experimental piece, but accepting this in no way diminishes either the social impetus or the craft capability to produce an object exceptional for its time.

Dunaverney, employing its own particular devices, carries forward this new-found desire to create individual masterpieces and certainly by this stage the process was widespread, if scattered, across Atlantic Europe – presumably disseminated quickly through inter-elite networks (fig 22b). An established vehicle for dissemination also explains the interchange of style elements, such as the bobbin style of cross-bar and the twist-effect shafts. It is also noteworthy that the *most* complex of the later-series flesh-hooks are currently evenly dispersed through the Atlantic regions – Dunaverney in Ireland, Little Thetford in Britain, Thorigné in France, Cantabrana in Spain and Baiões in Portugal. Each of these virtuoso pieces combines internationally exchanged elements, either directly copied or translated through skeuomorphism, with more locally relevant facets – pride in the highest craftsmanship and the embodiment of cosmological references appropriate to the home society.

A final and crucial question about the transformation from early to late flesh-hooks must be whether aggrandizement was accompanied by any change in utility. Certainly, to the modern mind, the attachment of dangles would seem to interfere with the easy service of food from the cauldron and would, moreover, leave them encrusted with undesirable residues. This in itself may not be a valid argument for divorcing the flesh-hook from its presumed primordial role during the thirteenth to twelfth centuries BC. But the whole process of elaboration speaks of social elevation of the kind that often leads to the creation of symbolic regalia, the objects still understood by society in terms of their original utilitarian function, but now serving it in an obscure or token way at celebratory festivals or in propitiation to the gods.

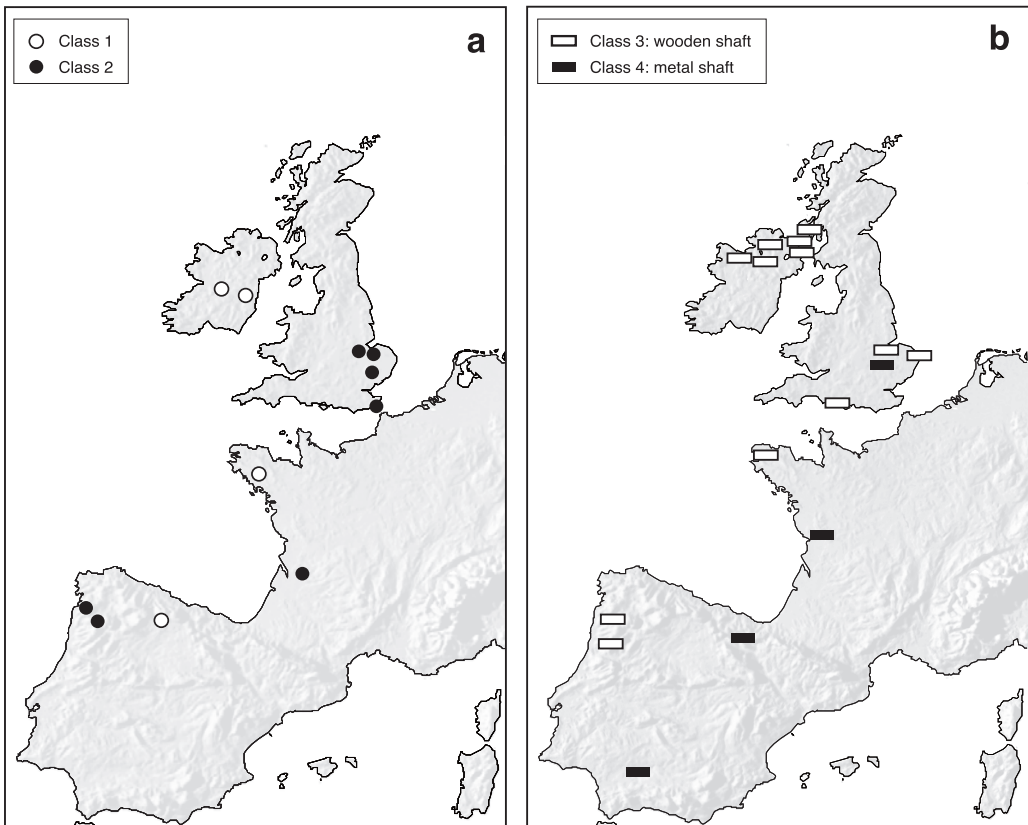


Fig 22. Map of recovery of Atlantic-zone flesh-hooks: (a) Classes 1 and 2; (b) Classes 3 and 4 (elaborate styles).

