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A Cromwellian Warship wrecked off Duart Castle, Mull, Scotland, in 1653

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Chapter 6

THE SHIP: OPERATION AND MANAGEMENT

6.1 Ballast

Apart from the exposed iron guns, the two mounds of stone ballast were the most distinctive features visible on the wreck-site at the time of its discovery in 1979 (John Dadd pers comm) (Illus 17). The cohesion of these mounds was further demonstrated during survey, when no attempt was made to delineate their boundaries artificially. When all the stones measuring 5cm or more had been plotted objectively across the whole survey area, and contouring at 0.1m intervals applied over the site, the mounds stood out as visually discrete entities, one at the western end of the wreck and the other towards the east (Excavation Plan and Illus 39). Their relationship to the surviving hull-structure, moreover, indicated strong post-depositional stability. A centre-line projected through the two mounds closely follows the axis defined by the keel and keelson (**095.074/280.060**), indicating that there has been little displacement from their original configurations within the hull, except perhaps some limited outwards spill on either side, particularly to port.

Sources of ballast materials

John McManus

Samples recovered from the ballast associated with the wreck-site off Duart Point consisted of boulders, pebbles, mixed gravel of a range of particle sizes, and clay. These materials were derived from identified parts of the wreck, from the west and east ends and also from the central area.

Clay from the central area

The pale-coloured clays were subjected to X-ray diffraction analysis in the School of Geography and Geosciences at the University of St Andrews, by Mr Angus Calder. The resultant graphs (McManus 2004: figs 1–2) were compared with widely used scientific standards and revealed that the clays were principally of the minerals illite and kaolinite, with variable amounts of fine-grained quartz. There are small quantities of smectite, chlorite, calcite, and halite. The latter, which is derived from marine salt waters, is to be expected from wreck-derived material.

The bulk of the clays, being of illite and kaolinite, are most probably from fireclays of Carboniferous age, which are common on the west coast of central Scotland (Ayrshire and the Clyde Estuary). They are not common in Highland regions. Smectites may be derived from volcanic rocks, also common on the west coast of central Scotland, but also present occasionally in soils of many of the Inner Hebridean islands. The assemblage of minerals indicates that these clays are not local to the site and would not have washed into the wreck subsequent to its sinking. However, they are essentially Scottish, for many of the East Anglian clays – which might have been present among the ballast had the vessel come from that area (see Chapters 1.2 and 2.2) are rich in smectite.

Boulders

The two boulders examined were each more than 200mm across (Site 9, Sample 15 ref 229295, and Site 8, Sample 13, ref 143967). Both were of granitic gneiss, pink-coloured due to a high content of potassium-rich feldspar crystals. There is some internal structural layering developed, with biotite, hornblende and quartz-feldspar layers evident in most places. These gneisses are typical of the North-West Highlands and the Outer Hebrides, principally Lewis. Their composition indicates that they are from the Laxfordian division of the Lewisian gneisses, which outcrop on the mainland north of Scourie, towards the north of Loch Laxford. Similar rocks also dominate the northern parts of Lewis.

Pebbles

Two sets of pebbles collected from the eastern and western ballast-mounds have been examined. The identities of some were very evident, but thin sections were made of a total of

23 pebbles partly to enable confirmation of the identifications through detailed petrological microscopic examination and partly to attempt to detect any unusual textures which might help precise source recognition. Photomicrographs of the thin sections, as seen under crossed polars, are given with brief comments in McManus 2004.

Western ballast-mound

The particles are of low-grade metamorphic rocks, principally from the Dalradian rocks of the southern Highlands, notably Argyll and the Cowal peninsula. The rocks are principally of chlorite-zone psammites and phyllites, with a few low-grade marbles and calc-silicates. This is a typical assemblage of the weakly metamorphosed rocks from the Dalradian. Typical among the fragments were:

(a) Uniformly fine-grained metamorphosed quartz sandstone with a few mud pellets, set in a calcite cement (eg 14/W).

(b) Fine-grained muddy metamorphosed limestone with layers of clay pellets and a thin quartz vein. This rock has a weakly developed series of muscovite-lined planes of weakness (eg 15/W).

(c) Medium-grained metamorphic quartzite with silica overgrowths on quartz grains. No calcite in the cement. About 5% of the detrital grains shown in the straining indicate that the parent rocks had experienced a structural distortion event before they were eroded to become the sandstone which was later metamorphosed. A few crystals of twinned feldspars are present (eg 12/W).

(d) Calcite-rich fine-grained phyllite with small mica flakes (eg 16/W and 11/W)

Eastern ballast-mound

There is some variety of pebbles from this part of the wreck.

(a) The pebbles from this section are largely gneisses of acid and basic composition. Many show signs of having been mylonitised (heavily crushed) at some stage in their development. In some cases there is evidence of multiple metamorphic activity with hornblende (a water-bearing mineral) rather than the typical dry pyroxenes of the granulite facies of metamorphism which the rocks certainly underwent early in their history. These are Lewisian gneisses in several of their forms. Typical examples are 01/E, 03/E and 15E.

(b) Two pieces of a well-indurated, possibly weakly metamorphosed reddish-coloured K-feldspar-rich coarse sandstone were recognised. They closely resemble the Torridonian sandstones which are derived directly from the breakdown of the Lewisian gneisses. The grains of feldspar, quartz and rock fragments are very tightly packed, and the resultant rock is very strong. The Torridonian rocks occur along the western Highland coasts, from Rum to Cape Wrath, but do not occur on the Outer Hebrides (eg 03/E and 16/E).

(c) Two pieces of fresh, black, very-fine-grained crystalline olivine dolerite or basalt (eg 04/E), a very common form of the coastal rocks of the northern Highlands and Islands. The basalts are basic, black lavas which took their origin from the ancient volcanoes which were

Table 6.1
The composition of the ballast gravels by particle numbers alone

Rock type	*all particles %*	*>20mm %*	*<20mm %*
Fine-grained basic igneous rock (basalt)	42.5	41	47.4
Pitchstone (deeply weathered)	22.5	29.5	23.0
Quartz sandstone	14.0	13	17.0
Quartzite	8.3	10.5	8.6
Vein quartz	6.6	4.5	1.2
Chert	1.9	5.0	1.1
Pitchstone (fresh)	1.7	4.5	1.0
Slate	0.7	1.0	0.3
Volcanic ash	0.7	0.0	0.4

centred on Mull, Skye, Rum and Ardnamurchan, but associated are doleritic intrusions of similar chemical and mineralogical composition, and which break across the indigenous rocks of the west. They may be found cutting through both the Dalradian metamorphic rocks and Lewisian gneisses, and are therefore not very helpful in seeking to identify a source of supply for the ballast.

(d) Several of the particles from the eastern ballast-mound are similar to those of the western, being of material which appears to be of the Dalradian metamorphic rock assemblage. One pebble of metamorphosed finely crystalline limestone (10/E) shows well-formed cubic crystals of galena, a lead-ore mineral, formerly mined in the Tyndrum and Strontian areas.

Gravel ballast

Five hundred and seventy-four particles have been identified using a hand-lens. Where necessary particles were broken open by hammer to reveal the nature of their interiors. Of the materials analysed, 135 of the particles were larger than 20mm in diameter, and of the remainder none smaller than 4mm diameter was identified. The confidence of identification of smaller particles by simple visual inspection was not believed to be sufficiently high to justify examination of such material. The components and their proportions are listed in Table 6.1.

Part of the problem of identification comes from the rocks themselves. A significant proportion of the material is of pitchstone, which is chemically unstable when left in water for any length of time. The result is that there has developed a kind of patina on the outside of the pebbles. Whereas the original rock is glassy and very darkly coloured, the weathered surface is very pale and rather earthy. A few small glassy pieces were within the sample bag, but very few.

The majority of the pebbles are of basic igneous rocks such as basalt, which is normally black or darkly coloured. This weathers to a reddish colour in an oxygen-rich environment. Fortunately this process takes rather longer to achieve under water than the pitchstone degeneration. There are white sandstones, and pale-coloured quartzites, probably of fairly local origin, possibly brought to the beach by glacial action. Likewise vein quartz, not uncommon; and a few pieces of volcanic ash, possibly of local origin, quite possibly all from one broken pebble. A few particles of slate were recognised and a little 'chert'. The latter could well be pitchstone, which is very similar in texture, but here the material is purple-coloured rather than the black of the pitchstone (Table 6.1).

The rocks represented are mainly those of the Inner Hebrides, and most could have come from the beaches of Mull, Rum, some parts of Skye, or even Arran. From the compositions which I have noted they are certainly not from the Outer Isles, and likewise I would not have anticipated finding most of the materials in mainland Argyll. There are white sandstones, quite possibly from Mull, and pale-coloured quartzites of local origin, possibly of glacial action. The vein quartz could be derived from virtually anywhere among the older rocks, but is not common among the volcanic basalts and pitchstones. Much of the gravel therefore appears to be local and could have come from the beaches of Mull before the final voyage started, perhaps as part of a final trimming.

Conclusions

The variety of materials represented in the various forms of ballast recovered from the wreck attest a history of activity along much of the western Highland seaboard, with material variously added from the Clyde Estuary-Ayrshire area, from south Argyll, from the Outer Isles or North-West Highlands, and gravels from more local sources, perhaps Mull itself. Clays are commonly considered to have been valuable in restricting the movement of casks and other mobile materials such as gravel. The presence of substantial quantities of ballast possibly from the Outer Isles suggests that heavy cargo may have been carried to the Stornoway area, necessitating some re-ballasting to trim the craft for subsequent voyages.

Significance of the ballast

Colin Martin

The two mounds are distinctively different in character. Stones among the western (forward) ballast-mound tend to be larger, and many are angular, flattish slabs which have been carefully packed in levelled strata to enhance stability and minimise packing space (Illus 161). The majority of these stones, as Professor McManus's analysis reveals, are Dalradian rocks from the South-West Highlands. The eastern (aft) ballast-mound, in contrast, is composed mainly of large rounded pebbles or small boulders, many of which are of Lewisian gneisses from the extreme North-West Highlands or the northern part of Lewis (Illus 162). These appear to have been more randomly packed, no doubt because their rounded shapes interlock naturally in a way which minimises interstices.

Excavation at the eastern end of the aft ballast-mound revealed its aftermost extent at **130.075**, where structural evidence indicates that the dead-rise of the stern begins. Significant quantities of cut heather (*Calluna vulgaris*) were noted here between the ship's ceiling planking and the ballast-stones, no doubt inserted as dunnage to protect the wooden structure (Illus 163). Evidence of this practice was not found in the small excavation conducted beneath the forward ballast-mound (**26.06**). Heather or other foliage was frequently used as dunnage in boats transporting cattle from the islands to

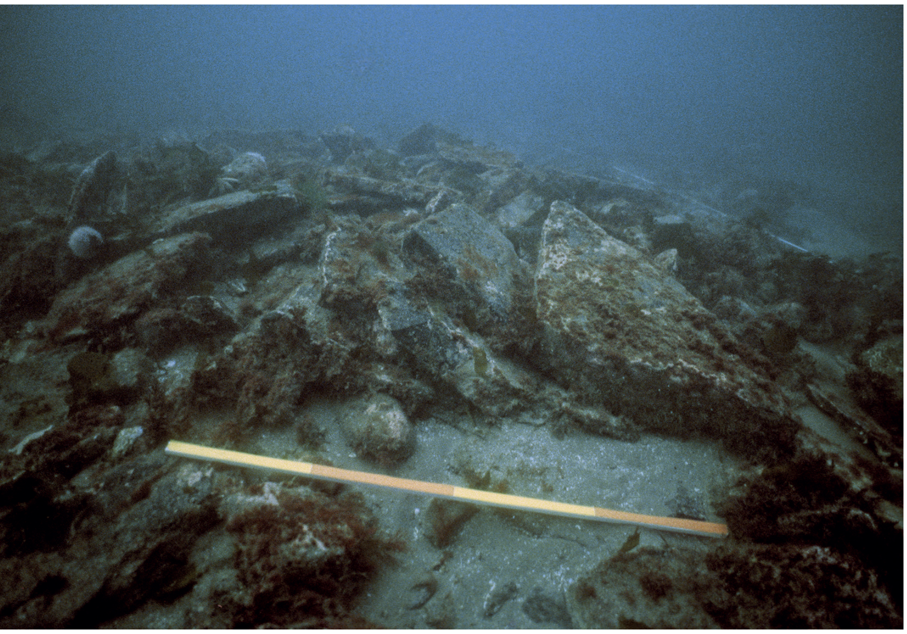


Illustration 161
The forward ballast-mound. Scale 1 metre (DP 173755)

the mainland in the West Highland droving trade, spread in a layer known as *farradh* in Gaelic (Haldane 1973: 73).

Much of the partially eroded floor in the midships section between the two ballast-mounds, above the ceiling planking, had been lined with a creamy-coloured clay. Professor McManus's analysis shows that this material is probably fireclay of the Carboniferous period. This is not common in Highland regions, but it could well have been derived from the west coast of central Scotland. Towards the port side of the hull, just before the upwards turn of the bilge, the clay lining is ribbed with three furrows up to 0.15m deep extending to the ceiling planks of the hull, exposing the longitudinal joints of the timbers (Illus 164). Above the clay is a layer of gravel distinctively different from the natural sea-bed shingle in this area, and this is also presumably ballast. The ribbing of the clay along the bilges may have been intended to stabilise the gravel against sideways movement when the ship rolled; alternatively, the furrows may have been settings for stabilising-boards, recalling Mainwaring's remarks on the securing of ballast, 'they make pouches, as they are called, that is bulkheads of boards, to keep it up fast that it do not run from one side to the other, as the ship doth heel upon a tack' (Manwaring & Perrin 1922: 93).

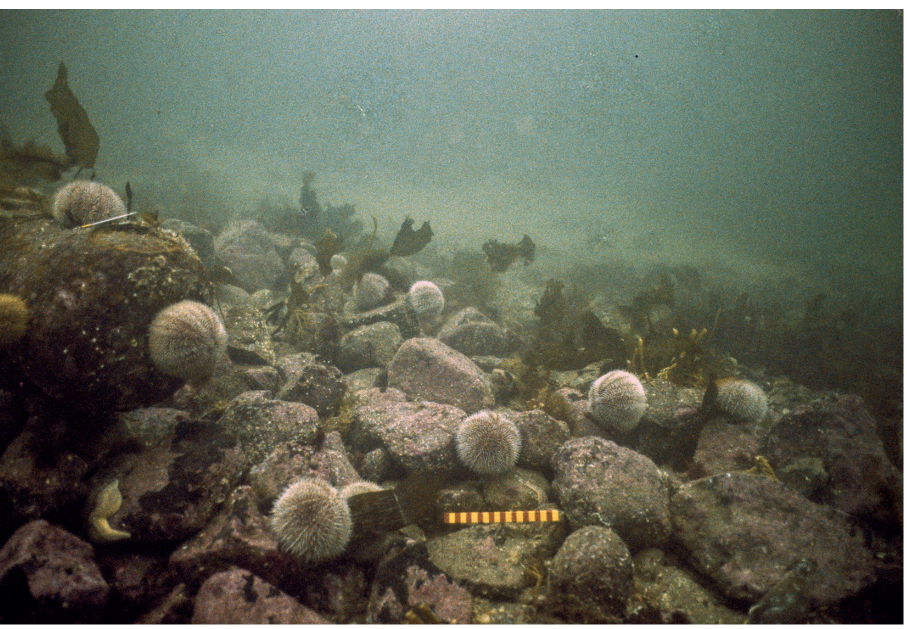


Illustration 162
The aft ballast-mound with the muzzle of Gun 3 left centre.
Scale 20 centimetres (DP 173757)

Illustration 163
Sample of heather dunnage (*Calluna vulgaris*) from the aft ballast-mound at **130.075**. It had been packed between the hull-planking and the ballast-stones. Scale in centimetres (DP 173416)

Samples of gravel were taken from the lower levels of the ribbed furrows to ensure that they were not contaminated with natural material (Illus 165). Professor McManus suggests that the ballast gravel may have come from the Inner Hebrides, but is unlikely to derive from mainland Argyll or the Outer Isles. Among the gravel ten water-abraded potsherds were identified (Illus 166). None of the fabrics matched ceramics found elsewhere on the wreck. The wares represented include olive jars from the region around Seville. One other sherd suggests a Spanish association while others, though not closely identified, appear to be of continental origin and possibly of significantly earlier date than pottery found elsewhere on the wreck (George Haggerty pers comm). The most probable explanation is that the gravel had been taken on board from a deposit somewhere in the Inner Hebrides or the adjacent mainland at which vessels with continental connections had discharged ballast. Because of the need to keep harbours and their approaches stable and free from erosion or silting, taking on and discharging ballast was a carefully regulated activity. Inappropriate dumping or removal was prohibited, and suitable locations were often designated for taking on or discharging ballast, in the course of which discarded artefacts such as potsherds might be exchanged between ships.

