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18th- and 19th-century shipyards at the south-east entrance to the West India Docks, London

Ken Pitt and Damian M. Goodburn with contributions from Roy Stephenson and Christopher Elmers

Museum of London Archaeology Service, Mortimer Wheeler House, 46 Eagle Wharf Road, London N1 7ED, UK

Archaeological fieldwork in 1997 on the Isle of Dogs, at the south-east entrance to the West India Docks, recovered evidence of 17th- to 19th-century shipyards, associated activities and foreign trade. Reused timbers may be the remains of the 17th-century Rolt's yard. Reclamation along the natural inlet was accompanied by the construction of a timber dry dock probably in the late 18th century. This soon fell out of use and was filled in with the construction of new dry docks to the south in 1806 by Thomas Pitcher. Much of the debris dating to the first half of the 19th century from ship repairing and building and from a range of ancillary crafts, together with ceramics from Iberia and the Far East, probably came from Pitcher's yard.

Key words: ceramics; London; shipyard; 17th century; 18th century; 19th century.

Introduction

There has been a growing international interest in the archaeological excavation of shipbuilding, breaking and repair yards and related maritime industrial sites, from all periods up to the earlier 20th century (for example Skamby-Madsen, 1991; Watkins, 1994; Saxby & Goodburn, 1998; Goodburn, 1999; Stammers, 1999). Dry dock structures are also beginning to receive deserved archaeological attention (Barker, 1998). One of the key reasons for this increased interest is the realization of the importance of ships, boats and maritime industries in the economic and political evolution of England during the last 500 years. Shipyards were large employers, users of traded bulk materials and often at the cutting edge of new technologies. Evidence for yard organization, and the tools, techniques and raw materials used in the London yards over the last four centuries is starting to receive detailed examination.

Isolated attempts at investigating industrial-period sites on the east London waterfront began in the early 1970s (Courtney, 1973; Courtney, 1974) but unfortunately were not followed up for over 20 years. However, advisory bodies for archaeology in London and surrounding counties have now highlighted maritime industrial sites as warranting systematic archaeological investigation (Williams & Brown, 1999: 21). As a result several large rescue excavations have been carried out on waterfront development sites (for example Saxby & Goodburn, 1998; Tyler, 2001; Divers, 2002; Divers, in prep.). Survey work on sections of the eroding Thames tidal foreshore has also yielded some new evidence of ship- and boatbuilding, breaking and repair sites and is currently being collated (Webber & Milne, in prep.). These rescue archaeology projects have provided evidence of structural remains and specific shipyard work such as block making, caulking or re-sheathing of ocean-going craft. They have also highlighted the international trading connections of London and its estuarine approaches in the early modern period.

This article summarizes the results of archaeological fieldwork undertaken on the east side of the Isle of Dogs, Blackwall, London, E14 (NGR 538320 179820) (Fig. 1), and of subsequent post-excavation analysis. The site was located on land south of the east entrance to the South Dock of the West India Docks; it covered an area of approximately 0.7 hectares and was bounded by the River Thames to the east, Manchester Road to the west, the South Dock entrance to the north and Stewart Street to the south. Archaeological work was

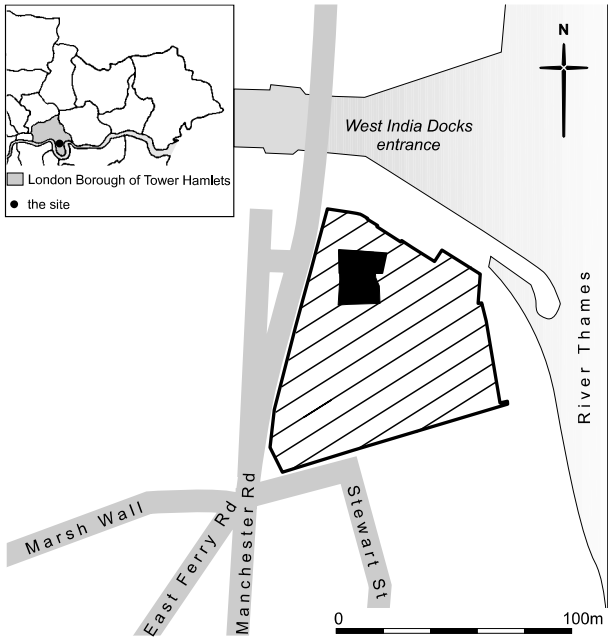

Figure 1. Site location, with inset of Greater London; the redevelopment site is hatched; the area of archaeological investigation is black (© Crown copyright. All rights reserved. Corporation of London 087254-2003).