DEDICATION

We dedicate this article to the late Christopher Hawkes. When, as a young curator in the British Museum, one of the authors (SN) first took an interest in the Little Thetford flesh-hook and proposed a technological sequence for its manufacture, Christopher gave much encouragement and entered into a lively correspondence on this and other subjects.

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Duncan Hook (ICP-AES and atomic absorption), Tony Simpson (XRF and boroscopic examination), Susan La Niece (XRD), Paul Craddock (technological discussion), Rebecca Stacey (GC-MS), Caroline Cartwright (wood identification) and Nigel Meeks (photomicrographs). We are also much indebted to Karen Hughes for the new drawings of the British Museum's two flesh-hooks, to Stephen Crummy for producing the illustrations for this paper and Tony Milton for the photographs.

NOTES

1. Needham and Bowman 2005.
2. For example, Jockenhövel 1974.
3. Needham and Bowman 2005.
4. *Ibid.*
5. Anon 1833a.
6. Carruthers 1854–5. We presume this to be George Petrie (1790–1866), the Dublin-based artist and antiquary. Petrie joined Caesar Otway (1780–1842) when he founded the *Dublin Penny Journal* in 1832 and wrote many articles for that *Journal*. He also worked for the Ordnance Survey from 1833 to 1846 and, through the publication of memoirs accompanying the maps, was a key figure in the recording of local history: Legg 2004.
7. Anon 1833b. Nearly a century later the steelyard theory was again advanced as the object's most likely function by Macalister (quoted in Armstrong 1924) and was reiterated in his book *The Archaeology of Ireland* (Macalister 1928), by which time he had become aware of the earlier steelyard proposal by 'T.A.'.
8. Day and McWilliams 1992, 19, 21.
9. By the time of Stokes's account, Mr Mant was already the Bishop of Down, as recorded in the *Dublin Penny Journal* of 6 Apr 1833, where the date of the exhibition is recorded as March 1829 and the date of discovery is given as that same year. The reference to 'a Dublin museum' is probably based on folk memory of that exhibition, as related to Stokes, since, prior to its acquisition by the British Museum, the object was only ever in private ownership.
10. Unfortunately, Benjamin Spear is not listed as a resident in a Valuation list for this period: Keith Beattie, pers comm.
11. Day and McWilliams 1992, 25.
12. Cahill *et al* 2004.
13. Letter dated 9 Apr 1888. Given a gap of some 40 years, perhaps George Carruthers' memory of the event was coloured by the fact that the flesh-hook came into the possession of the Bishop of Down as a gift from his son who had purchased it from the finder: Carruthers 1854–5.
14. Anon 1852.
15. Letter from James Carruthers to Richard Caulfield, 16 Dec 1852: Cahill *et al* 2004, 251.
16. Carruthers 1854–5.
17. Carruthers (*ibid*) also notes that: 'A short distance from this relic were found fragments of wooden vessels, one large bronze pin, about ten inches in length, and some specimens of stone hatchets.' However, we cannot assume that all of these objects were one deposit as the bogs in the Ballymoney area have produced many finds.
18. The letter dated 9 Apr 1888 from George Carruthers, James's son, to the British Museum also comments on the circulation of the lithograph: 'My father had it lithographed, and sent them round the Scientific world, but tho [*sic*] there were dozens of answers, all were speculation. Even the great Mr Worsaae of Copenhagen had to give it up.' J J A Worsaae, the renowned Danish archaeologist, visited Ireland twice in 1846 to address the Royal Irish Academy: Waddell 1998, 1.
19. Anon 1836–7.
20. In the way of these things, many months later a copy of the lithograph did come to light in an unindexed portfolio of early drawings in the Department of Prehistory and Europe at the British Museum.
21. Carruthers' suggestion that the flesh-hook was possibly used for divination may have arisen from a knowledge of the Irish myths in which corvids are associated with prognosis (for example, Ross 1967, 243). Not everyone has seen the resemblance to corvids in the two birds on the butt-end of the flesh-hook. Macalister suggested that they were 'not unlike thrushes' (1928, 143), and Christopher Hawkes noted: 'I remember