In the absence of total excavation the volume, weight, and distribution of ballast cannot be determined precisely. However, the general horizon of the lower hull, and the contour survey, allow the approximate volumes of the two ballast-mounds to be calculated and their weights determined, using a specific-mass factor of 1.5 for well-packed stone. A figure of 2 may be adopted for gravel and compacted clay. The forward mound works out at *c* 4m^3, or 6 tonnes, while the aft one is *c* 5.5m^3, or 8.25 tonnes. The clay lining, if spread to a constant depth of 100mm across the central hold between the bilges, would require 2m^3 of material, or 4 tonnes, while a 70mm topping of gravel (1.5m^3) would account for another 3 tonnes. In all, the total of 'dead' ballast (that is, material stowed for its weight alone) works out by this estimate at *c* 21 tons, or about 15% of the vessel's calculated displacement of *c* 135 tons.

6.2 Casks and stowage capacity

Consideration may now be given as to how this arrangement of ballast may have determined the stowage of other material inside the hold. The midships area, extending some 4m forward of the mainmast and spanning much the same distance athwartships, with its relatively flat floor and resilient clay and gravel lining, will no doubt have been allocated for the stacking of casks and other provisions, as was normal practice (Lavery 1987: 187). In order to estimate stowage capacity two tiers of 491 litre (108 gallon) butts have been assumed. Fifty-two such containers can comfortably be accommodated without encroaching on the mainmast-step or pump-wells, with extra runs of six smaller hogsheads (245.5 litres/54 gallons) filling the rising space above the bilge, outboard of the second tier on either side. This gives a total liquid stowage capacity in the hold of 6,264 gallons, or 28.5 tonnes, though the weight would have varied with the commodities stored. Most provisions, with the exception of bread, would have been contained in casks.

The lower tier would have been well bedded into the gravel ballast and the casks thus stowed would occupy some 1.6m vertical height (5ft 3in), well within the estimated 2.44m (8ft) depth of the hold. Some additional space may have been taken up by firewood dunnage packed between and above the casks (Illus 167). This arrangement is well illustrated in the sectional depiction of a privateer by Henrik af Chapman in 1768 (pl 32), while a plan of the ballast and lower tier of casks in the frigate *Artois* (1794) is reproduced by Lavery (1987: 190). Both these sources show the casks laid belly-to-belly rather than the overlapping 'bilge and cantline' method recommended by the *Admiralty Manual of Seamanship* (Vol. 3, 1964: 82) which is a more logical and secure means of stowage. I have adopted the latter method in my reconstruction (Illus 159). For obvious reasons casks are always stowed bung uppermost.

The stone ballast concentrations fore and aft were spread in the lower hold to a depth of no more than *c* 0.5m (1ft 8in), leaving an estimated 1.96m (6ft 5in) of vertical space beneath the main deck. It is possible that light decking covered the ballast areas, though no evidence for this was found. The forward space no

Illustration 164
Clay lining of the lower hold. The clay has been ribbed longitudinally down to the ceiling planking as it approaches the port bilge, presumably to stabilise the gravel laid above it. Three parallel channels are shown partly excavated here. Scale 15 centimetres (DP 173758)

Illustration 165
Sample of gravel from the channels in the midships clay ballast. Scale in centimetres (DP 173762)

Illustration 166
Intrusive water-worn potsherds found among the gravel ballast (see Chapter 9.3). Scale in centimetres (DP 173763)

doubt accommodated the main cable tier, directly beneath the windlass postulated aft of the forecastle (see Chapter 5.6 above). This area is also likely to have provided stowage for coal and peat, of which traces have been found in its vicinity, perhaps in bunkers ranged around the sides and blunt nose of the bow. The traditional location of the bread-room was in the hold close to the stern, where the rising deadwood raised the frame-timbers well above the keel and so kept this area safe from bilge-water (Lavery 1987: 189). Gunpowder, too, was frequently secured in this dry area, while fish was often stored aft to isolate its strong smell. That this may have been so on the Duart Point ship is suggested by a substantial deposit of fish bones in the area of the lower-stern structure (see Chapter 3 Area 4, and Chapter 6.7). A spirit-room a little further forward

Illustration 167
Scraps of oak brushwood, which may have served as packing for stacked casks. Scale in centimetres (DP 174124)

is hinted at by the find hereabouts of four stoneware *bartmann* jars, and it was usually just aft of the mainmast that the main store of roundshot was located, though no evidence of this was found. That only three pieces of iron shot were found in the course of the excavation may indicate that most of the ship's munitions had been taken ashore with the invasion force.

While it is likely that the ship was designed to carry a considerable quantity of provisions in its hold (the available space between the fore and aft ballast-mounds being estimated at *c* 300m^3, see above), much of which would normally have been stowed in casks, very few pieces of these versatile containers were recovered during the excavation. Various factors may explain their scarcity. When the upper part of the central hull collapsed during the wrecking process (see Chapter 4) any casks stowed in the hold would have been vulnerable to disintegration as their hoops decayed, rendering the loose components prone to dispersal by current.

More probably, perhaps, most of the provisions and other materials stowed in cask had been off-loaded prior to the wrecking to provide logistical support for the task-force when it came ashore. Lead shot would certainly have been present in some quantity on board a warship carrying soldiers, and this commodity was normally transported in small casks (for example on *Vasa*, Cederlund 2006: 368). But we may suppose that it was brought ashore when the troops disembarked. The relatively small quantity of loose shot found among the wreckage (see Chapter 2.2), none of which occurred in large clusters, militates against its being the in situ contents of disintegrated bulk containers. In any case it is likely that had any shot-casks been present the lead bullets within them would have pinned down and preserved their remains. On the wreck of *La Belle* nearly 300,000 lead balls were found, preserved mainly in 33 largely intact small casks (Bruseth & Turner 2005: 95–6).

It should also be remembered that evidence adduced below (sections 6.5–6.7) strongly suggests that supplies of fresh food were routinely obtained ashore, and for the most part this would not involve stowage in cask. Water was also shipped in cask, but the bulk required for a long voyage would not be required for inshore work of the kind engaged in by Cobbett's expedition, where boat-parties could be sent ashore to fill a few casks whenever required, thus ensuring freshness and reducing the ship's deadweight cargo – an advantage which might be exploited either by carrying something else or by enhancing performance, especially under oars.

Another cask-contained liquid usually prominent in the English naval diet was beer. A late 16th-century source indicates that, of the ton of stowage capacity allocated to four men's provisions for a month, no less than half was for beer, a quarter for wood and water, and the remainder for solid food (Oppenheim 1896: 144). But such prodigality was not evident in the Commonwealth navy. In June 1653 beer supplied by the victualling department was so bad that it had to be withdrawn from issue (one of the supplying brewers complained that it was the best he could provide for the money offered), the men concerned being given water and an allowance of two pence per day in recompense (Oppenheim 1896: 326). Given these constraints, and the fact that Cobbett's squadron seems to have relied on the opportunistic gathering of fresh supplies from local resources in the West Highlands, it seems unlikely that the ship would have carried much bulk beer in cask. Although none of these factors is capable of absolute proof, they may together explain the paucity of cooperage-related artefacts, which are described below.

Cask remains

A very full account of shipboard casks and the methodology of their study is provided by Loewen 2007, and see also Rodriguez 2005 for comparative material from *Mary Rose*. All the cask components identified were of oak (*Quercus* sp)

Heads

39 DP01/075, **189.091**, a chamfered centre-piece, broken at one end, from a 560mm-diameter head, 12mm thick (22 × ½in) (Illus 168). The edges are not quite parallel. Complex angular pattern of scored lines of unknown significance. Two dowel-holes on each side. This diameter is appropriate to a 35in tall (0.89m) hogshead with a capacity of 52.5 imperial gallons (239 litres).

40 DP97/A023, **064.094**, chamfered cant-segment (one end broken off) and middle piece of a 420mm-diameter head, 16mm thick (16½ × ⅝in) (Illus 168). Vent or bung-hole 9mm diameter. Towards the right edge of the middle piece the letters 'RP', extending the full width of the board, are neatly cut. The segmental arc of the two pieces indicates a balanced pair of boards on the other side, and a joining centre-piece of similar width to the middle boards. Probably from a barrel of *c* 36 imperial gallons capacity (164 litres).

41 DP03/054, **119.070**, chamfered cant-segment representing half the circumference of a 370mm-diameter head,

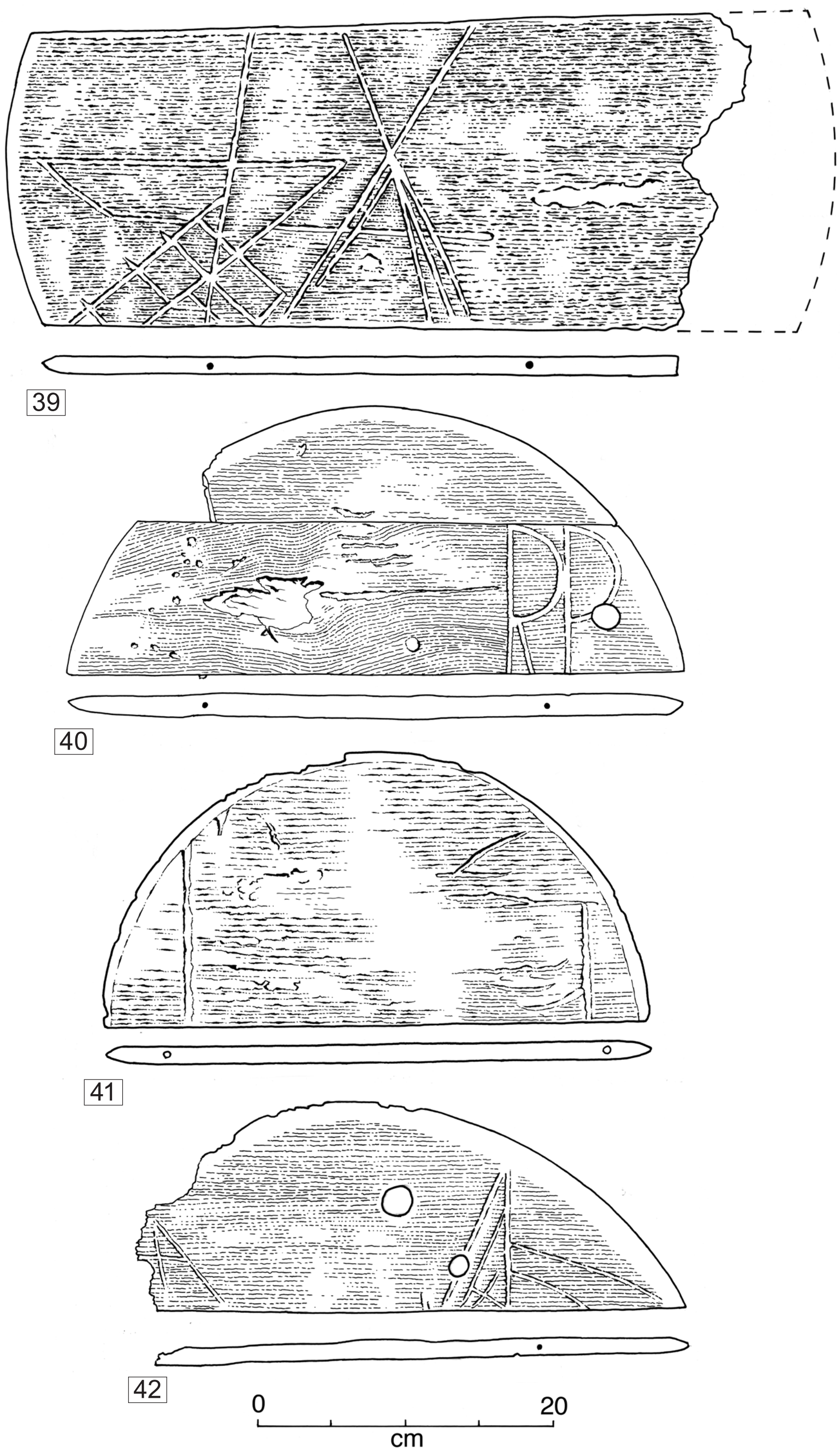


Illustration 168
Marked cask-ends 39–42

12mm thick (14½ × ½in) (Illus 168). Vertical scored lines roughly cut at each end, with some indeterminate marks between.

42 DP01/088, **180.093**, broken chamfered cant-segment from a 500mm-diameter head, 12mm thick (19¾ × ½in) (Illus 168). Vent- or bung-holes 10mm and 6mm diameter. Angular patterns of scored lines at each end.

43 DP01/074, **189.091**, chamfered cant-segment from a 600mm-diameter head, 12mm thick (24 × ½in) (Illus 169). Two dowel-holes.

44 DP01/027, **169.095**, chamfered cant-segment from a 240mm-diameter head, 12mm thick (9½ × ¼in) (Illus 169). Two dowels, one in situ.

45 DP03/048, **113.072**, broken chamfered cant-segment from a 560mm-diameter head, 16mm thick (15 × ⅝in) (Illus 169). Two dowel-holes.

46 DP96/002, **030.013**, chamfered cant-segment representing half the circumference of a 280mm-diameter head, 12mm thick (11 × ½in) (Illus 169). Two dowels in situ.

47 DP03/071 and 073, **121.082**, two conjoining chamfered cant-segments of a 186mm-diameter head, 6mm thick (9½ × ¼in) (Illus 169). Two dowels, one in situ.

48 DP01/047, **077.156**, piece of wood with chamfered edges, slightly more than half a circle, 203mm diameter, 8mm thick (Illus 169).

Staves

49 DP92/264, findspot uncertain, broken stave, surviving length 387mm, head end 104mm wide, width towards booge 124mm. Croze-groove 6mm wide × 4mm deep. Thickness at head 8mm, towards booge 11mm (Illus 170).

50 DP03/074a, **123.070**, broken stave, surviving length 180mm, head end 36mm wide, width towards booge 50mm. Croze-groove 5mm wide × 2mm deep. Thickness at head 8mm, towards booge 8mm (Illus 170).

51 DP03/074b, **123.070**, broken stave, surviving length 220mm, head end 44mm wide, width towards booge 50mm. Croze-groove 4mm wide × 3mm deep. Thickness at head 8mm, towards booge 8mm (Illus 170).

52 DP00/192, **107.083**, complete stave 283mm long, head end 25mm wide, 38mm at booge. Croze-groove 5mm wide × 4mm deep. Thickness at head 8mm, at booge 6mm (Illus 170).

Barrel-wedge

53 DP99/036, **077.093**, barrel head-piece tightening peg, 65mm × 19mm (Illus 171).

No remains of iron hoops were discovered in association with the cask remains (apart from the concretion at **276.100**), and only a few fragments of split-withy hoops (DP01/047a, 058, 072, 078, 081) in association with several of the cask-end segments. None was found elsewhere on the wreck, except in connection with the staved vessels described in Chapter 9.6.