commissioned by Barratt London Limited, in advance of residential development. The fieldwork consisted of archaeological trial trenches, excavation and watching brief, carried out under the site code SWI97 by the Museum of London Archaeology Service (MoLAS) between April and July 1997. Initially a single trench was excavated in the north-west quadrant of the site. The discovery of a backfilled dock full of debris from ship repairing and breaking led to the archaeological excavation of an extended trench, designed to recover the profile and base of the dock. This was followed by an archaeological watching brief on ground reduction.[1]

Archaeological and historical background

There is evidence in the vicinity of the site for the exploitation of the riverside marshes by prehistoric peoples. A layer of peat excavated at Blackwall Yard, immediately to the north, included fragments of a petrified forest belonging to the Palaeolithic period (Webber & Milne, in prep.). Neolithic finds in the vicinity are limited to the chance recovery of axeheads from the River Thames (Greater London Sites and Monuments Record, nos 110037, 112004, 112005, 112006). The Roman River Lea crossing was at Old Ford, about 3 km north of the site, and it is highly probable that there was a roadside settlement there, while extensive Roman structures have been excavated to the west at Shadwell (Lakin, 2002: 2–3; Denison, 2003).

There is no evidence for occupation on or near the site in medieval times and the area remained an open landscape of marsh and fields. At the time of the Armada scare in 1588 a boom was apparently put across the Thames at Blackwall, with fortlets on each side (Greater London Sites and Monuments Record, nos 071008, 082246). The forts were not reported in official records of the river defences and no trace of them has since been found.

The waterfront east of London became associated with shipbuilding at an early date. There is evidence for shipbuilding in Ratcliff in the 14th century and at Limehouse in the 15th, both on the north bank of the Thames to the west of the site (Banbury, 1971; Tyler, 2001). During the second decade of the 17th century, Blackwall Yard was constructed by the East India Company for building and repairing its ships, but the site of the future West India Docks to the south remained marshy throughout the 18th century. In the early 18th century, to the south of Blackwall Yard, Johnson's Upper Dock, later known as Coldharbour, was recorded (Survey of London, 1994: 552). Gascoyne's map of 1703 shows a shipyard to the south of Coldharbour called 'Roults Yard'; its proprietor was John Rolt (Banbury, 1971: 140; Survey of London, 1994: 3 fig. 1, 602). The yard, which probably dated from the 1660s, was dominated by two dry docks and dealt in ship repair rather than building. Rolt apparently gave up the yard in about 1717, and the area was left unoccupied from at least the late 1730s to the late 1740s; in 1756 it became a glue house (Survey of London, 1994: 602). The precise limits of the yard are not clear; it was not shown on Rocque's map of 1746 (Rocque, 1746). A principal aim of the archaeological investigation was to establish the presence or absence on the site of this lost 17th-century shipyard, as well as investigating the remains of industrial-period shipbuilding.

The main development of the Isle of Dogs occurred from the beginning of the 19th century when in 1802 the West India Docks and warehouses opened to handle cargoes of sugar, coffee, mahogany and rum from the West Indies (Survey of London, 1994: 255). In 1805 the City Canal was opened to provide a short cut across the Isle of Dogs for ships sailing to the City docks. The canal