- Smith laughing at this, when he and I and Kendrick were discussing Little Thetford, '29': letter dated 20 Aug 1980 to Stuart Needham. At that time, Hawkes, Reginald Smith and Thomas Kendrick were all curators at the British Museum.
22. Cahill *et al* 2004.
 23. Evans 1881, 406.
 24. Dawkins 1885, 48–9.
 25. *Ibid*, 49.
 26. British Museum 1904, 103.
 27. The reference to flesh-hooks with three teeth is in 1 Sam 2: 13–14, which says (in the Authorized Version): 'And the priests' custom with the people was, that, when any man offered sacrifice, the priest's servant came, while the flesh was in seething, with a fleshhook of three teeth in his hand' [v 13]; 'And he struck it into the pan, or kettle, or caldron, or pot; all that the fleshhook brought up the priest took for himself. So they did in Shiloh unto all the Israelites that came thither' [v 14]. None of the other Biblical references describes the form of these instruments (see Exod 27:3 and 38:3; Num 4:14; 1 Chr 28:17; 2 Chr 4:16; Ezek 40:43).
 28. Armstrong 1924, 117–18; Macalister 1928, 142–3.
 29. Piggott and Daniel 1951, pl 36.
 30. Armstrong 1924, fig 11; Macalister 1928, fig 9.
 31. Brailsford 1953. A detail shot, not showing the butt-end, was almost certainly taken at the same time and appeared two years earlier in Piggott and Daniel 1951.
 32. Had the loss of the ring on the end of the butt ferrule been contemporary with the damage that necessitated the restoration of the rods and rings beneath the swans, we would have expected the butt-end ring also to have been replaced.
 33. Anon 1929. Christopher Hawkes was working at the British Museum with Smith at that time and it is clear from comments Hawkes made in a letter to Stuart Needham that Smith wrote both the 1929 account of the discovery of Little Thetford and the 1904 *British Museum Guide to the Antiquities of the Bronze Age* in which the Dunaverney flesh-hook features.
 34. The hook ferrule weighs 182g and is 274mm long, the central ferrule 122g and 117mm, and the butt ferrule 155g and 174mm, excluding the end loop. The internal socket lengths are 152, 117 and 153mm respectively.
 35. In 1852, Carruthers refers to the then extant length: 'the three inches of oak' (letter from James Carruthers to Richard Caulfield, 16 Dec 1852: Cahill *et al* 2004, 251).
 36. Radiography of the butt-end, where a fragment of wooden shaft was discovered trapped by the rods beneath the ravens, confirmed that only the exposed lengths of shaft were inlaid.
 37. Internal diameter of hook-end socket mouth: 15 × 15.6mm; external diameter 17.6 × 17.7mm. The minimum external diameter of the ferrule is 15.3 × 14.6mm.
 38. External diameter of the socket mouth of the central ferrule: 17.6 × 17.1mm (swan 1 end), 17.6 × 17.2mm (swan 5 end); internal diameter 15 × 14.5mm (swan 1 end), 15 × 14.6mm (swan 5 end). Maximum external diameter of the ferrule is 17.7 × 17mm.
 39. All of the rings appear in the woodcut of the Dunaverney flesh-hook published in 1833 (fig 6); the Carruthers lithograph dates to about 1852: Cahill *et al* 2004.
 40. Length (chest to tail): 37.5, 37mm; height: 34, 33mm; body width: 16.2, 16.5mm; head length: 14.1, 13.3mm; diameter top of rod: 4, 4mm. In each case the first dimension is that for swan 1.
 41. Length (chest to tail): 23.5, 22.5, 22.5mm; height: 17.5, 17, 17mm; body width: 9.9, 9.7, 9.6mm; head length: 10.4, 10.5, 10.2mm; diameter top of rod: 4.5, 4, 3.5mm. In each case the first dimension is that for swan 3 and the last for swan 5.
 42. External diameter of the butt-end socket mouth: 17.9 × 18.2mm; internal diameter: 16.1 × 16.1mm. The minimum external diameter of the ferrule is 14 × 13.5mm.
 43. Length: 49.2, 48.4mm; height: 21.5, 21.5mm; body width: 15.8, 15.7mm; head length: 19.1, 19.1mm; diameter top of rod: c 4.5, c 4.5mm. In each case the first dimension is that for raven 1.
 44. Anon 1929.
 45. The overall length of the hook-end, including the prongs, is 329mm.
 46. Information on the radiography of the flesh-hooks was kindly supplied by Janet Ambers: in all cases both Kodak MX and AA films were used for each exposure, with 0.125mm lead screens at both the back and the front of the films. Different exposures were employed depending on the density of the features being examined (a current of 7mA was normally used, but