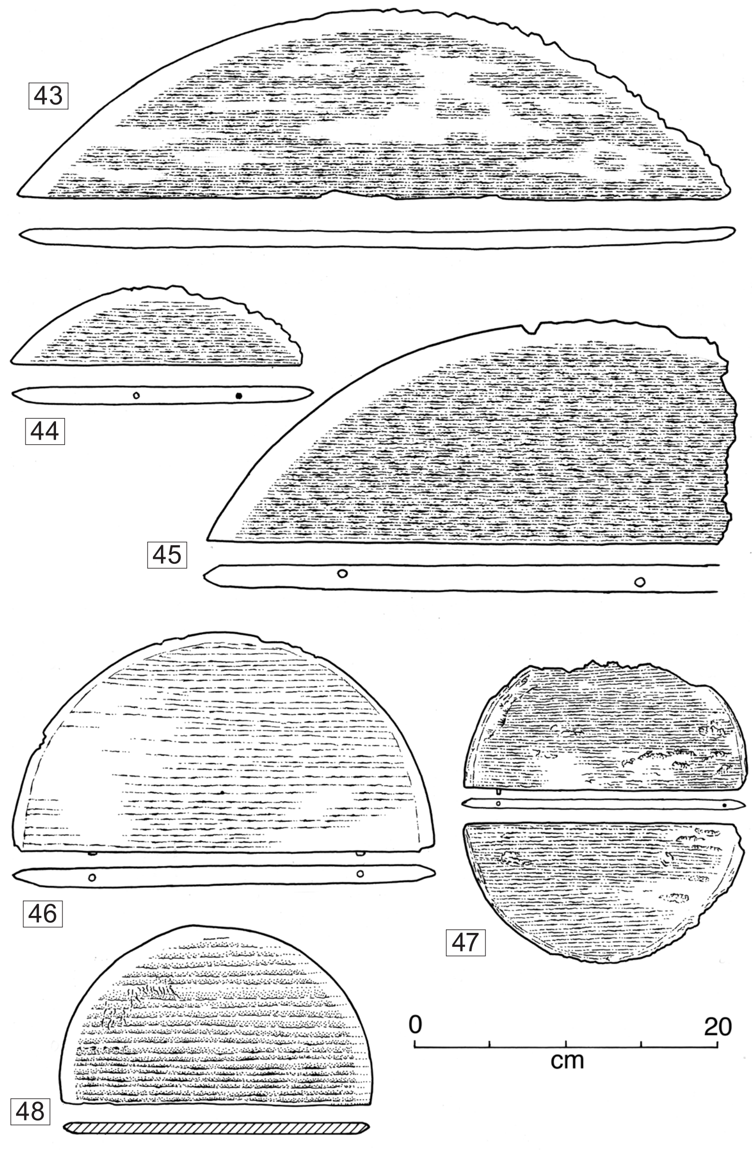


Illustration 169
Unmarked cask-ends 43–8

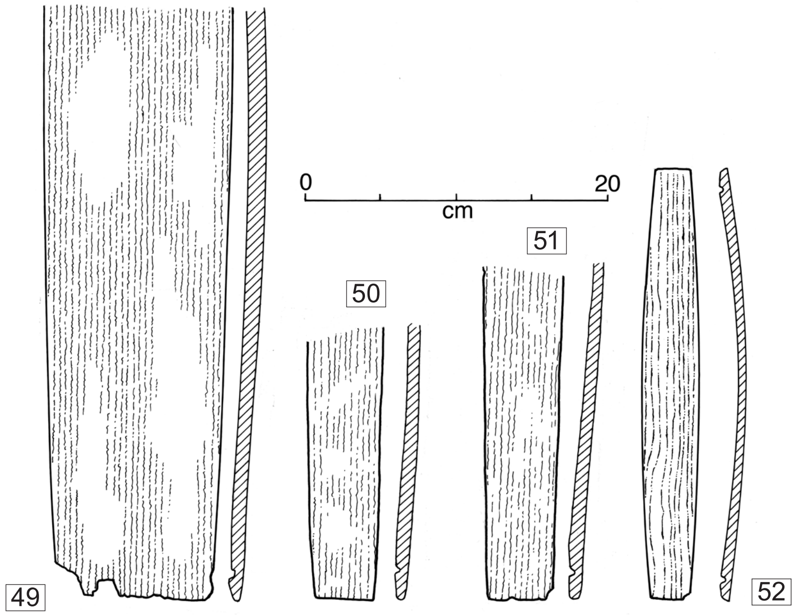
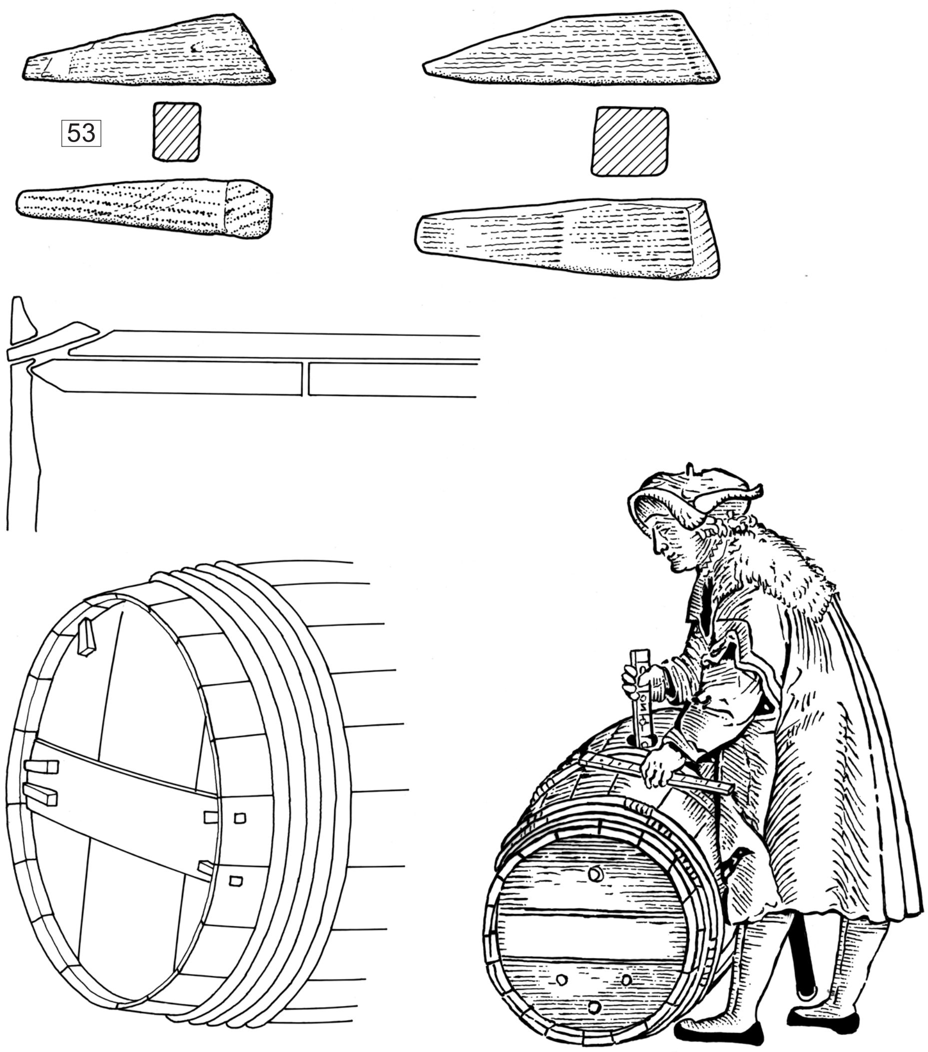


Illustration 170
Cask- and keg-staves 49–52

Illustration 171
Top left: barrel-wedge 53. Top right: a comparative example from the Spanish Armada wreck *La Trinidad Valencera* (both scale 1:2). Centre and bottom left: diagrams showing how the barrel-head was reinforced and tightened with wedges (after Loewen 2007: figs 8.8, 8.4). Bottom right: a 16th-century barrel with reinforced head (adapted from Frey 1531: title page)



6.3 Pumps

It has rightly been observed that pumps are the most important pieces of equipment aboard a ship (Oertling 1996: 9). All hulls leak to some extent, and take on water from spray, breaking waves, and rain. Waterways and scuppers were placed to direct as much as possible out of the ship by natural drainage, but once water percolated below the waterline it had to be gathered and expelled mechanically by human effort. This was a routine chore in all sailing vessels, and no doubt consumed a significant proportion of the available manpower. The crew's ability to pump out water faster than it entered the hull ultimately determined whether or not a vessel stayed afloat.

Several components of wooden pumps were recovered from the wreck, and the structural remains of one of the main pump-wells were recorded. This evidence, read in conjunction with contemporary written sources, allows the pumping arrangements aboard the vessel to be reconstructed in some detail.

Common suction-pump components

54 DP97/A012, **079.092**, lower pump-valve of elm (*Ulmus* sp), 110mm top diameter tapering to 90mm at base, 60mm deep (Illus 172–3). Single groove for sealing-ring around body. Leather claque in place, with roughly squared wooden weight above. Elliptical bore. Concreted remains of an iron staple on top, and corresponding holes beneath.

55 DP99/009, **072.103**, lower pump-valve of elm (*Ulmus* sp), diameter at mid-point 115mm tapering to 105mm at top and bottom (Illus 173). 18mm sealing groove around girth with central raised beading. Elliptical bore. Staple-holes present but lacking claque or weight.

56 DP97/A013; **080.093**, lower pump-valve of elm (*Ulmus* sp), 100mm diameter at top tapering to 87mm at base and 58mm deep (Illus 172–3). Single groove for sealing-ring around body. Wooden top-weight present but no leather claque, though six small nail-holes along one side of the top surface indicate its fixing-points. Elliptical bore. Concreted remains of a staple on top; corresponding holes beneath.

57 DP99/023; **069.104**, lower pump-valve of elm (*Ulmus* sp), 122mm diameter at top tapering to 110mm at base, and 70mm deep (Illus 173). Double groove for sealing-ring towards top; single one beneath. Leather claque with six fixing-holes and wooden top-weight. Elliptical bore. Concreted remains of staple on top and corresponding holes beneath.

Not from the wreck but probably similar to the missing upper component of the Duart Point suction-pump (Illus 173), traditional Irish upper pump-box made by Mr Raymond Grace before 1956 (after O'Sullivan 1969: 112 fig 11). No scale given in the original but is adjusted here to match the 110mm average diameter of the Duart Point lower valves.

Falconer's description of the common suction-pump (1780: 221) cannot be bettered, and should be read in conjunction with Illus 173–4.

Illustration 172
Lower common pump-valves; left 55; right 57 (DP 173310)

> The common pump is … a long wooden tube whose lower end rests upon the ship's bottom, between the timbers, in an apartment called the well, inclosed for this purpose near the middle of the ship's length. This pump is managed by means of the breaks [levers], and the two boxes, or pistons. Near the middle of the tube, in the chamber of the pump is fixed the lower-box, which is furnished with a staple, by which it may at any time be hooked and drawn up, in order to examine it. To the upper-box is fixed a long bar of iron, called the spear, whose upper end is fastened to the end of the break, by means of an iron bolt passing through both. At a small distance from this bolt the break is confined by another bolt between two cheeks or ears, fixed perpendicularly on top of the pump. Thus the break acts upon the spear as a lever, whose fulcrum is the bolt between the two cheeks, and discharges the water by means of valves, or clappers fixed on the upper and lower boxes.

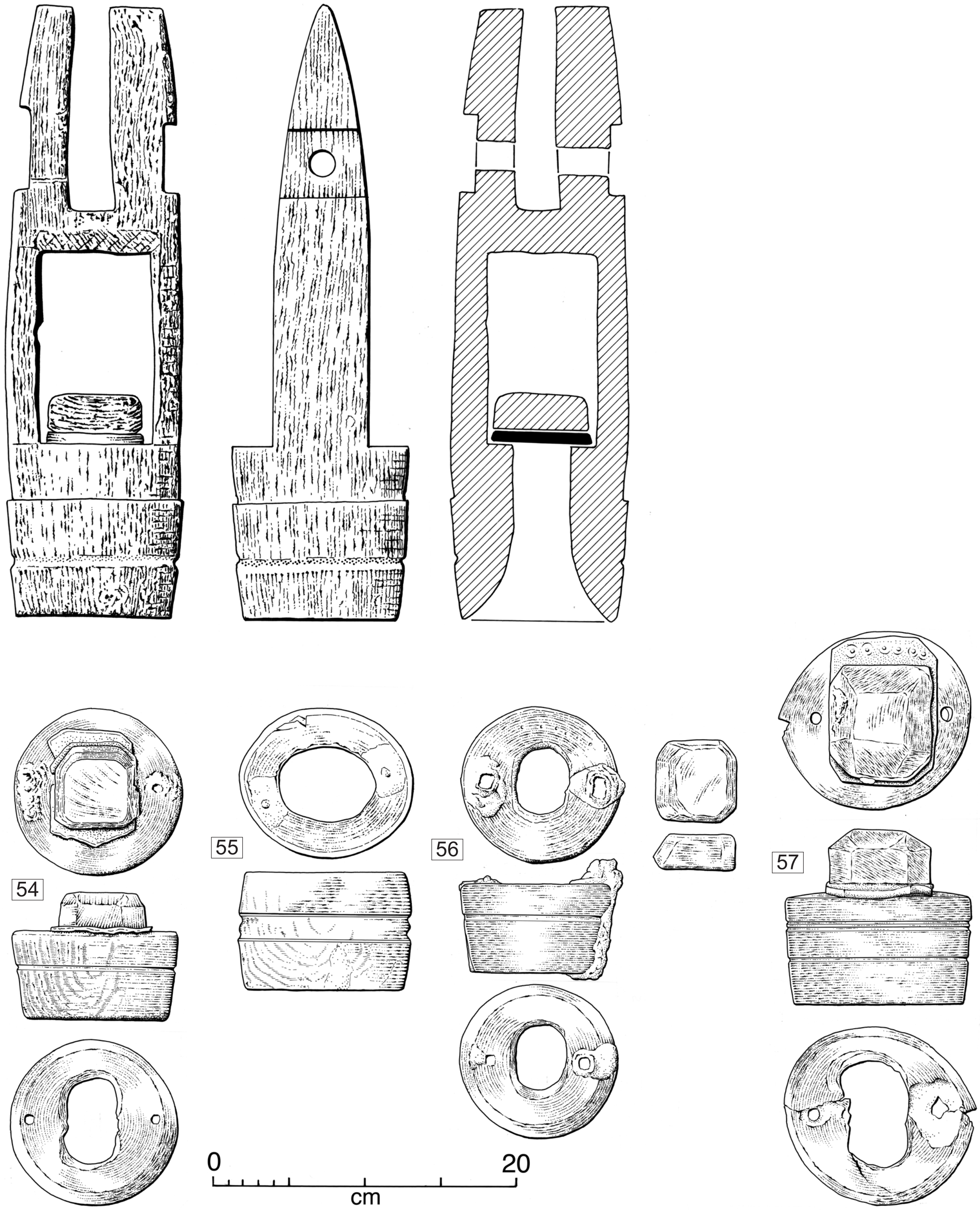


Illustration 173

Top: a modern Irish upper common pump-valve (drawn after O'Sullivan 1969: 112 fig 11), with its scale adjusted to approximate to that of the Duart Point valves. No upper valves were found on the wreck, but they are likely to have been similar to this vernacular Irish example. Bottom: lower common pump-valves 54–7

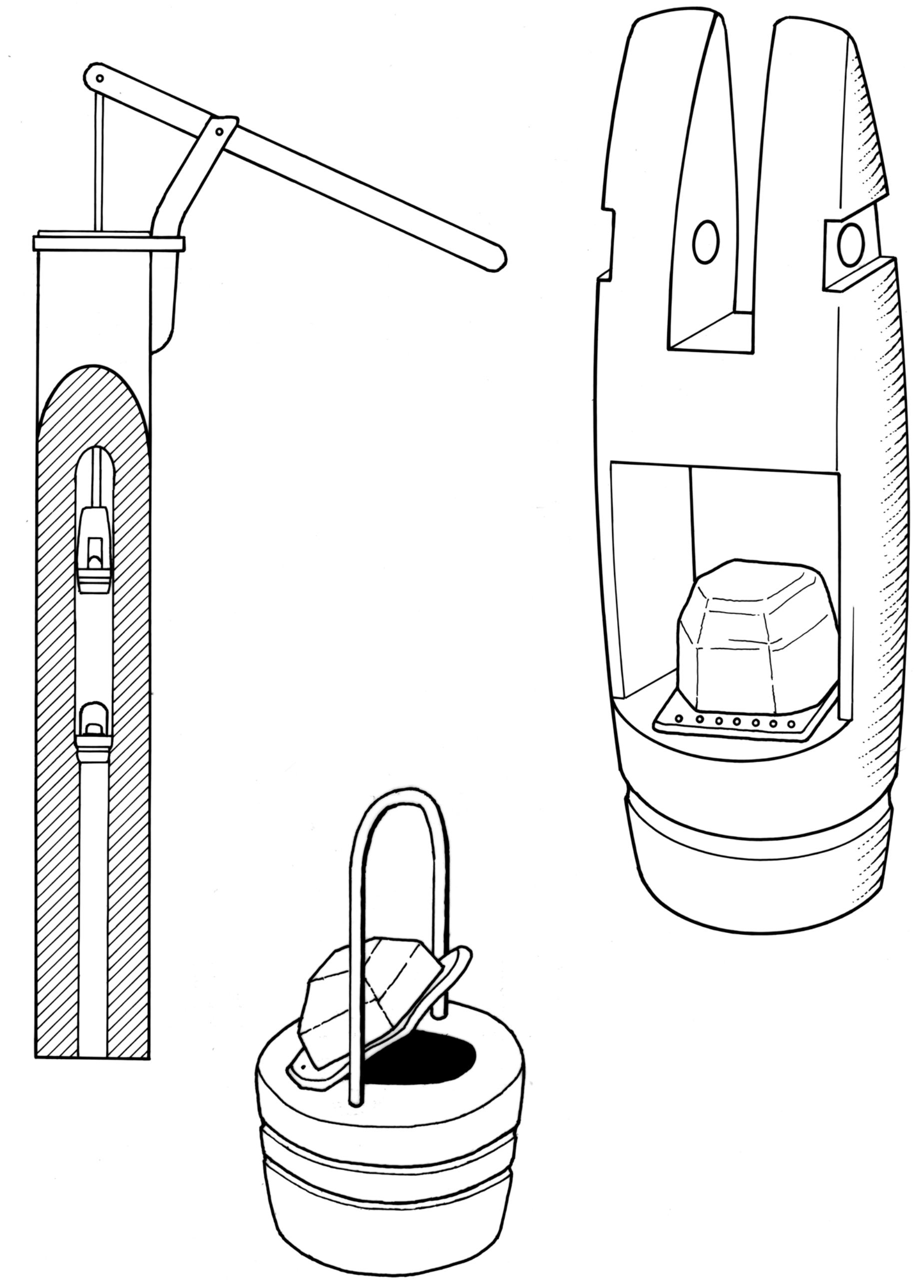


Illustration 174
Diagram showing the working principle of the common suction-pump with details of the lower and upper valves (adapted from Oertling 1996: fig 9)

A pump of this type is limited by physical laws relating to barometric pressure, and can only lift a column of water to a maximum height of *c* 28ft (8.5m) (Oertling 1996: 23). This would be more than sufficient to service the Duart Point ship.