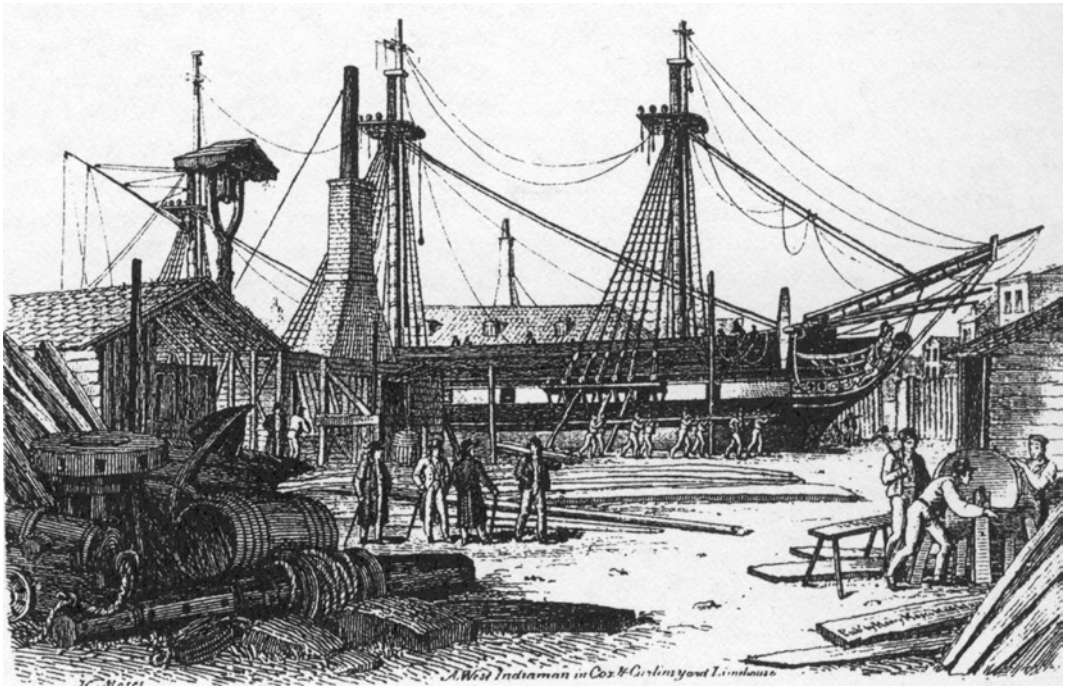

Figure 2. A West Indiaman in Cox, Curling & Company's yard, reproduced from an engraving of 1837 by H. Moses (Museum in Docklands PLA (Port of London Authority) Collection, Limehouse portfolio 44/3).

was not a commercial success, so in 1829 it was sold to the West India Dock Company who converted it into the South Dock. From 1806 the site was the location of a shipyard developed by one Thomas Pitcher. In 1815 Pitcher retired and his sons managed the yard until 1850, when it was sold to shipowners Joseph and Frederick Somes. The Merchant Shipping Company owned the yard from 1866 until 1886, when it was bought by the Dry Docks Corporation of London. In 1868, the north part of the yard was 'curtailed' for the widening of the south-east entrance to the West India Dock. The yard was sold to John Stewart and Sons in 1891; final closure of the yard came in 1923, when the two masonry dry docks, a feature since the time of Thomas Pitcher, were filled in (Survey of London, 1994: 249–53, 257, 275–8, 602–3).

By London standards Pitcher's yard was a medium-sized operation. The two masonry dry docks constructed in 1806 were originally each around 230 ft in length with wooden floors, sides and gates. The lower dock was later extended to 290 and then 295 ft. A slipway for building, or repairing, had also been built by 1814. In 1848 William Pitcher had advertised the yard for sale as '. . . two spacious dry docks for the reception of vessels of the largest class, wharf ways extensive for breaming ships' bottoms, lay-by for barges, space for building ships, mould loft, sawpits, engine-house, store-houses, joiner's shops, timber sheds, steam kiln, pitch and tar furnaces, landing crane, capstans, smiths' shop, coal and iron yards, counting-house, lodges, landing stairs and numerous useful appurtences'. These sale particulars clearly indicate that the yard was engaged in both ship repairing and shipbuilding. In the early years employment at the yard apparently fluctuated between 15 and 131 men, dependent upon work in hand (Survey of London, 1994: 602–3). Henry Moses' 1837 engraving of Cox, Curling & Company's yard, Limehouse—with a West Indiaman in dry dock—gives a fair impression of what Pitcher's yard might have looked like (Fig. 2).

The site was unoccupied after 1923 until 1952, when houses were built, and left vacant again when the area was declared unfit for habitation due to subsidence in recent years (1957 Ordnance Survey map; A. Werner, pers. comm.). This vacant site then became the subject of the archaeological investigation reported here.

The archaeological sequence

Deposits making up the natural foreshore were plotted across the width of the trench, and shown

to slope down from north to south. They were located at 2.67 m OD to the east and between 2.45 m and 2.69 m OD to the west. The foreshore deposits were cut through by a shallow feature, subsequently filled with slumped sand and alluvial clay, which is interpreted as a natural inlet. This was sealed by a firm, dark blue flood-deposited clay. An overlying layer of gravel and wood fragments was undated, but may have been a surface or waterlain debris from the general vicinity.

Reclamation first took place in the post-medieval period. Dumped deposits of mixed sand, silt and gravel were dated to around 1770 to 1850 by a small group of pottery and clay pipes. The domestic dumped pottery consisted of pearlware, Chinese porcelain, and English stoneware which had been made for export (Fig. 5, P1: an aerated-water bottle with 'Calcutta' impressed on it). Post-medieval redware fragments included two from a sugar-cone mould, indicating sugar refining at or near the site, an activity often associated with riverside sites in London. In addition, there are fragments from a stoneware vessel with impressed rouletted decoration, and two sherds of a fine redware with sparse quartz inclusions, part of a vessel with a burnished external surface and zigzag decoration.