- occasionally 10mA, the range of voltages was from 100 to 320kV and of exposure time from 4 to 10 minutes; copper filters of either 0.6 or 1.1mm were used). When the thickness of the metal in the flesh-hooks caused considerable radiation scatter and hence fogging of the initial images, quantities of lead sheet and lead shot were packed around the object as closely as possible while leaving the edges free. This made it possible to record internal details which could not otherwise be seen. For a discussion of the use of radiography in the examination of cultural material, see Lang and Middleton 2005.
47. Shellac is a resin secreted by the scale insect *Laccifer lacca* which infests various host trees from northern India to Indo-China, and is farmed commercially in India and Thailand (information and analysis kindly provided by Rebecca Stacey).
 48. The identifications by x-ray diffraction (XRD) were done by Susan La Niece who also kindly provided the following information. Paris green is also known as Emerald Green and was developed as a pigment in the early 19th century. It is a copper-aceto-arsenite. Barium sulphate is white and came into use as an artists' pigment in the late 18th century and was also used as an extender for oil paints. However, in this case, the barium sulphate was probably added because sulphur dulls the brightness of the Paris green pigment.
 49. For details of the XRF technique, see Cowell 1998.
 50. The majority of samples for ICP were taken using a 1mm diameter steel drill bit to extract approximately 10–15mg of metal, discarding any potentially unrepresentative surface metal. Where drilling with a bit of even this small size was not feasible, one sample was taken using a 0.8mm drill bit and another using a jeweller's saw: see Hook 1998 for details of the technique. The ICP detection limit for bismuth (Bi) is relatively high; this element was therefore analysed using atomic absorption: see Hughes *et al* 1976.
 51. See, for example, Rohl and Needham 1998.
 52. The few British Bronze Age crucible fragments which are of a sufficient size for reliable capacities to be estimated indicate capacities of 250–300cc, the upper size holding roughly 2.8kg of molten bronze when brim full: Needham 1980; Tylecote and Biek 1991. Hence, Dunaverney, with a total weight of c 460g, could in theory have been cast from a single crucible of metal even allowing for loss in the casting jets, etc. However, it is multi-component, requiring all of the moulds to be kept hot and the bronze to be returned frequently to the furnace. In practice, it would have been easier to cast in stages, even if the smith had wanted to use the same alloy composition.
 53. See especially Allen *et al* 1970; Craddock 1978.
 54. Northover 1980; Northover 1982.
 55. Northover 1982; IMPLI 18 in Rohl and Needham 1998.
 56. Northover 1982.
 57. *Ibid.*
 58. The errors on the analyses are ± 15 per cent relative for tin and ± 40 per cent relative for copper: Duncan Hook, pers comm.
 59. Needham and Hook 1988; Rohl and Northover 2001.
 60. Rohl and Needham 1998, plot 32C.
 61. *Ibid.*, 106.
 62. Needham *et al* 1997.
 63. Bronk Ramsey 2007.
 64. Armbruster 1998, 184.
 65. For other objects, inlaying is equally rare. A probable Bronze Age shale bracelet, inlaid with white metal, was found at Fengate Power Station: Coombs 2001, cat. no. 257.
 66. Holmes 1979, fig 10.
 67. Paul Craddock, pers comm.
 68. Reference to *cire perdue*, or lost-wax casting, should be taken also to include the use of any relatively low-melting-point material such as lead for the model.
 69. Holmes 1979, fig 8. However, Holmes did not have the benefit of radiography, and it is possible that some loops on Irish horns were attached using *cire perdue*.
 70. Staniaszek and Northover 1982. However, the surface appearance of the sheet was very poor: Peter Northover, pers comm.
 71. All analysed components of the Cantabrana and Thorigné Class 4 flesh-hooks contain less lead than any of the components of the Little Thetford and Dunaverney examples: Delibes de Castro *et al* 1992–3; Pautreau and Gomez de Soto nd. The tradition of high-lead bronzes seen in the Late Bronze Age in Britain is not mirrored in those regions on the Continent.