The lower tube of a broadly contemporary common pump was recovered during the excavation of a 16th- and 17th-century saltworks at Port Eynon on the Gower Peninsula of south-west Wales (Lowcock 1998: fig 11). 1.75m (5ft 9in) of the elm pipe survives, including the intact lower end (Illus 175). Its upper 0.64m (25in) is bored to a diameter of 160mm (6in) which reduces to 60mm (2⅓in) at the lower end. There is a taper where the bore reduces, and in here is wedged a slightly tapered lower box-valve of the kind described by Falconer and recorded at Duart Point. Pumps of this type were made in Ireland until the mid 20th century, and in 1965 the last traditional pump-maker, Mr James Reville of Ballyburn, Kilmore, in County Wexford, crafted one for the National Museum of Ireland, the process being recorded in its entirety by John O'Sullivan (1969) (Illus 173 top). The apparatus is in all practical respects identical to the Port Eynon pump and, by implication, to that on the Duart Point ship.

A substantially intact pumping system survived on the wreck of *Vasa* (1628) (Cederlund 2006: figs 11.23, 12.24 and plan 2). The main pump was set well aft, just before the dead-rise, an arrangement which confirms that the ship was designed with a stern-down trim so that water would naturally flow towards and accumulate at this location. The pump-tube was a bored-out alder trunk which discharged on the lower gun-deck, nearly 9m above a sump on the level of the keelson. This is close to the maximum height a common pump could lift. An auxiliary pump was provided amidships abaft the mainmast. This tube was a single lead pipe rising 5m from its sump through the orlop before bifurcating into twin pump-barrels and discharging at the level of the lower gun-deck, just over 7m above the sump.

No example of the upper valve required for a common pump or its associated spear was found on the Duart Point wreck, but such items are known from the wrecks of *Machault* (1760) (Oertling 1996: 26–9) and *Invincible* (1758) (Lavery 1987: 77; Bingeman 2010: 75).

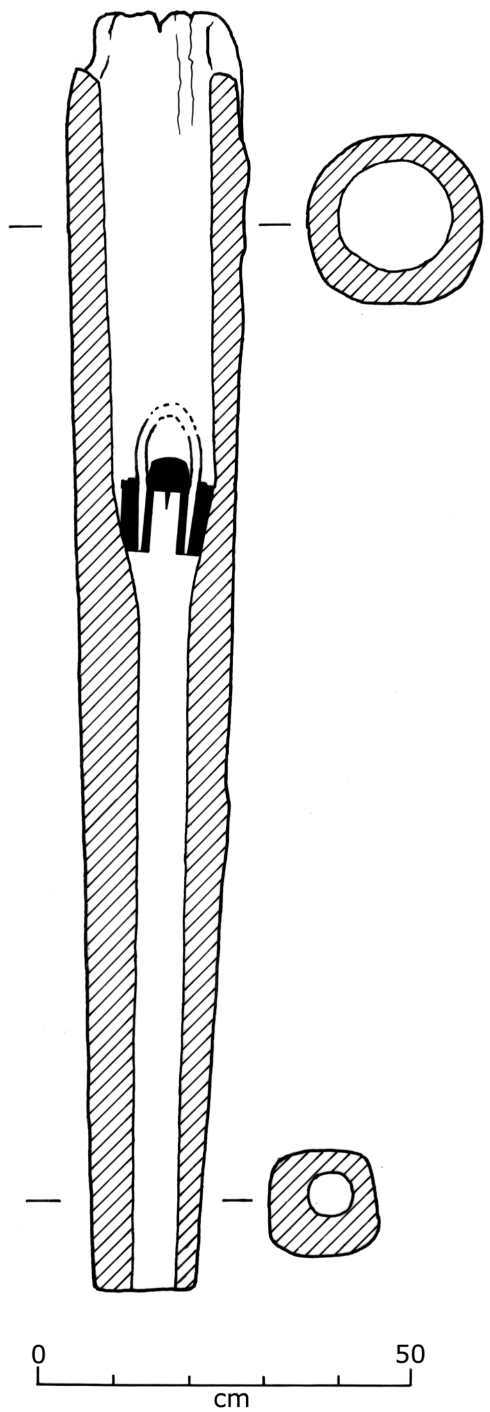


Illustration 175
The Port Eynon lower pump-tube with its lower valve in situ (after Wilkinson et al 1998: fig 11) (DP 174876)

Burr-pump spear

58 DP92/046, **078.087**, complete spear of elm (*Ulmus* sp) from a burr pump, 1.424m (4ft 8in) long (Illus 176). The missing upper valve of the pump assembly would have consisted of a leather cone-shaped gasket nailed to the conical butt at the lower end of the spear. No nail-holes could be identified on the Duart Point example, suggesting that it was an unused spare.

The burr pump was a simple machine which probably had earlier origins than the common suction-pump (Oertling 1996: 16–21) (Illus 177). Its main component was a wooden spear which incorporated the upper valve. This was in the form of a truncated cone (the burr), to which an extending leather skirt was nailed. On the downward stroke the skirt collapsed, opening the valve. When pulled upwards the pressure of water extended the skirt, pressing its edges against the sides of the pump-tube to make a seal, creating a pressure-differential which opened an inlet valve at the foot of the tube. In terms of mechanical advantage the design was superior to the common pump, but its disadvantage was that it required many more operators, as described by Mainwaring in the early 17th century:

> [The burr pump] is not used in English ships, but the Flemings have them in the sides of their ships, and are called by the name of bilge pumps, because they have long broad floors that do hold much bilge water. The manner of these is to have a staff some six or seven feet long, at the end whereof is a burr of wood whereto the leather is nailed, and this doth serve instead of the box; and so two men standing right over the pump do thrust down this staff, to the midst [i.e. the top] whereof is seized a rope long enough for six, eight, ten or more to hold by, and so they pull it up and draw the water. (Manwaring and Perrin 1922: 203)

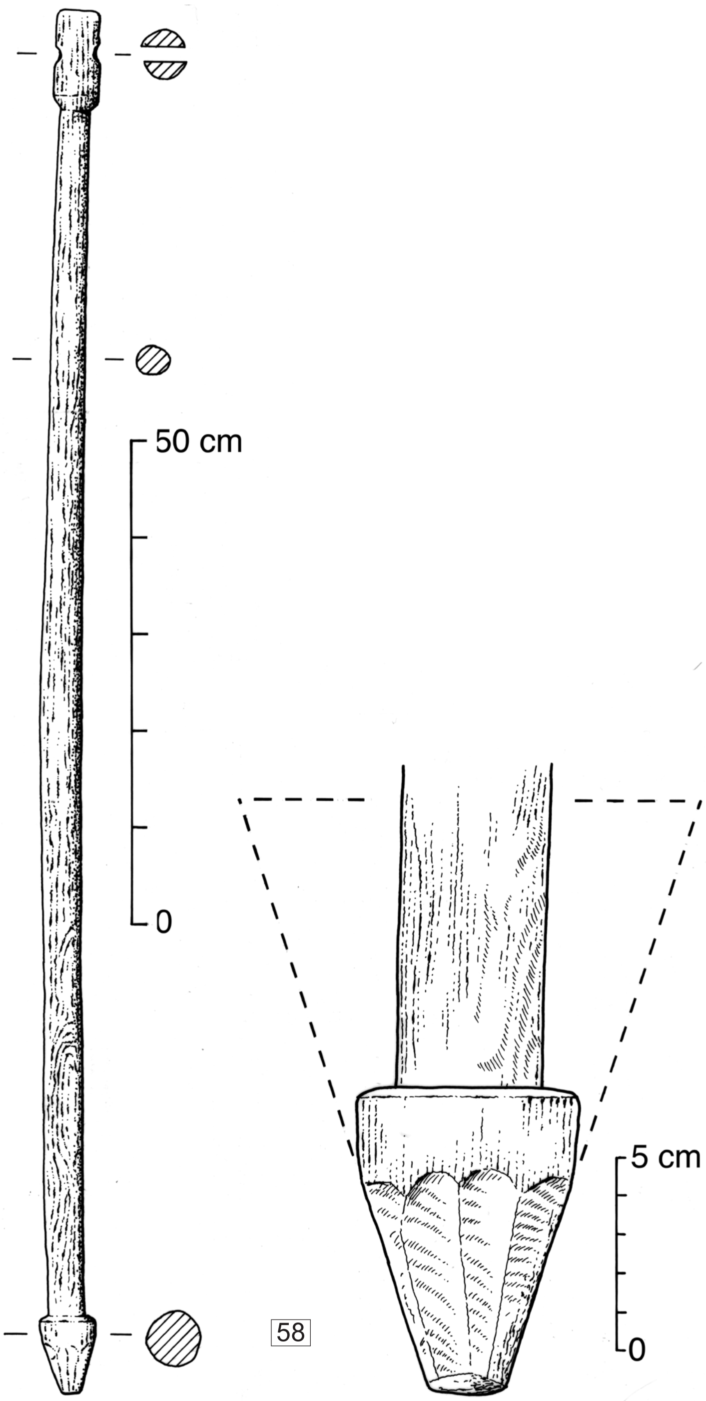


Illustration 176
Burr-pump spear 58, with enlargement of head

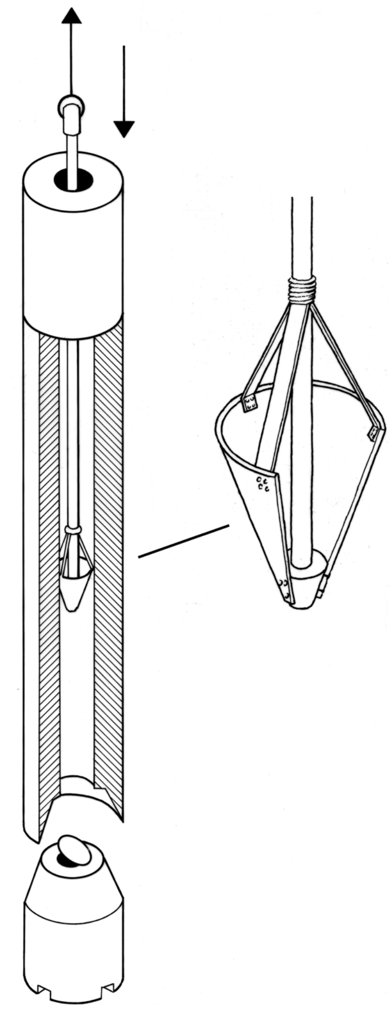


Illustration 177
Diagram showing the working principle of the burr pump with details of the lower and upper valves (adapted from Oertling 1996: fig 3)

A vertical upwards pull would have required the pumping squad to be positioned on the deck above the pump, pulling the pump-rope horizontally via a suitably placed sheave. A second team, standing at the pump-head, would be needed to thrust the spear back down the tube after it had reached the top of its travel. The Duart Point 1.424m (4ft 8in) spear is significantly shorter than Mainwaring's 6ft or 7ft one, so its burr pump's output and crew would be reduced accordingly. A single down-thruster and a pulling team of three or four would probably have sufficed.

The pump-wells

Immediately aft of the transverse mainmast-step, on the line of the limber planking and hard against the keelson on the port side at **188.074**, is a small box-like structure measuring 0.3m × 0.2m (1ft × 8in) (Illus 178) (see Chapter 3.2 area 6). Its forward edge is formed by the side of the transverse mast-step, its starboard edge by the keelson, the port by a short plank fastened to the forward side of Frame 3.6A, and the aft by another short, slightly angled plank. At the forward port-side corner of the box a rectangular hole measuring 200mm × 150mm (8in × 6in) has been cut through the limber-

Illustration 178
The port-side pump-sump and box. The abraded keelson is at the top (with 15cm scale) while the remains of the transverse mainmast-step (eroded almost to extinction) are on the left (DP 173785)

plank immediately above the port-side limber-hole on the underside of Frame 3.0A. Tool-marks on the forward face in a corresponding position indicate that there was a similar feature on the starboard side at **187.068**, now destroyed.

These features were undoubtedly sumps for the port and starboard pump-tubes. Some form of filtration is likely to have been provided at the base of the suction-tube to prevent the pumps from blocking, and while no evidence of this was found, the relatively clean state of the bilges, gaps between the frames, limber-holes and pump-sumps suggest that there was a regular and significant flow of water through the ship's natural drainage-courses. This, as pointed out at the end of the previous chapter, is a symptom of a leaky ship.

Conclusion

That two types of pump – the common suction-pump and the burr pump – appear to have been in use on the Duart Point ship requires explanation. It seems likely that the two midships pumps were of the common suction sort, operated by brakes (levers) on the main deck and discharging athwartships via port and starboard pump-dales. The burr pump, as Mainwaring noted, was characteristically used by Flemish ships, because their flat-bottomed configuration meant that water had insufficient fall to gather in depth at the pump-well amidships, so tended to accumulate in the bilges, especially when the ship was heeled to leeward or lying aground. For this reason burr pumps were often mounted at the sides of the ship. No doubt they could be set up on either side as need arose, and perhaps port and starboard tubes and bottom valves were kept permanently in place, requiring only the insertion of a burr-pump spear to render them operational.

Small warships of this period, if not actually built in Flanders, were much influenced by Flemish design (Thrush 1991), and it seems likely that the Duart Point ship was one such. While not particularly flat-bottomed, her lower hull was fairly shallow and, given the varied sea-conditions she was likely to encounter among the western seaways, an ability to deal with sudden water ingress, whatever sailing attitude the ship might adopt, may have been an essential rather than a desirable attribute.

6.4 Assessment of samples from the bilges

Headland Archaeology, 2003

Three samples were selected as being representative of the whole. A 0.5 litre sub-sample of each was wet-sieved using a 1mm mesh. The resulting material was examined under a binocular microscope and any items of potential archaeological significance noted. The results of this are presented in Table 6.2. The three samples were very different in composition, although all contained fragments of decomposing wood, presumably pieces of the ship's hull.

Sample B

The sample labelled 'B' had all the appearance of a purely natural deposit, being dominated by clean sand with marine shell and crustacean fragments. Two small fragments that had the appearance of cinders were also encountered. There were, however, so small that they could equally be metal corrosion products or natural concretions.

Sample 18/15

The preservation of organic materials in this sample was good, but the concentration was much lower than in DP01 below. Apart from the differing concentrations the two samples had essentially the same character. Moss and monocotyledon stem fragments were present in small quantities. The most important element from this sample was probably several large pieces of leather, some with stitching-holes.

Sample DP01

The preservation of organic material in this sample was extremely good, with fragments of moss stem and leaves and also monocotyledon (probably grass or sedge) stems. While it is known that moss was used as caulking material, much of the bulk of this sample was well humified and its composition would seem more likely to be that of a sedge peat. There might

Table 6.2
Composition of retents, samples from the bilges

Sample no	*Finds*	*Wood*	*Marine shell*	*Moss frags*	*Possible cinders*	*Fish otolith*	*Monocotyledon stem frags*	*Crustacean frags*	*Comments*
B		++	++++		+	+		++	Primarily clean sand
18/15	three large pieces of leather and one large piece of wood	++++	+++	+			+		
DP01	three large pieces of wood	++	++	++			+++		

be many reasons why such material might accumulate in the bilge, but it is possible that is was used as fuel or for the packing of delicate materials.

Comments

This assessment has shown that the preservation of organic materials in these samples is variable but in some cases it is good. In the case of Sample DP01 peat seems to have formed the main bulk of the sample, but given that the preservation is good, other materials might be expected to survive elsewhere in the bilge.

6.5 The galley

Bricks

59 DP96/015, DP00/133, DP01/066, 110, DP02/019 (4 whole, 2 half), DP03/015 (the majority), from around the port-side edge of the forward ballast-mound, 17 complete bricks, two broken ones and a few fragments (Illus 179).

They may be interpreted as parts of the collapsed galley range, which would have been located in the forecastle, probably on the port side of the foremast. The 15° lean to port of the forward hull, determined from the structural evidence, would have tipped the galley and its contents towards that side, depositing the bricks around the edge of the ballast-mound. This area contained other material associated with cooking and food preparation, notably coal, a copper-alloy kettle and a rotary hand-mill (see below). The bricks can be divided into four types, distinguished by their fabrics. These are:

- Type 1. Light purplish fabric, few inclusions (eight examples).
- Type 2. Pinkish-red fabric, no visible inclusions (four examples).
- Type 3. Dark buff fabric with a dark-grey core and large inclusions of broken red brick (three examples, all broken). Straw impressions on the face of one example.
- Type 4. Refractory bricks. Light buff fabric with crushed brick inclusions (four examples).