The late 18th-century dry dock and traces of an earlier structure

Evidence for the dock consisted of a large irregular feature dug through reclamation deposits; the only dating evidence was a single pipe bowl dated to around 1730 to 1780. Perpendicular to the edge of this cut was a line of three posts which may be a relict of an earlier timber structure, possibly part of Rolt's yard of the 17th century. Tree-ring samples were taken but could not be dated. These posts were reused decayed oak frame elements from a large carvel built ship, pierced with shaved 38 mm diameter oak treenails.

At the base of the dock cut was a timber dry dock structure (Fig. 3); from watching brief observations, its dimensions were at least 15 m across north–south, with a platform of timber more than 15 m east–west and with a depth of approximately 4 m (Fig. 4). Analysis of the tree-ring samples from this structure showed that they were all of pine (*Pinus* sp.) and that much of the timber was fairly slow-grown (Boswijk & Tyers, 1997: 3). Thus the term pine is used below, despite its lack of precision, as all the softwood timber appeared to be visually very similar. Clearly, this timber dry dock was of too late a date to be considered part of the 17th-century Rolt's yard; it appears to have been constructed shortly after, or possibly in the final stages of, the reclamation, probably in the late 18th century.

The dry dock was built with a foundation of hewn, roughly squared piles, which had tenon joints to their upper ends and pointed bases with iron shoes. Joined to the sides of the piles by iron spikes was a framework of intersecting planks. Attached to the top of the piles by mortice joints were rows of east–west aligned beams, 380 mm by 340 mm in cross-section. Across the east–west timbers a second layer of north–south aligned timbers, about 360 mm square in cross section, had been placed at 0.6 m intervals, the two layers being held in place by large iron spikes. A final layer of east–west timbers, 380 mm wide, 140 mm thick and about 7.5 m long, completed the platform, the top of which was at 0.38–0.46 m OD. The top of the central platform would have been about 3.0–3.5 m below high spring tide levels in around 1800. An east–west aligned revetment against the north edge of the timber dock had collapsed to the south. This revetment was constructed with squared pine piles and pit-sawn elm boards. Much of the dock structure was only exposed during the watching brief.

A representative sample of the timbers was drawn. Features such as race knife cut 'merchants marks' and traces of corroded iron pileshoes were noted. The carpentry of the dry dock reflects carpentry practice on land at the end of the 18th century in England. The widespread use of iron, simple lap and halving joints and—mostly imported—pine timber are characteristics also seen in large buildings at this time. This is in marked contrast with early post-medieval waterfront carpentry in London when native species of timber and extensive use of more complex jointing and framing procedures dominated (Goodburn in Tyler, 2001; Goodburn in Bluer & Blatherwick, in prep.). The influence of the 'time is money' ethos of early industrial capitalism had replaced the lingering traces of medieval craft standards set by the guilds. London was one of the largest international ports in the 18th century and drew resources such as huge consignments of timber from all over the world. This is shown in the use of pine in the carpentry of the dry dock and teak in the shipwrights' work. The use of New World and tropical forests was increasing exponentially with the consolidation of the industrial revolution in Britain and expansion of the empire, which could not have