72. We are very grateful to Peter Northover for this information in advance of the publication of the results in a corpus of cauldrons by Sabine Gerloff in the *Prähistorische Bronzefunde* series (Gerloff 2008).
73. Key references for these flesh-hooks are given in tables 5 and 6.
74. The length estimate for the Lurgy flesh-hook is based on a sketch discovered in a portfolio of drawings in the Department of Prehistory and Europe at the British Museum and likely to pre-date the illustration in Armstrong (1924, fig 12) in which the wooden shaft is more deformed. Armstrong gives the length as 2ft 3in. (ie, about 0.69m).
75. Day and McWilliams 1992, 21, 25, where it is reported to have been 'about 2 and one half feet long' (ie, 0.76m).
76. In the sketch of the Lurgy flesh-hook in the British Museum, the exposed shaft is roughly 250mm in length.
77. Hencken 1942; Jockenhövel 1974, Abb 1, no. 2; Newman 1997; Delibes de Castro *et al* 1992–3, fig 2.
78. Needham and Bowman 2005; see also below.
79. Baiões perhaps comes closest in design originality in being the only other flesh-hook with a central ferrule and rings; in addition it has three prongs as well as cast-in spiral motifs on the hook-end. It has been published as seemingly having two central ferrules (see, for example, Armbruster 1998, Abb. 1). The socket on the hook-end is extremely shallow, at only 4mm deep, and has no obvious rivet hole (ibid, Abb. 4). It has an internal diameter of only 5mm, significantly smaller than that of the other ferrule (13mm; ibid, Abb. 4). Hence Barbara Armbruster notes it would have been impossible to fix the hook-end to a wooden shaft. Instead she postulates that a bronze rod, now lost, was cast on to the hook-end and used to connect together the other three components. We wonder whether there is a simpler explanation – that the Baiões flesh-hook, like Dunaverney, originally only had three ferrules connected by sections of wooden shaft. We have not been able to study the flesh-hook at first hand, but the evidence is consistent with the ferrule nearest to the hook-end in the drawing reproduced in Armbruster's Abb. 1 having originally been part of the hook-end. Unfortunately, this 'ferrule' was not available for her to study. If it was, in fact, part of the hook-end, then the 'mouth' of the hook-end we see today is in fact only the bottom 4mm of the original socket. Our hypothesis is supported by the plane of the 'mouth' not being perpendicular to the axis of the socket (ibid, Abb. 3); furthermore, the 'socket mouth' itself is off-centre (Abb. 4), whereas the mouth is the part of the socket at which it would have been easiest to ensure that the casting core remained central during the pouring of the bronze. Most telling, however, is that the narrow end of the adjacent 'ferrule' shows an identical off-centre socket (ibid, Abb. 1 and 4 respectively). Altogether, the evidence suggests that the hook-end was broken, possibly owing to the narrowing of the implement at this point and the wall of the socket being relatively thin on one side. From Barbara Armbruster's photographs, the corrosion over the broken surface of the hook-end 'mouth' appears similar to that over the surface of the rest of the flesh-hook and would suggest that the break happened in antiquity.
80. The new, fragmentary find from the river Genil, near Seville, southern Spain, shares the twisted-bar construction but its shaft comprises just two bars instead of three: Armada Pita and López Palomo 2003. Sadly, none of its hooked end survives. Note also there are twisted bars on Sicilian instruments believed to be flesh-hooks: Needham and Bowman 2005.
81. Needham and Bowman 2005, fig 7.
82. A similar derivation might be argued for the presently unique form of the Solveira socketed flesh-hook from Trás-os-Montes, Portugal: Needham and Bowman 2005.
83. See, for example, Tylecote 1986.
84. See Needham and Bowman 2005, fig 6; all four of the Class 2 flesh-hooks known to date from the British Isles are from the east of England, indeed, one being from the off-shore assemblage from Langdon Bay, possibly part of a cargo lost in transit by sea: Muckleroy 1981; Needham and Dean 1987. Only four certain Class 1 flesh-hooks have been found, two in Ireland and one each in France and Spain, and even the French example is not a typical Class 1 flesh-hook and is in a later context: see Needham and Bowman 2005, fig 1.
85. Leeds 1930, fig 1; some Class B cauldrons also have cast-on staples: ibid, 9.
86. Ibid, 6.
87. The socket of the associated flesh-hook from Feltwell, Norfolk (Norfolk Museums