Between them they show evidence of a smoothed upper face, marks on the upper face indicating that they were scraped lengthwise with a board, and an underside texture that suggests that while wet they had lain on a straw-covered surface. A Proclamation of 1625 specified 9in × 4⅜in × 2¼in (229mm × 113mm × 57mm) as the minimum size of bricks sold in London, though this was by no means universal (Lloyd 1925: 12). The graph (Illus 180) shows median values quite close to this standard, although there are discrepancies of up to 15mm on some bricks. Most of the discrepancies fall below the prescribed standard.

Illustration 179
Top: bricks 59 from the galley area showing the four fabric types (DP 174195). Middle: brick showing marks of the grass on which it was laid while still soft. Scale 10 centimetres. Bottom: the interior of a Type 3 brick revealed by breakage, showing poorly mixed clays and brick inclusions

Tile fragments

60 DP93/005, DP01/002, 022, 034 (2), 135a (3), DP02/019, in the same area as the bricks, fragments of tile in a light yellowish-buff fabric with numerous small dark angular inclusions (Illus 181). Average thickness is *c* 10mm and the edges have a squared finish. The largest fragment includes a right-angled corner within which is a nail-hole *c* 8mm square, set at an angle through the tile. The tiles were probably from a fireproof cladding, hung on a wooden framework surrounding the galley firebox.

Fuel

Small fragments of coal were found scattered across the site, with concentrations of larger pieces in the area of bricks, tiles, and other material among the collapsed galley around grid square **28.07** (Illus 182) and in the adjacent area under the ballast in the vicinity of grid square **27.06**. A total of 8.5kg was recovered. Coal was evidently the main cooking fuel in Cobbett's fleet. The nature of the coal does not allow close geological provenancing (John McManus pers comm) but is typical of the Central Scottish coal measures which extend from the Fife to the Clyde coasts (Unstead 1964: 214), and may well have been taken aboard at Ayr. Its distribution on the wreck suggests that it was stowed close to the bow, no doubt immediately above the ballast.

Degraded fragments of peat were also identified among the bilge debris (see 6.4 above). Beneath the hull, at **230.053**, was found a single almost-intact cut block of peat, *c* 150mm long and 50mm thick, with one rounded and one flat face (DP01/007) (Illus 183). Stratigraphic striations ran longitudinally, indicating that the billet had been cut by breasting; that is, in horizontal slices from the face or breast of the bank using a peat-iron (Grant 1995: 199–200). This traditional method allowed the peats to cohere more positively during the drying process, and has been in use until recent times (Fenton 1999: 125–6). It is uncertain whether the block was additional fuel obtained locally, or whether it derives from an earlier episode in the ship's history. In either case it lends support to the vessel's strong Scottish connections and consequently to its identification as *Swan*.

Among the collapsed aft end of the wreck several oak twigs were found, some with leaves still attached (Illus 167). These may have been firewood, or dunnage associated with cargo stowage. In the latter case they might have been used as fuel once the cargo was consumed or discharged.

Copper-alloy kettle

61 DP79/002, in the area of the forward ballast-mound adjacent to Gun 6 and probably associated with the collapsed galley debris (John Dadd pers comm) (*c* **29.09**),

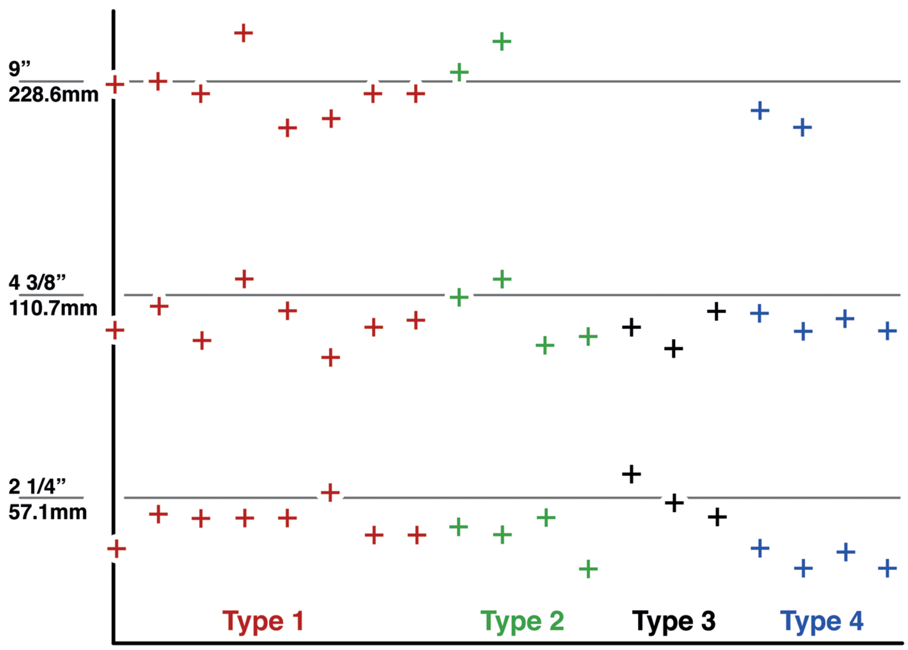


Illustration 180
Graph of the brick measurements, showing the extent of deviation from the standard

riveted sheet-copper-alloy kettle, diameter 400mm, height 412mm, capacity *c* 50 litres (11 gallons) (Illus 184). The body is made of a bottom piece beaten into a shallow pan, to which a sheet metal cylinder is attached. A shallower cylinder with a rolled rim provides the top segment. The overlapping edges are riveted at intervals ranging from 10mm to 45mm. Two loop-handles with their ends beaten into leaf-shaped flanges are riveted to opposite sides of the rim.

Comparable vessels have been found on the 17th-century wreck off Mingary Castle, Ardnamurchan (in NMS collections), *Vergulde Draeck* (1656) (Green 1977: 199) and on Wreck E81 in the drained NE Polder of the former Zuider Zee (Vlierman 1997: 30). The Duart Point kettle would provide servings for the complement to be expected in a ship of this size, and it is reasonable to suppose that it was the main cook-pot in the galley. A 1626/7 survey of the 100-ton warship *Moon* specifies a main kettle 2ft wide and 17in deep, which gives a capacity of

Illustration 181
Examples of broken tiles [60] from the galley area. Scale 10 centimetres (DP 174198)

Illustration 182
Coal from the area of the collapsed galley. Scale 50 centimetres

126 litres (27.75 gallons), and another 1ft broad and 7in deep (13 litres or 2.85 gallons) (Lavery 1988: 26).

Rotary hand-mill

62 DP02/003, **282.079**, the top- and bed-stones of a rotary hand-mill or quern (Illus 114, 185–6). They were found with the two stones face-to-face but inverted, among the galley debris at the port edge of the forward ballast-mound, suggesting that they had been secured as a working pair when they fell from the forecastle deck above. They are of typical coarse sandstone. The upper stone is 610mm in diameter, 156mm deep, and its sides angled slightly downwards. The central hole is hopper-shaped at the top, where it is 176mm in diameter, narrowing to 96mm before flaring out to 128mm at the bottom. There is a hole 44mm deep and 32mm in diameter on the top, its centre 56mm from the edge. Dovetail slots 15mm deep are cut in the underside on opposite sides of the hole. The grinding face is cut with 12 offset groups (known to millers as 'harps') of raised ribs and grooves ('lands' and 'furrows') slanting in a clockwise direction towards the edge. Little wear is

Illustration 183
Peat block retaining the form of the cutting-spade. Scale in centimetres (DP 174127)

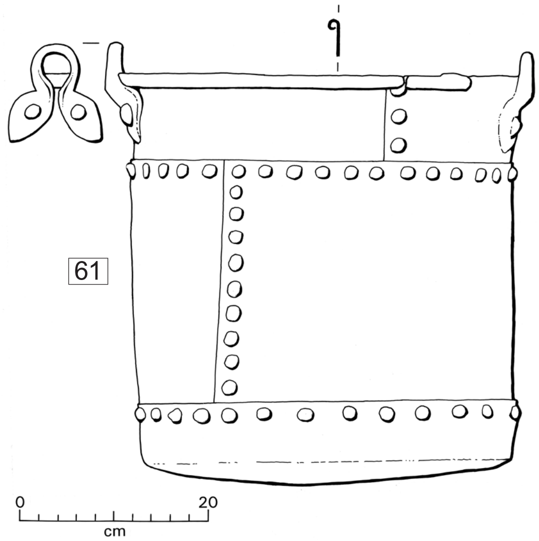


Illustration 184
Riveted copper-alloy kettle 61, probably associated with the galley (DP 174849)

evident. The bed-stone's sides are also angled, though less sharply than the upper one. Its maximum diameter is 572mm, and its depth 126mm. There is a single central hole 18mm in diameter and 64mm deep. The upper face of the stone is dressed in the same way as the lower face of the top stone. It should be noted that the direction of the grooving is opposed when the stones are placed face-to-face.

There are traces of iron corrosion in the dovetail slots on the lower face, together with the lead filling around the edges which had secured a bar spanning the hole. This would have allowed the rotating top stone to turn on a pin set in the hole in the stationary bed, where evidence of iron corrosion was noted. It may be presumed that the lower stone was fixed to a wooden board or tray (known as a 'quern house') from which the ground meal could be collected (Fenton 1978: 389).

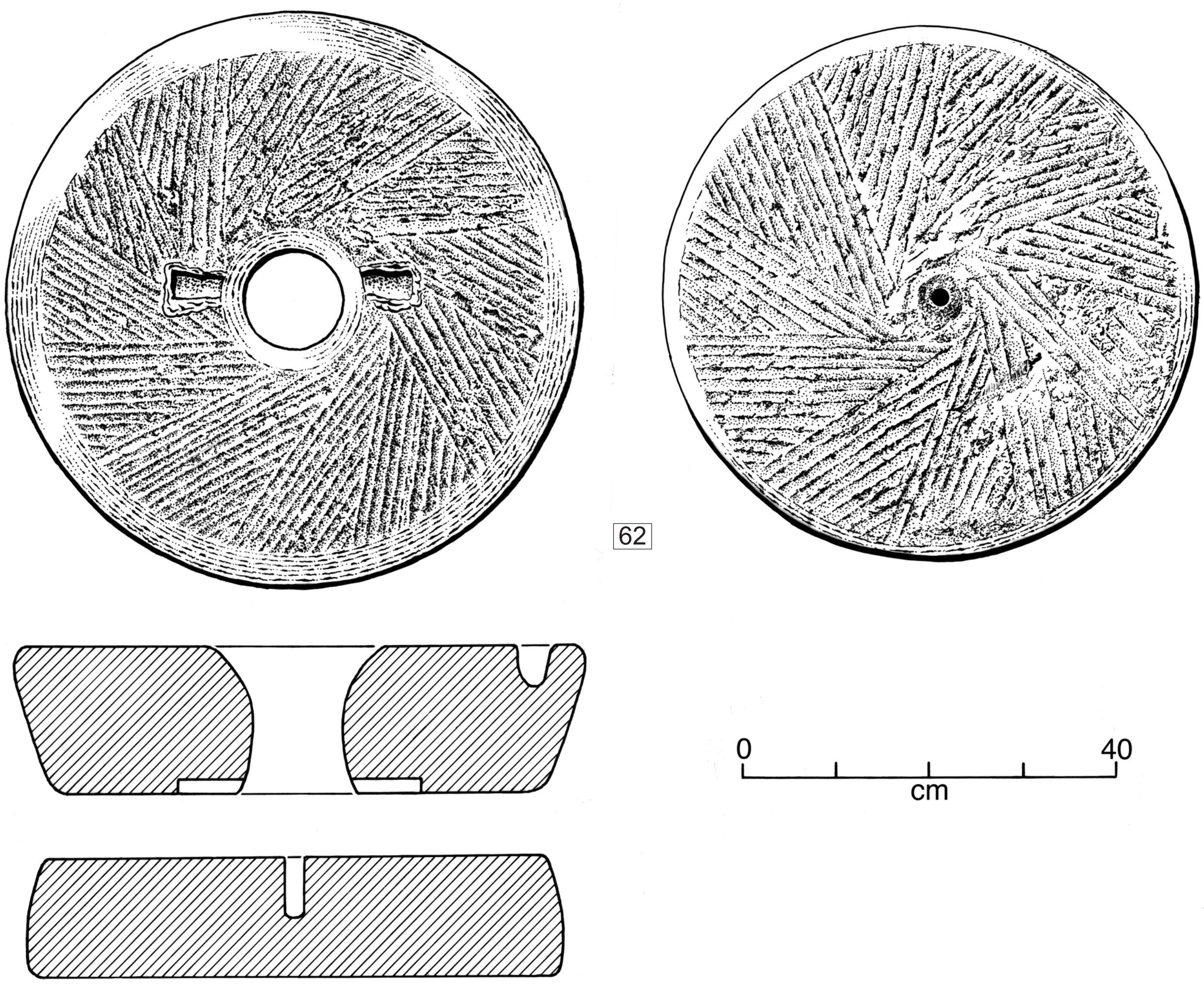


Illustration 185
The two halves of a quern or hand-mill 62, found in the collapsed galley area (DP 174846)

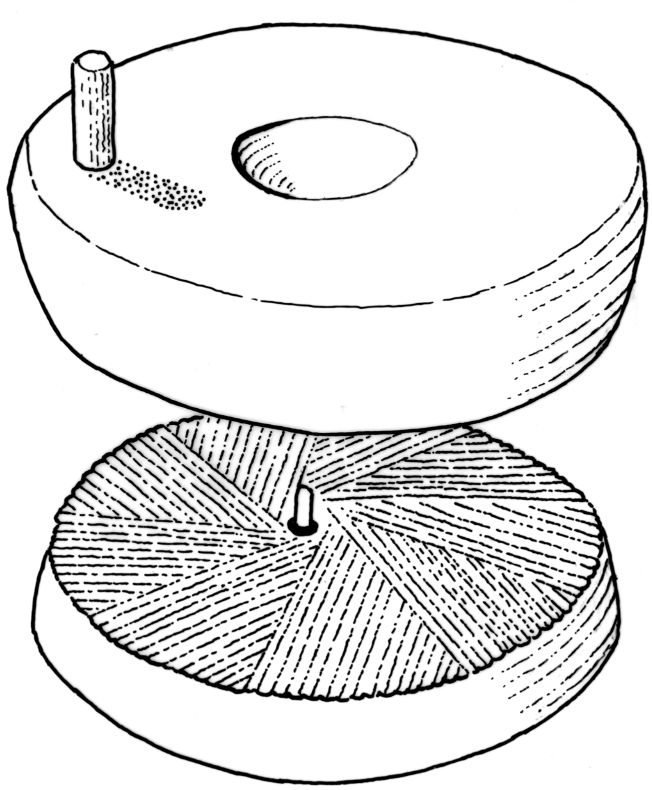


Illustration 186
Reconstruction of the quern or hand-mill (DP 174845)

This simple device has been known in Scotland since late prehistory (Illus 187), though the potential of detailed studies into its manufacture, distribution and use has only recently been recognised (McLaren & Hunter 2008). In more modern times its use has been prohibited in Scotland (or at least driven to clandestine operation) because tenants were 'thirled' to use the powered mill belonging to the landowner, but the use of hand-mills remained widespread in Orkney and particularly Shetland until the modern era (Fenton 1978: 388–410). They were also a regular piece of equipment for armies in the field, for the capacity of the land to feed invading forces was often a strategic consideration when planning the timing of a campaign. That Cobbett's invasion of Mull took place in early September, when the grain crop would have been ripe, is surely significant. But effective foraging required the right equipment. When Lord Inchiquin was on campaign with a Parliamentary army in south Tipperary during the late summer of 1647 he was unable to make use of the abundant grain 'through want of hand-mills' in spite of having 'often and earnestly written' for them (Carey 1842: 352). He spitefully burnt the unharvested fields instead.

The Duart Point hand-mill, presumably supplied by a more efficient Cromwellian commissariat, is of quite sophisticated design. The complex pattern of harps with their lands and furrows on the grinding faces, designed to work more efficiently and throw the flour outwards, is normally found on full-sized millstones rather than querns. Although the ironwork associated with the pivoting of the quern no longer survives the arrangement seems quite elaborate, and may have incorporated some kind of adjustment for regulating the fineness of the grind (Fenton 1978: 389–90). The feed-hole or hopper also displays an understanding of the principles involved, with its funnel-shaped entry for feeding the grain and the restricted central hole which would have pressed it towards the flared bottom, encouraging flow into the grinding cycle.

6.6 Animal bones

Catherine Smith, 9 December 2003

Methods and measurement

The mammal and bird bones were identified with direct reference to modern comparative material and allocated to particular bone and species where possible. Where the bones

Illustration 187
An 18th-century Highland quern in use: detail from an engraving by Moses Grifith (Pennant 1774 vol 1: pl xxxiv, author's collection)

could not be identified as far as species level, the terms 'large ungulate', 'small ungulate' and 'indeterminate mammal' are used: thus all large vertebrae other than the atlas and axis are described as large ungulate, while small vertebrae are described as small ungulate. Ribs are similarly allocated depending on their size. On the basis of probability, large ungulate bones are most likely to have come from cattle, but could also have come from horse or red deer. However, since neither of these two species was positively identified, it may safely be assumed that all large ungulate fragments come from cattle. Similarly, small ungulate bones are most likely to have come from sheep, for no species of comparable size (goat, pig or roe deer) was identified in the collection. All other mammalian fragments for which neither species nor bone could be ascertained are described as indeterminate mammal.

Measurements were made in accordance with the scheme of Driesch (1976). Additional measurements on the humerus follow Legge & Rowley-Conwy (1988: 124). Mandibular tooth wear and eruption patterns were assessed using Grant's scheme (1982) for cattle and sheep/goats, as well as Payne's scheme (1973) for sheep/goats.

Table 6.3
Numbers of bones by species

Species	*No of fragments*
Cattle	64
cf Cattle	2
Sheep/goat	21
Large ungulate	91
Small ungulate	13
Indeterminate mammal	14
Domestic fowl	6
cf Fowl	5
cf Goose	1
? Bird	1
Total	**218**

The animal bones

During the excavation of the wreck a number of animal bones and bone fragments was retrieved. The faunal assemblage was recovered during several seasons' work and was scattered over the site, with the bulk located towards the stern. Close examination of the bones revealed that only a restricted number of animal and bird species was present (the fish remains form the subject of a separate report below). The assemblage is dominated by the bones of cattle (and large ungulate), while sheep/goats are the second most numerous species. Surprisingly, pig bones are absent. No wild-mammal species were present. A small number of bones from domestic poultry was also recovered, consisting mainly of domestic fowl (*Gallus gallus*). One bone was probably from a domestic/greylag goose (*Anser anser*).

The numbers of fragments from each species are summarised in Table 6.3. A complete catalogue of the animal remains can be found in the archived report (Smith 2003: table 7 and appendix 1). Sixty-six bones from cattle represent a minimum of three different animals (based on the presence of three right innominates (pelves)), while 21 sheep/goat bones represent a minimum number of two sheep/goats (based on the presence of two right innominates). Of the bones recovered, the percentage of cattle/large ungulate bones was 82.2%, while the percentage of sheep/goat/small ungulate bones was 17.8%.

Chaplin (1971: 134) suggests the concept of 'sheep equivalent' as a unitary value for calculations of meat quantities involving species of different sizes, notably sheep and cattle. In his scheme, one dressed cattle carcass provides 12 times the quantity of meat of a sheep carcass. Thus the (minimum of) three cattle carcasses aboard the Duart Point ship roughly equate to 36 mutton carcasses. If each mutton carcass has a dressed weight of 25lb (Chaplin 1971: 134), then the bones represent 900lb/408kg of beef and 50lb/22.7kg of mutton. Translated into percentages, this random sample suggests that 94.7% of the meat in the diet was beef while only 5.3% was mutton.

This will in no way reflect the total quantity of meat originally supplied, since waste bones would probably have been discarded overboard once the meat was consumed, while much of the remaining supplies must have been devoured by marine scavengers after the ship was wrecked, along with some of the bones. Indeed several bone fragments showed long scrape-marks which are not man-made but may be the result of scavenging by crustaceans or other marine carnivores. Further factors include the survival characteristics of the bones and the proportion of the total assemblage that has been recovered. Many were probably lost or degraded during the site-formation processes before the wreck stabilised within the sea-bed environment. It should also be remembered that excavation was restricted to those parts of the site which had become exposed in recent times, leaving substantial, though unquantifiable, stable archaeological deposits undisturbed. Even within the excavated areas it is unlikely that all the bones deposited were recovered, so, as on other sites, there is probably a sample bias towards larger fragments. This would tend to favour the recovery of cattle bones rather than of smaller sheep bones.

Age of animals at death

Unfortunately, few mandibles with dentition survived. However one cattle mandible with a mandible wear-stage of 41 according to Grant's scheme (1982) came from a fully mature animal at least five years old. A sheep/goat mandible, on the other hand, came from a young lamb under two months old (Payne 1973).

The state of epiphysial fusion of all available cattle and sheep long bones was also assessed. Epiphyses are the articular ends of long bones, which do not become fully fused to the bone-shafts until the animal has reached maturity. The state of fusion of the articulations to the shafts can therefore be used as a guide to the ages at which animals died or were killed. Although no absolute ages can be stated, age-categories can be assigned. Epiphysial-fusion evidence is summarised in the full report (Smith 2003: table 2). Although the sample numbers are very small, there is evidence that more young sheep/goats than young cattle were present. Since the survival of young bones is usually far poorer than of mature bones, this would seem to be a true reflection of the age-pattern of the animals eaten on board ship.

Size of animals

Where possible anatomical measurements were made on the long bones of cattle and sheep/goats. A summary of measurements is presented in the archived report (Smith 2003: tables 3 and 4). As there are few (if any) comparanda for animals of 17th-century date in Scotland, the measurements were compared with the large body of data available for medieval Scottish animals. The most substantial medieval assemblage, dating from the 11th to the 14th centuries, was recorded at the Perth High Street excavation (Hodgson et al 2011). Bones of cattle and sheep/goat from the Duart Point wreck fall, with only one exception, within the ranges for these medieval animals, and in most cases the cattle were smaller than the averages recorded at Perth. One cattle metacarpal which falls outside the Perth range was slightly smaller than the medieval examples, with a greatest length of 151.5mm.

In some cases it was possible to estimate withers-heights of animals when alive from the lengths of intact metapodia. Two intact cattle metacarpals came from beasts with estimated withers-heights of *c* 0.93m and 1.11m, while a metatarsal was estimated to come from an animal of 1m at the withers. These figures compare with a range of 0.96–1.13m reported at Perth High Street. Thus some of the cattle aboard the Duart Point ship were smaller than those found in Scotland during the medieval period. The source of at least some of these beasts may have been north-west Scotland or the Western Isles, since animals from island populations tend to be smaller than their mainland counterparts. Edmund Burt, an Englishman associated with military activities in Scotland during the 1720s, wrote a series of letters which incorporate many observations on Highland life. He referred to the increasingly small size of the cattle and sheep the further north he went in the Highlands (1754 vol 1: 30). The sheep found on board were similarly small, and would not have been out of place in a medieval population. All of the sheep/goat bones from Duart Point fell within the Perth High Street ranges.

Evidence of butchery

Despite their prolonged immersion the condition of many of the bones was still good enough to reveal butchery-marks. These consisted of cuts made by knives, and chop-marks caused by axes or cleavers. Chop-marks were particularly common on the shafts of the ribs of large ungulate/cattle. The majority of the vertebrae were chopped in the median or sagittal plane, although some were butchered by removal of the lateral processes. Those which had been chopped neatly in half in the sagittal plane indicated that they came from carcasses which had been cut into two equal 'sides' of beef. A small number of small ungulate/sheep vertebrae were found; of these, half were chopped across the lateral processes and half were chopped neatly in two. Sterna and innominates (pelves) chopped in half also indicated the division of the carcass into sides, for example a cattle innominate bore several dorso-ventral hacks parallel to the pubic symphysis, in the middle of the pelvis.

The bones from this site are in contrast to the usual type of archaeological faunal assemblage from an excavation on land, where it would be expected that most of the bones are the evidence of meat which has been eaten. Since it is likely that the ship went down carrying provisions which had not yet been consumed, some of the bones should represent complete, articulated parts of carcasses. As Colin Martin argues below, much if not all the meat on the ship was probably purchased or requisitioned from the local area, which implies that it was either consumed fresh or processed for short-term storage. The size of the rib, vertebral, and innominate fragments, and the presence of intact metapodia, indicates that large pieces of beef were involved. Several articulating fragments, and the presence of paired cattle metacarpals, also indicate the presence of whole pieces of beef or mutton (for example, the paired sheep metacarpals).

Some of the bones do, however, bear knife-cuts around the articulations, indicating that the meat was stripped off, for example a sheep/goat humerus with about ten fine knife-cuts around the distal end. One large ungulate vertebra fragment was calcined by heat, either because it had been part of a cooked joint, or because the remains had been discarded in the cooking-fire.

Summaries of the types of cattle and sheep/goat bones (or anatomical elements) are shown in the archived report (Smith 2003: tables 5 and 6). Almost all parts of the cattle carcass are represented. Low meat-yielding elements such as the metapodia are as common as high meat-yielding bones such as the humerus and femur. Large ungulate/cattle rib and vertebral fragments are among the commonest elements found. The ribs would have been contained in the meat-joints known as flank and brisket: these are considered suitable for salting or boiling (Gerrard 1949: 241). Flank beef is a fatty cut which does not contain much muscle and is best used in soups, while brisket is more meaty. The rib portion (fore-rib) which articulates with the vertebral column is the part which makes the best roasting joint from the forequarter. Since a good proportion of the ribs in the assemblage included an articulation, it might be assumed that at least some of the beef on board was of reasonable, though not high, quality. Bones from the hindquarter, which is considered to be of better quality than the forequarter, were also present; for example, innominates include the cut known as the aitch- or heuk-bone, which is still sold by butchers in Scotland today.

Vertebrae, with the exception of neck and tail vertebrae, are generally to be found in good-quality meat joints such as the sirloin. Lumbar vertebrae were indeed present, while a number of caudal (tail) vertebrae were also found in the assemblage. The latter could only have been used in soups or stews – these are the bones used in ox-tail soup.

One cattle 2nd phalange (toe bone) displayed signs of pathology. The bone was entirely surrounded by extensive new bone growth, with the exception of the proximal articular surface. There was some evidence of eburnation (polishing) of the distal articulation. Since the first interphalangeal joint was affected, the condition may be described as 'high ring bone', defined as any bony exostosis affecting an interphalangeal joint (Baker & Brothwell 1980: 120). The animal from which the bone came may have been lame, possibly a factor in culling it.

Conclusions

with contributions from Colin Martin

The animal-bone assemblage from Duart Point is of great interest, since it represents supplies which went down, mostly uneaten, with the ship. Discarded bones from consumed meat were doubtless thrown overboard. The surviving bones show signs of butchery, in the form of chop-marks and knife-cuts, but the large size of many of the bone fragments and the presence of several intact long bones indicates that they were not heavily processed. Since all parts of the carcass were represented to some degree, a mixture of best and poorer-quality meat joints must have been available. Allocation of the meat probably depended on individual crew members' places in the ship's hierarchy.

Official rations in the English/British navy varied little between the 16th and 18th centuries, and were predicated on a weekly allocation of protein in which meat was issued on four days and cheese and/or fish on the remaining three. This was supplemented by a pound of bread or biscuit and a gallon of beer every day, oatmeal and butter on cheese/fish days, and four issues of dried peas over the course of the week (Oppenheim 1896: 140; Baugh 1965: 365). The meat was generally either salted beef or salted pork, and the ration varied between 1lb and 2lbs per day.

Several intact casks with beef bones inside were recovered from the wreck of *Mary Rose* (Coy 2005). The bones are from all the main body areas except the head, neck, tail, legs and upper haunches. However, although the long bones themselves were absent, the cask assemblages contained processes cut or torn from limb bones during butchery. Some had evidently been chopped off with a cleaver, suggesting that the meat had been stripped from the main bones before they were discarded. The report goes on to suggest that 'the casks, as well as containing many chopped-up blocks of trunk including pieces of backbone and ribs, must have been stocked with prime meat from the fore and hind quarters which had been efficiently, but swiftly, stripped from the limbs with a minimum of butchery cuts' (Coy 2005: 573).

That cattle/large ungulate limb bones were present in the Duart Point assemblage indicates that such a procedure was not followed here, which raises the possibility that fresh meat was obtained locally for immediate or short-term use. This is supported by the small size of the beasts, indicative of a West Highland origin. Burt (1754 vol 1: 124) notes that the local 'small Beef, when fresh, is very sweet and succulent'. We may also note the complaint of Martin Macpherson, minister of Duirinish in Skye, who following the Restoration in 1660 claimed compensation for losses he had incurred during Colonel Cobbett's assault on Skye in 1653, in which *Swan* may have participated, when the soldiers 'plundered the minister most barbarously and inhumanely of his goods, gear, sheep and nolt [cattle]' (Grant 1959: 300).

The relatively small number of sheep/goat bones in the Duart Point assemblage, and the total absence of pig remains, may also be significant. The west of Scotland was predominately a cattle-based economy, which by the 17th century had been stimulated by the droving trade to the Lowlands and the south (Haldane 1973). Sheep were present in the area at the time but relatively rare, while pigs were virtually unknown. Burt explains why pork was not reared there: 'I own I never saw any Swine among the Mountains, and there is good Reason for it: those People have no Offal wherewith to fed them: and were they to give them other Food, one single Sow would devour all the Provisions of a Family' (1754 vol 1: 123–4). On his Highland journey in the 1770s Dr Johnson also noted that pork and bacon were abhorred, and 'accordingly I never saw a hog in the Hebrides, except one at Dunvegan' (Johnson 1996: 53). The problem of rearing pigs in a region of limited arable potential is that they are not grazing animals but eat much the same grain crops as people do.

Since pork is particularly amenable to salted preservation its absence from the assemblage suggests that the ship's provisioning had not come from regular supply depots in the agriculturally productive south and east of Scotland, where Burt (1754 vol 1: 123) affirms that pork was plentiful, but from local resources in the West Highlands, no doubt by forcible requisition of the kind the Reverend Macpherson describes. Beef and mutton were probably obtained fresh, and therefore presumably locally, while the presence on board of equipment for the small-scale milling of grain suggests that this commodity too was 'barbarously and inhumanely' seized from the arable parts of the landscape (see 4.7 above). In terms of provisioning the Duart Point ship may well have been self-sufficient within the confines of her operational area.

This method of provisioning would only be possible in waters adjacent to a coast where crops and livestock were accessible and, in the case of grain, ripe in the fields or in storage. It would also require a political environment which permitted the seizure of such resources, and the availability of sufficient force to do so with impunity. For these reasons the methods by which the Duart Point ship seems to have supplied herself are unlikely to be characteristic of the Commonwealth navy as a whole. Nevertheless such a strategy, in the context of Colonel Cobbett's expedition, would have been convenient, economic, and, from an aggressor's point of view, an effective means of punishing the recalcitrant locals. Certainly, as Professor Black's analysis has shown, the only known victim of the shipwreck appears to have been fit and well-fed (see Chapter 10).

6.7 Fish bones

Rachel L Parks and James H Barrett, 2004

The excavation produced a small assemblage of 789 fish bones, derived during the field seasons in 2000, 2002 and 2003. In 2000, a very small quantity of fish bone (46 fragments, of which only a few ling bones were identifiable) was hand-collected from the ship's bilge and pump-well. These were recovered along with more abundant mammal bone (Colin Martin pers comm), but given the tiny sample and the biases inherent in hand-recovery (Jones 1982; Vale & Gargett 2002) little can be said about them. In contrast, a slightly larger deposit of concentrated fish bone (743 specimens) was identified by the base of the ship's stern in 2002. Some of this material was hand-collected that year, but in 2003 a bulk sample of 5 litres of this sediment was removed and sieved on land using a 1.5mm mesh (Colin Martin pers comm). Fragments of barrels were also found in the vicinity, but the location of the fish-bone deposit is inappropriate for storage, and human bone (probably all belonging to one individual) was also scattered across the area. The base of the stern probably acted as a trap for water-borne flotsam within the wreck until the material was immobilised by sediment. It should be pointed out, however, that the fish could have been stored well aft. The material must therefore be interpreted in terms of both human and natural accumulation processes.

Although the number of bones from the stern deposit is modest, it does show a very narrow species diversity and an unusual element distribution, both of which can be interpreted in terms of cured (probably dried and salted) fish. The assemblage thus adds to the story of early modern maritime provisioning emerging from other broadly contemporary sites (eg Brinkhuizen 1994; Hamilton-Dyer 1995).

Methods

The assemblage was recorded following the York protocol (Harland et al 2003), which entails the detailed recording of *c* 20 diagnostic elements. These bones are identified to the finest possible taxonomic group and recorded in detail – typically including, as appropriate, element, side, count, measurements, weight, modifications (including burning and butchery), fragmentation, texture, and estimates of fish size. Although identified as diagnostic elements, fish vertebrae are recorded in slightly less detail (measurements are not taken and texture is not scored, for example). 'Non-diagnostic' elements (quantification category 0) are typically not identified beyond class. Given the tiny quantity from the Duart Point wreck, however, all identifiable cranial elements were quantified in this case. Fin-rays and pterygiophores make up the bulk of the remaining 'unidentified' specimens, but virtually all of these are probably from ling. The small number of measurements follow Harland et al (2003) and references therein.