- Service 1977, cat. no. 87), is virtually full of the original shaft head of hornbeam (*Carpinus betulus*). John Davies and Alan West at the Norwich Castle Museum kindly agreed to sampling, thus giving a unique opportunity to obtain an independent date for a Class 2 flesh-hook considered to be earlier than the two subjects of this paper: Needham and Bowman 2005. At the same time this provided invaluable confirmation of the date of the early-style cauldron with which it was associated: Gerloff 1986. The result was 3013 ± 36 BP (OxA-10859), calibrated using OxCal (Bronk Ramsey 2007) to 1390–1120 BC at the 2 sigma level.
88. Norfolk Museums Service 1977, cat. no. 108; Needham and Bowman 2005, note 15, for the other associated finds.
 89. Gerloff 1986, 86.
 90. Leeds 1930, 7.
 91. The use of *cire perdue* in the manufacture of Baiões is discussed by Armbruster (1998 and 2000): the technique was more commonly used on the Continent in the Late Bronze Age.
 92. Holmes 1979, fig 8, shows how the loops on some Irish horns might have been pre-cast and incorporated into the mould assembly for casting the ferrule (but see also note 69). We doubt that rings would have been pre-attached to such loops as the ring and loop would not lie in the same plane, making it difficult to construct the mould assembly.
 93. Meeks *et al* in press.
 94. Coles 1959–60; Cowie 1988.
 95. See Eogan 1983; indeed two hoards from the vicinity of Dunaverney each contain an example: Bootown – Eogan's no. 35; Seacon More – no. 41.
 96. On the Continent, free-running rings are a feature of *tintinnabula*, or *sistres*, which are found from central to eastern France; however, the rings are not always closed annuli: Cordier 1963. The example from Boissy-aux-Cailles (Seine-et-Marne) is particularly ornate: the cylindrical body is patterned and has three sets of three loops, through each of which is a ring and through each ring there are two smaller rings: Nouel 1957. Nouel inferred that the rings were soldered; however, this has not been recorded for any British and Irish objects of this period.
 97. Reinach 1896.
 98. Needham and Bowman 2005.
 99. Burgess and O'Connor (2004) have ventured that the ultimate inspiration could have come from Nuraghic-period Sardinia, renowned for its abundance of bronze figurines of varied kinds and also known to have links with the west, highlighted not least by the Monte Santa Idda spit fragment: Lo Schiavo 1991. Colin Burgess has also suggested (*pers comm*) that there are implements from Nuraghic sites that might deserve consideration as flesh-hooks. Our own research (Needham and Bowman 2005) has brought to light flesh-hooks from Sicily, of which a fragment from Adrano (Giardino 1995), if it is indeed from a flesh-hook, has two birds forming part of a ring that is incorporated into the twisted shaft.
 100. Carruthers 1854–5.
 101. We thank Richard Warner for drawing this to our attention. Ross 1967, 234ff.
 102. Eogan 1974.
 103. Ross 1967; Green 1993.
 104. Needham and Bowman 2005.
 105. Anon 1929: the author of this account of the discovery of Little Thetford was identified as Smith by Christopher Hawkes (see note 33), and Hawkes himself repeated the notion that Little Thetford had originally carried birds: Hawkes 1931, 93.
 106. The possible central ferrule from Plouguerneau also has a ring: Briard 1991. While we are not convinced that it is from a flesh-hook, we cannot identify another implement type with such a ferrule. Its internal diameter (*c* 16mm) is similar to that of Class 3 flesh-hooks like Dunaverney, but its length, at only about 70mm, is significantly shorter than that of either Dunaverney or Baiões (116 and 126mm respectively). The Plouguerneau ferrule does have a rod or tang passing through the centre of it, hanging from one end of which is a ring which is not cast on, echoing the rods through the Dunaverney ferrule, but if it ever had a decorative model this is no longer extant. However, as there is only one rod and no other peg holes, the Plouguerneau ferrule could not have functioned in the same way as the Baiões and Dunaverney ones, unless the two lengths of rebated wooden shaft were also shaped to overlap within the ferrule.
 107. Pearce (1983, cat. no. 383) has suggested