The assemblage has been quantified by number of identified specimens (NISP), including all bones or only the diagnostic elements as indicated. The archive will be deposited with the main site archive, the Dr Colin and Dr Paula Martin Collection, HES, as a Microsoft Access database file, and a series of text files that duplicate its content.

Preservation

The bones from the Duart Point wreck were not highly fragmented. Most were over 60% complete and many over 80% complete. This observation may imply little post-depositional disturbance after an initial episode of fluvial transport. However, the preservation of the bone tissue itself was rather poor, with many specimens exhibiting extensive flaky or powdery areas. None of the material showed evidence of burning, but three vertebrae were crushed. One of these also exhibited a tooth-impression, suggesting that the bones had been chewed. The tooth-mark is not characteristic of carnivore gnawing (cf Lyman 1994), and may well be human.

Table 6.4
Taxonomic and element distributions by NISP (all specimens).
Elements are listed in order of abundance

Element	*2000*	*2002*	*2003*	***Total***
Salmonidae				
Caudal vertebra		1		1
Gadidae				
Cleithrum			1	**1**
Epihyal			1	**1**
Gadus morhua				
Caudal vertebra Group 2			2	**2**
Caudal vertebra Group 1			1	**1**
Molva molva				
Caudal vertebra Group 1		1	21	**22**
Cleithrum	1	6	13	**20**
Caudal vertebra Group 2			13	**13**
Dentary		5	8	**13**
Supracleithrum		4	3	**7**
Caudal verteba		1	5	**6**
Ceratohyal	1	1	4	**6**
Ectopterygoid		3	2	**5**
Epihyal	1	1	3	**5**
Articular			4	**4**
Vomer		3		3
Abdominal vertebra Group 3			2	**2**
Frontal		2		2
Interopercular		1	1	**2**
Opercular		1	1	**2**
Preopercular		1	1	**2**
Quadrate			2	**2**
Scapula			2	**2**
Basipterygium			1	**1**
Hyomandibular			1	**1**
Maxilla			1	**1**
Parietal		1		1
Premaxilla			1	**1**
Subopercular			1	**1**
Ultimate vertebra			1	**1**
Unidentified (most or all *Molva molva*)				
Fin rays, Pterygiophores, etc	43	17	598	658
Total	**46**	**49**	**694**	**789**

Results and discussion

A total of 789 fish bones weighing *c* 410g was examined (Table 6.4). Of these, 131 were identified cranial, appendicular, or vertebral elements. The remainder were tiny fragments of bone, fin-rays and pterygiophores – most or all of which were from the species (particularly ling) represented by the identified elements.

The assemblage includes a very narrow species diversity. It is almost entirely composed of ling. The only exceptions are one salmonid (probably salmon) vertebra, three cod vertebrae, and two bones that could only be identified as cod family (probably cod or ling). The salmon aside, the bones are all from large fish, even if the hand-collected material is excluded to avoid recovery bias. The cod bones are from fish of 0.5 to 0.8m total length and all the ling bones are from fish of more than 1m total length. The largest ling specimens may have been from individuals greater than 1.5m total length (Table 6.5). Ling are known to inhabit wreck-sites (Wheeler 1978), but the narrow species diversity and size-range represented makes it unlikely that this is a natural-death assemblage – an observation which is corroborated by the presence of cut-marks on at least two of the specimens (Table 6.6). The skeletal-element distribution is also inconsistent with whole fish (Table 6.4).

The three cod bones are caudal vertebrae, but little can be inferred from so few specimens. The number of ling bones is also small, but a distinctive element distribution is nevertheless clear. Firstly, the most abundant elements are caudal (tail) vertebrae of different kinds and cleithra. These are the bones typically left in dried (or salted) cod and ling during storage and transport (Barrett 1997). Two cut-marks on supracleithra, which imply the decapitation of ling anterior to the cleithrum, are also consistent with this distinctive butchery pattern. The assemblage may thus have been partly composed of preserved ling. Stockfish, dried by wind alone, tend to be made from fish of less than 1m total length (Perdikaris 1999), so the Duart Point ship's provisions were either salted or, most likely, salted and dried as a *klippfisk* type of product (split, salted, and dried flat).

Secondly, however, ling dentaries (from the lower jaw) were also abundant, and other cranial elements were present in trace numbers. These bones were from fish of approximately the same size as the cleithra (Table 6.5). Superficially the dentaries look to be from slightly larger fish, but the difference is not statistically significant at this sample size ($T = 2.15$, $P = 0.060$, $DF = 9$). They indicate either that a mixture of whole and cured ling was present on the ship, or that ling heads were also dried and/or salted as provisions. The drying of fish-heads is known among Scandinavian stockfish producers, so the latter interpretation is not unreasonable, but they were typically used for animal fodder (Vollan 1974). It is not surprising that these fish-heads are best represented by dentaries, as they are one of the heaviest and most robust elements in a ling cranium. They would be least susceptible to onward fluvial transport once trapped in the stern, and thus imply an assemblage which has in effect been winnowed (cf Butler 1993).

The Duart Point assemblage can be interpreted in the context of material from other broadly contemporary wrecks. For example, the warship *Mary Rose* (Hamilton-Dyer 1995),

Table 6.5
Measurements and estimated total length (after Jones 1982; Harland et al 2003) for ling cleithra and dentaries from the sieved deposit

Sample	*Element*	*Measurement (mm)*	*Estimated length (mm)*
33.16	Cleithrum	20.96	1182
34.15	Cleithrum	18.16	1080
34.16	Cleithrum	21.32	1194
34.16	Cleithrum	19.46	1128
34.16	Cleithrum	17.12	1040
Mean	Cleithrum	19.4	1125
34.15	Dentary	15.06	1551
34.15	Dentary	10.6	1175
34.16	Dentary	11.7	1270
34.16	Dentary	11.15	1223
34.16	Dentary	11.13	1221
34.16	Dentary	8.81	1015
34.16	Dentary	11.3	1236
34.16	Dentary	15.78	1609
Mean	Dentary	11.94	1287

Table 6.6
Butchery marks and other modifications (all specimens)

Modification	*Element*	*2000*	*2002*	*2003*
Molva molva				
Crushed	Caudal vertebra Group 1			2
Knife cut	Supracleithrum		1	
Knife cut	Supracleithrum		1	
Crushed and possibly cut	Caudal vertebra Group 1			1

and the merchant vessel *Scheurrak SO1*, lost off Holland some time after 1589 (Brinkhuizen 1994). The fish-bone assemblages from both sites are considerably larger than that from Duart Point, and have provided conclusive evidence that the ships were carrying stockfish or a similar product.

The fish-bone assemblage from *Mary Rose* was recovered from a sealed deposit in the first deck and hold area of the stern (Hamilton-Dyer 1995: 577–84). Over 30,000 bones were recovered, the majority of which were cod. The element distribution and butchery evidence was typical of stockfish. In addition to cod, smaller quantities of haddock, pollack and hake were represented by caudal vertebrae only. Hamilton-Dyer suggests that the tails of these species were included to inflate the number of fish. Brinkhuizen's (1994) analysis of the bone from *Scheurrak SO1* also revealed variation in the species and parts of fish included as stockfish. The assemblage was recovered from barrels in the first deck. One contained almost exclusively appendicular elements (such as the cleithrum) and vertebrae of cod. The other contained similarly processed fish, but with a wider range of species, sizes and elements present.

Cured gadid fish clearly played a role in the provisioning of 16th/17th-century shipping. In this the Duart Point ship is not unique. The use of ling, however, may be significant given the ship's apparently Scottish sphere of activity. This species has a northerly distribution (Wheeler 1978) and formed one mainstay of Shetland's salt-fish trade in the early modern period (Goodlad 1971; Smith 1984). To qualify this possible connection, however, it should be pointed out that Shetland's catches were widely exported and ling were also caught elsewhere (Nicholson 1989). Significant fisheries were also operating in the Outer Hebrides in the 18th century (McKay 1980: 81–2). The Duart Point ship need not necessarily have acquired her supplies locally, though it is entirely possible that she did.

6.8 Rigging equipment

Though wind-energy captured by the sails and transmitted through the yards and masts to the structure of the hull provided a ship with its primary propulsive power, human muscle drove the ancillary systems which made it a functioning and controllable entity. These included raising, lowering and adjusting the sails; the management of anchors; steering; pumping; rowing; working the guns; and handling cargo or equipment. In harnessing manpower for these purposes various devices were applied to increase mechanical advantage and reduce friction. Much of this involved rigging, which is categorised as two types – standing rigging which can be tensioned to brace and support the masts, and running rigging which facilitates the raising, lowering and adjusting of the sailing rig, and other activities involving lifting and movement.

Standing rigging

Deadeyes were rigged in pairs as tensioners for ropes, typically used for connecting the shrouds with the chain-plates. They are tear-shaped and pierced with three holes – one towards the narrower end, and two at the broader rounded one. A U-shaped groove is cut around the edge to which the ropes or chains were seized. The lower deadeye was set with its two holes uppermost; the top one with them facing downwards. Both deadeyes were linked by a lanyard secured in one of the lower top holes which passed back and forth through alternate holes until it emerged from the opposite lower one, at which point it could be heaved tight with a mechanical advantage of 5:1. The term 'deadeye' does not derive from the object's superficial resemblance to a skull, but from the fact that it is a block without sheaves, and consequently its holes or eyes are 'dead'.

63 DP99/037, **071.102**, small deadeye 97mm × 70mm × 21mm (3¾in × 2¾in × ¾ in). Holes 11mm (⅜in) diameter (Illus 188).

64 DP00/104, **128.083**, deadeye with part of the bottom missing, 150mm (estimated) × 122mm × 38mm (6in × 4¾in × 1½in). Holes 25mm (1in) diameter. Fragment of three-strand rope in one of the lower holes (Illus 188).

65 DP00/018c, **087.109**, deadeye attached to the oar-port lid within concretion (Illus 81), so has not been drawn.

A euphroe was a narrow block with a single line of dead holes along its axis, used to anchor a fan-shaped setting of lines extending from a single point, such as a crow-foot to support sails or awnings.

66 DP99/019, **067.102**, broken euphroe 128mm × 39mm × 25mm (5in × 1½in × 1in) with four 13mm (½in) holes surviving (Illus 189).

Running rigging

Blocks are contrivances for leading ropes in various directions, singly or combined with other blocks. In combination they can increase mechanical advantage. They are used to increase the power obtained by pulling on a rope rove through them. A simple block consists of an outer shell, usually grooved at top and bottom so that a rope strop can be seized around it. A rectangular slot cut through the shell is called the swallow. This accommodates a lathe-turned pulley-wheel or sheave with a rope-groove around its circumference, which rotates around a pin or axle. The size of a block is defined by its longer axis. Sheaves are measured across the outer face and lengths and diameters are given for pins.

67 DP03/050, **101.075**, elm (*Ulmus* sp) half-shell of a 95mm (3¾in) block with a 40mm × 14mm (1½in × ½in) pin in place (Illus 190).

68 DP92/DG10, findspot unknown, elm half-shell of a 150mm (6in) block with pin and sheave in place. Piece of concretion attached and fragment of 18mm (¾in) rope lodged in throat. Sheave 10mm (4¼in) diameter, 19mm (¾in) thick; oak pin 67mm × 20mm (2½in × ¾in) (Illus 190).

69 DP00/008, **113.104**, elm shell missing part of its top, from an (estimated) 150mm (6in) block with pin and sheave in place. Sheave 100mm (4in) diameter, 22mm (⅞in) thick, oak pin 68mm × 14mm (2¾in × ½in) (Illus 190).

70 DP00/080, **113.087**, oak pin 65mm × 18mm (2½in × ¾in), from a block of comparable size to 68 and 69. Heavy asymmetric wear on running surface (Illus 191).

71 DP00/062, **072.098**, oak pin 95mm × 29mm (3¾in × 1⅛in). Evidently from a large block. Heavy asymmetric wear on running surface (Illus 191).

72 DP03/075, **117.098**, sheave, 132mm diameter, 27mm thickness, hole diameter 26mm, eroded surfaces (Illus 191).

73 DP00/141, **111.082**, sheave 138mm × 25mm (5½in × 1in) with 28mm (1⅛in) diameter hole. There is a pronounced dish (4mm) towards the centre on one face, and pronounced turning-marks (Illus 191).

74 DP97/A011, **074.104**, sheave, 108mm diameter, 24mm thick, hole diameter 21mm (Illus 191).

75 DP00/043, **101.100**, sheave, restored diameter 198mm, thickness 38mm, hole diameter *c* 40mm, badly eroded (Illus 191).

76 DP03/004, loose on surface in Excavation Area 4, sheave, no outer edge surviving, diameter > 85mm, thickness 23mm, hole diameter 23mm, badly eroded (Illus 191).

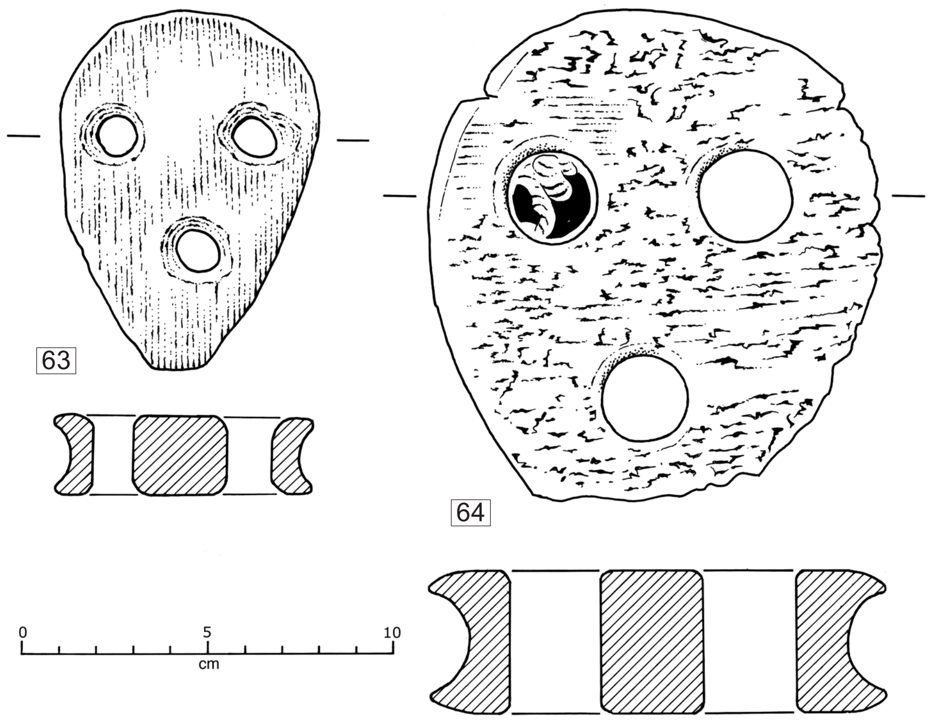


Illustration 188
Deadeyes 63 and 64

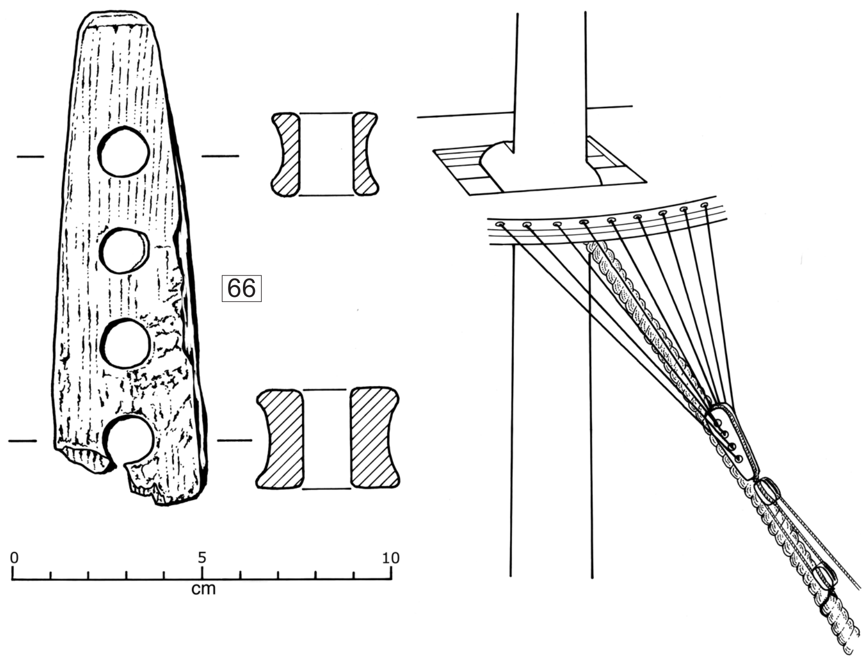


Illustration 189
Euphroe 66, and diagram of its function

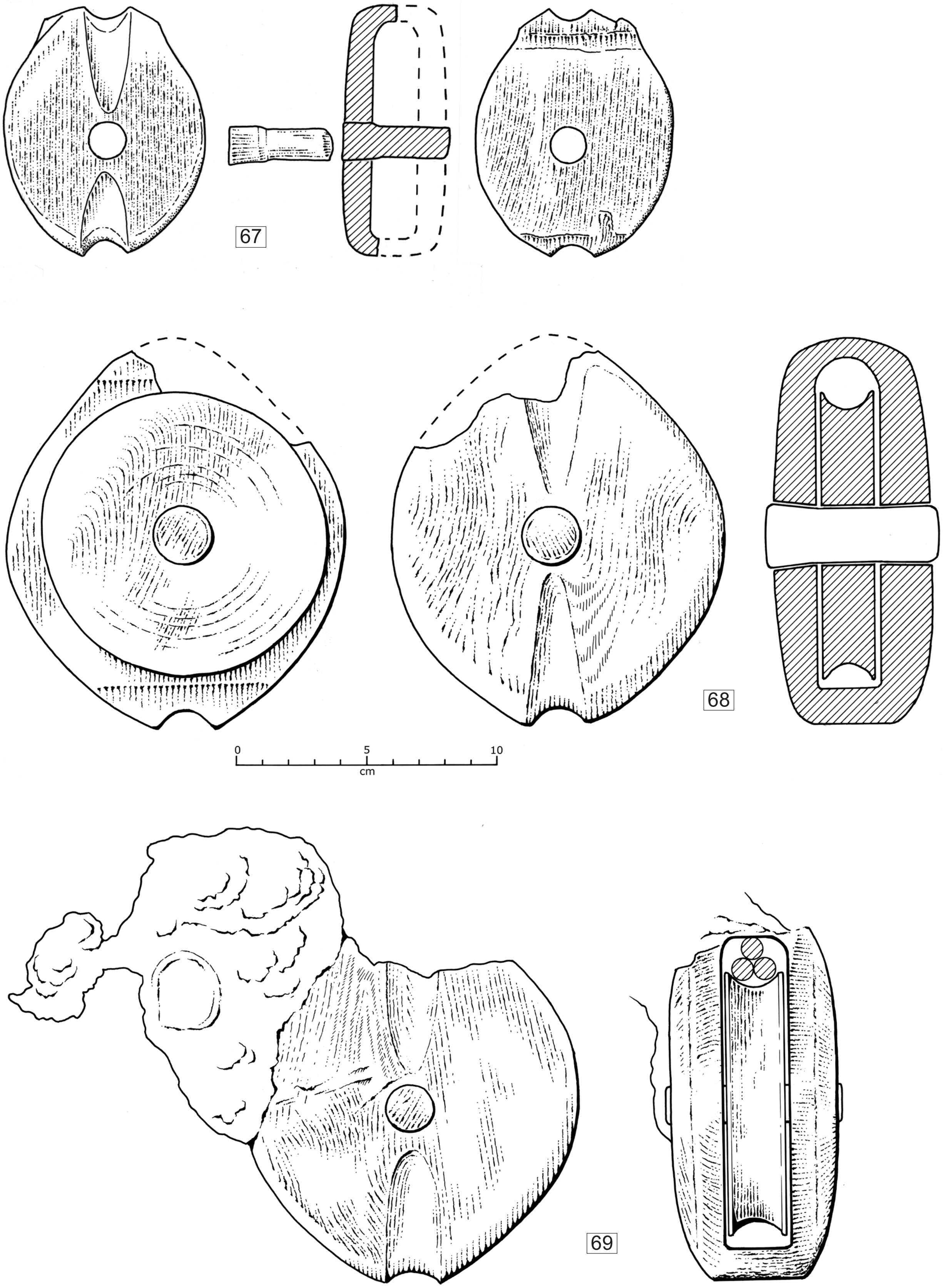


Illustration 190
Wooden blocks 67–9

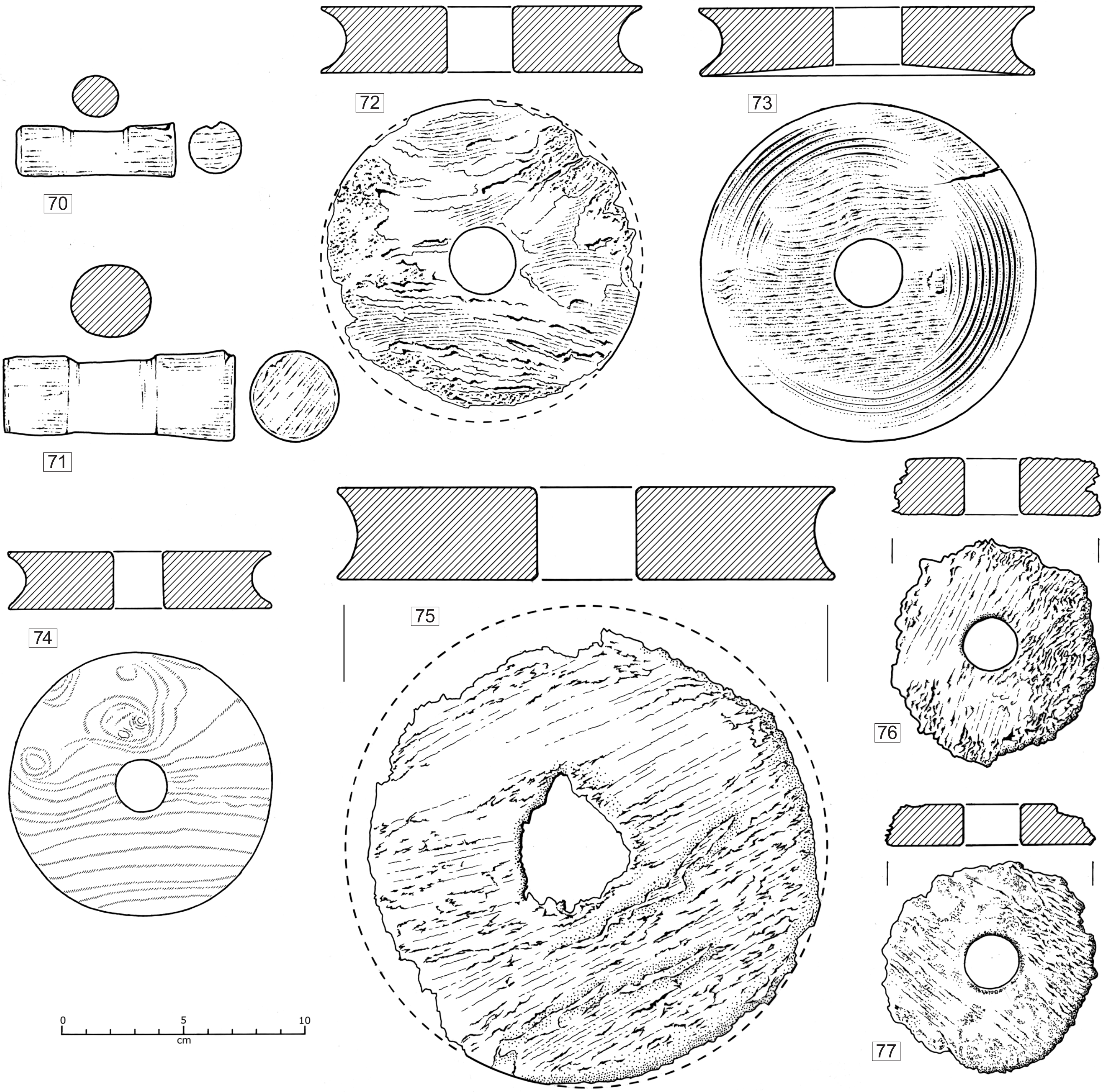
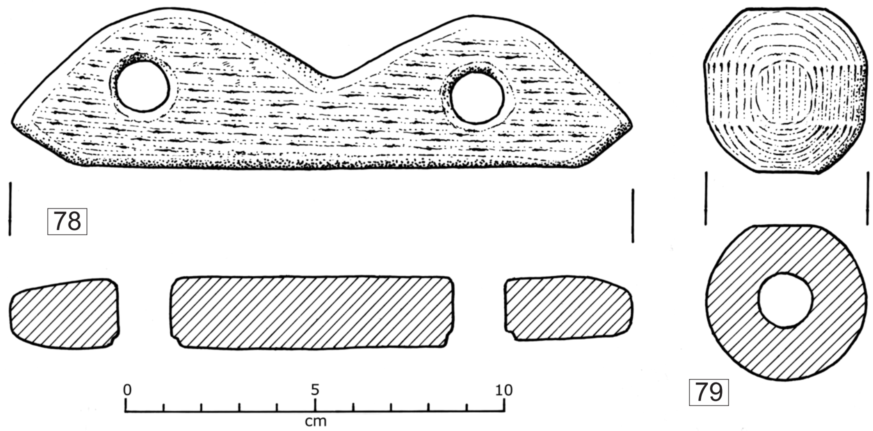


Illustration 191
Wooden sheaves and pins 70–7



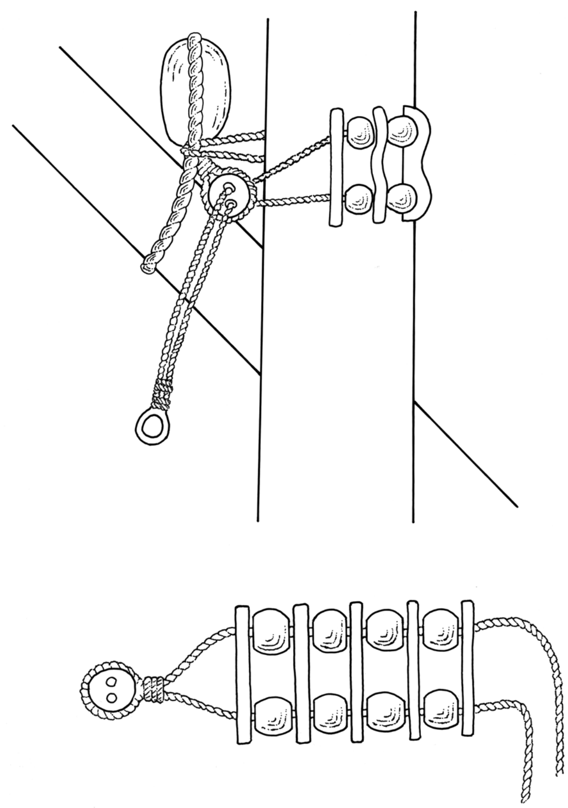


Illustration 192
Parrel-truck 79 and spacer 78, and diagram showing a parrel assembly

77 DP03/016, **113.086**, sheave, no outer edge surviving, diameter >90mm, thickness 17mm, hole diameter 23mm (Illus 191).

Wear on the two pins 70 and 71 is such as seriously to have affected the efficiency of the sheaves which rotated on them, causing them to rattle or even jam. They may of course have been from unserviceable blocks, or ones awaiting repair, but their presence may also reflect general standards of serviceability and maintenance aboard the ship.

Parrel trucks and ribs

Friction-reducing collars of rotating trucks threaded on a light rope secured the yards to the masts. The trucks were separated by spacers or 'ribs', straight on the edge which was in contact with the mast, and shaped to the roundness of the trucks on the other. Each rib had holes for the ropes, positioned so the trucks projected just beyond the flat edge. This projection brought the trucks into contact with the mast and allowed the collar to move up and down without undue friction. One example of each element from a two-row assembly was found. There could be two or more rows in a parrel assembly. A complete example from *Mary Rose* has five horizontal rows comprising in all 30 trucks and seven ribs (Endsor 2009: 258–60).

78 DP00/140, **111.082**, parrel rib 164mm × 42mm × 19mm (6½in × 1⅝in × ¾in) (Illus 192).

79 DP00/181, **109.088**, parrel truck 43mm in diameter, 43mm wide, central 14mm hole (1⅝in × 1⅝in × ½in) (Illus 192).

Wear on one side of the parrel truck 79 is extensive. An assembly of trucks thus affected would have slid rather than rolled against the surface of the mast, negating the purpose for which it was designed. Though the same cautions apply as for the remarks concerning the asymmetric block-pins, this may be another hint that the Duart Point ship was not in a fully serviceable condition. Much greater wear is apparent on a parrel truck recovered from the Newport ship (Erica McCarthy, Newport Museum and Heritage Service pers comm). The parrel assembly from the *Mary Rose* also showed evidence of wear: the ropes were frayed and there were indications of scorching on the flat edges of the ribs. It was found on the orlop deck and it has been suggested that it may have been in store awaiting repair (Endsor 2009: 258).

Cordage

Although modern commercial practice is to measure rope by its metric diameter, in the Royal Navy cordage is still described by its circumference in inches (*Admiralty Manual of Seamanship* vol 1 1972: 104). It is so described here.

Small fragments and individual fibres of hemp cordage were frequently observed in the archaeological deposits, particularly among detritus between the frames (see above, 6.4), but finds of structured rope were few. Short pieces of 25mm (1in) Z-laid hawser were preserved in a deadeye 64 and in a block 69, while a substantial cache of coherent cordage was recovered from the port bilge just aft of midships. These finds were delivered to the National Museum before the publication of Sanders's paper on methodologies for the study of cordage from shipwrecks (2010), and are currently in conservation, so the following descriptions should be regarded as provisional.

80 DP97/A015, **079.092**, the longest example, three-strand Z-laid hawser of 38mm diameter (1½in) 1.6m long, disposed in one-and-a-half coiled loops (Illus 193). At one point a single lie of spun-yarn worming is evident, though this has been lost from all other spaces between the hawser strands which have lost their servings. Along most of its length it is served with a continuous binding of 2.5mm spun yarn which increases the diameter to 43mm (1¾in). Pieces of its leather parcelling are shown on the left. This is part of a group of cordage found in Excavation Area 5, in a deposit largely filled with organic material. It consists of three main elements of probably conjoining hemp cordage and two associated leather items, and appears to derive from a single length of hemp hawser which has been wormed, served, and parcelled with leather. Such protective treatment, which rendered the rope at least partly waterproof, was generally reserved for standing rigging (Stopford 1953: 40–1. Procedures for dressing rope in this way are described in the *Admiralty Manual of Seamanship* vol 1 1972: 188–90).

Illustration 193
Rope 80, wormed, served and parcelled (DP 173271); top left: detail of rope showing the partial unwrapping of its outer worming and serving. Scale 10 centimetres (DP 174087)

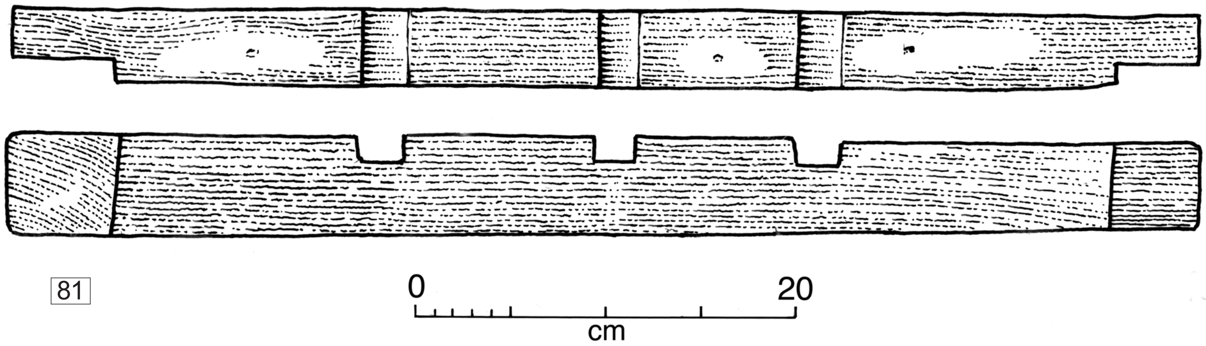


Illustration 194
Wooden grating-bar 81

Grating

81 DP00/200, **085.097**, rectangular-sectioned wooden bar 630mm × 50mm × 40mm (Illus 194). The ends of the wider face are lapped for halving joints while three housings for cross-halving joints are cut across the central part of the narrower face. There is no evidence of fastenings to indicate that any of the joints had previously been assembled, and the item may have been a spare.

It can be identified as part of a small grating or scuttle, the purpose of which is described by Smith (1627: 7):

> A scuttle-hatch is a little hatch doth cover a little square hole we call the scuttle, where but one man alone can go down into the ship, there are divers of the ship whereby men pass from deck to deck, and there is also small scuttles grated, to give light to them betwixt decks, and for the smoke of the ordnances to pass away by.

Mainwaring adds further detail, 'there are small scuttles with gratings. They have all covers fitted for them lest men in the night should fall into them' (Manwaring & Perrin 1922: 218).