- that a ferrule with rings provenanced only to 'Dorchester' is possibly also from a flesh-hook. The piece is about 60mm long, but has an internal diameter of only about 6mm; hence this attribution is unlikely. Indeed, the object may not even be of Bronze Age date.
108. Leeds 1930; Coles 1963; Gerloff 2008.
 109. Needham and Bowman 2005.
 110. Coombs 1975; O'Connor 1980.
 111. See, for example, O'Connor 1980, fig 49A, 31.
 112. Needham and Bowman 2005.
 113. Northover 1982.
 114. Needham and Hook 1988; Rohl and Northover 2001, 302, table 10.2, 306–8.
 115. Northover 1982; Coles 1962; Needham 1979. Although most shields belong to the Penard metalworking tradition, the two styles represented at Coveney (*Coveney* and *Harlech*) are thought to be slightly later developments.
 116. Needham and Bowman 2005; Briscoe and Furness 1955; Norfolk Museums Service 1977, 29–30, figs 87 and 108.
 117. Pryor 2001.
 118. Ibid. Bradley Fen: Chris Evans and Mark Knight, pers comm.
 119. Eogan 1983, 36, no. 16.17; Hencken 1942; Jockenhövel 1974, Abb. 1, no. 2; Newman 1997.
 120. The Lurgy flesh-hook is published only as an illustration (Armstrong 1924, fig 12) and mentioned briefly by Carruthers (1854–5). We intend to publish the Irish examples in the near future.
 121. Eogan 1983.
 122. Brindley 2001.
 123. Eogan 1983, cat. nos 2, 7, 16, 23.
 124. Brindley 2001; Needham *et al* 1997.
 125. Brindley 2001.
 126. Needham *et al* 1997.
 127. Eogan 1965.
 128. Brindley 2001.
 129. Eogan 1974, 322, Abb. 2A. The three types that best define a north-eastern province in the Late Bronze Age are bronze Class I horns, sheet-bronze buckets and gold sleeve fasteners. The strongest concentrations of these types fall in Antrim and the borderlands linking Armagh, Tyrone, Monaghan and Fermanagh. Class A cauldrons are less specific, being split between the north east and the west Midlands.
 130. We are grateful to Keith Beattie for information on local finds and to Richard Warner for first drawing our attention to the proximity of some of this material.
 131. The chronology of Atlantic flesh-hooks as a whole is discussed in Needham and Bowman 2005.
 132. Gerloff 1986, 87; Needham and Bowman 2005.
 133. Burgess and O'Connor 2004.
 134. Coles 1962; Leeds 1930; Gerloff 1986; 2008.

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