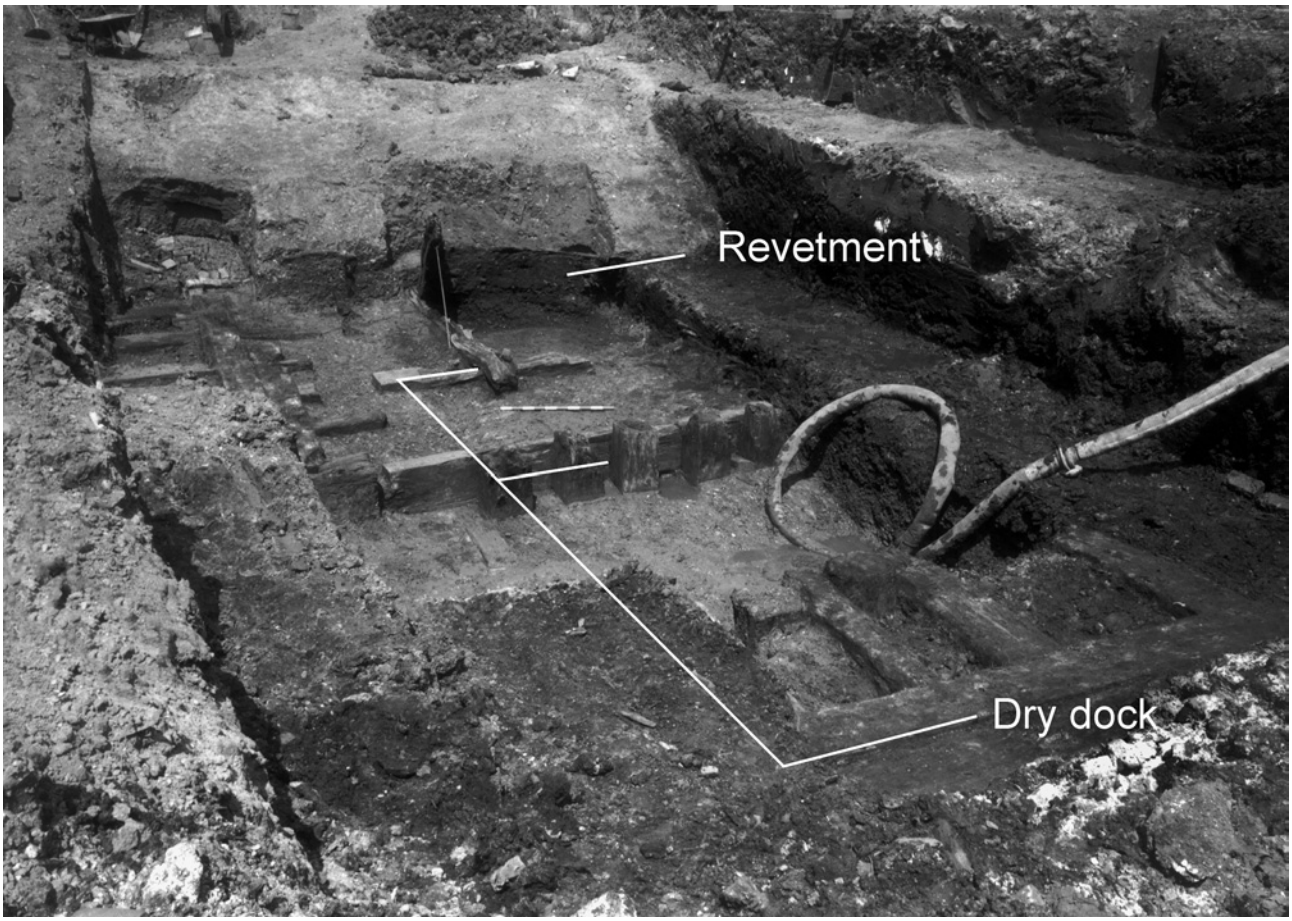

Figure 3. The timber dry dock structure, looking north.

happened without the use of ships, and the boats and barges used to service and supply them.

After the dock had fallen out of use it was partially dismantled, and then filled in with deposits containing a variety of boatyard debris (see below). The infill deposits have been dated from the ceramics to around 1740 to 1850 and produced an abundance of notable and exotic pottery fragments. These include body sherds from amphora-type vessels, possibly originating from Iberia; these vessels are of a similar size (the rims measure 220 mm and 252 mm in diameter) (Fig. 5, P2 and P3). Other possible Iberian imports include what appears to be a *terra sigillata* type ware possibly manufactured in Estremoz, Portugal, in a jar-type form with a flat top with a double internal cordon (Fig. 5, P4). Externally the vessel is decorated with a single cordon below the shoulder, under which is an incised row of decoration resembling fingernail marks. The outside and part of the inside of the vessel is covered with a smooth fine clear glaze; the unglazed portions reveal that the vessel is heavily tempered with mica. There are also sherds from other similar vessels, although not as well finished. Further noteworthy sherds come from a barrel-shaped costrel in Merida type ware, and from what appears to be an abraded bowl with a dark slip around the rim.

One further possible Iberian import is a large storage vessel decorated with incised lines (Fig. 5, P5). The fabric is a vitrified stoneware, with an external thick glossy olive glaze, within which are areas bare of glaze. These areas consist of horizontal and wavy lines and resemble areas left by a coating of wax prior to firing. This is a technique used in *Cuerda secca* pottery produced in the Seville region, although this is a white ware with polychrome areas of decoration which are separated by unglazed bands formed by painting with wax which burns away during firing (Hurst *et al.*, 1986: 60). Although these sherds are not part of the *Cuerda secca* industry they have been decorated using a similar technique. The fabric is very hard and cream-coloured with moderate to abundant

Figure 4. Plan of the timber platform.

black inclusions and occasional large white quartz inclusions.

Other noteworthy ceramics include three funnel-like forms (for example Fig. 5, P6), two of which seem to have a similar fabric to the *terra sigillata* jar (Fig. 5, P4). A further example is unglazed and not burnished and is a slightly larger version of the same form, the fabric distinctly micaceous.

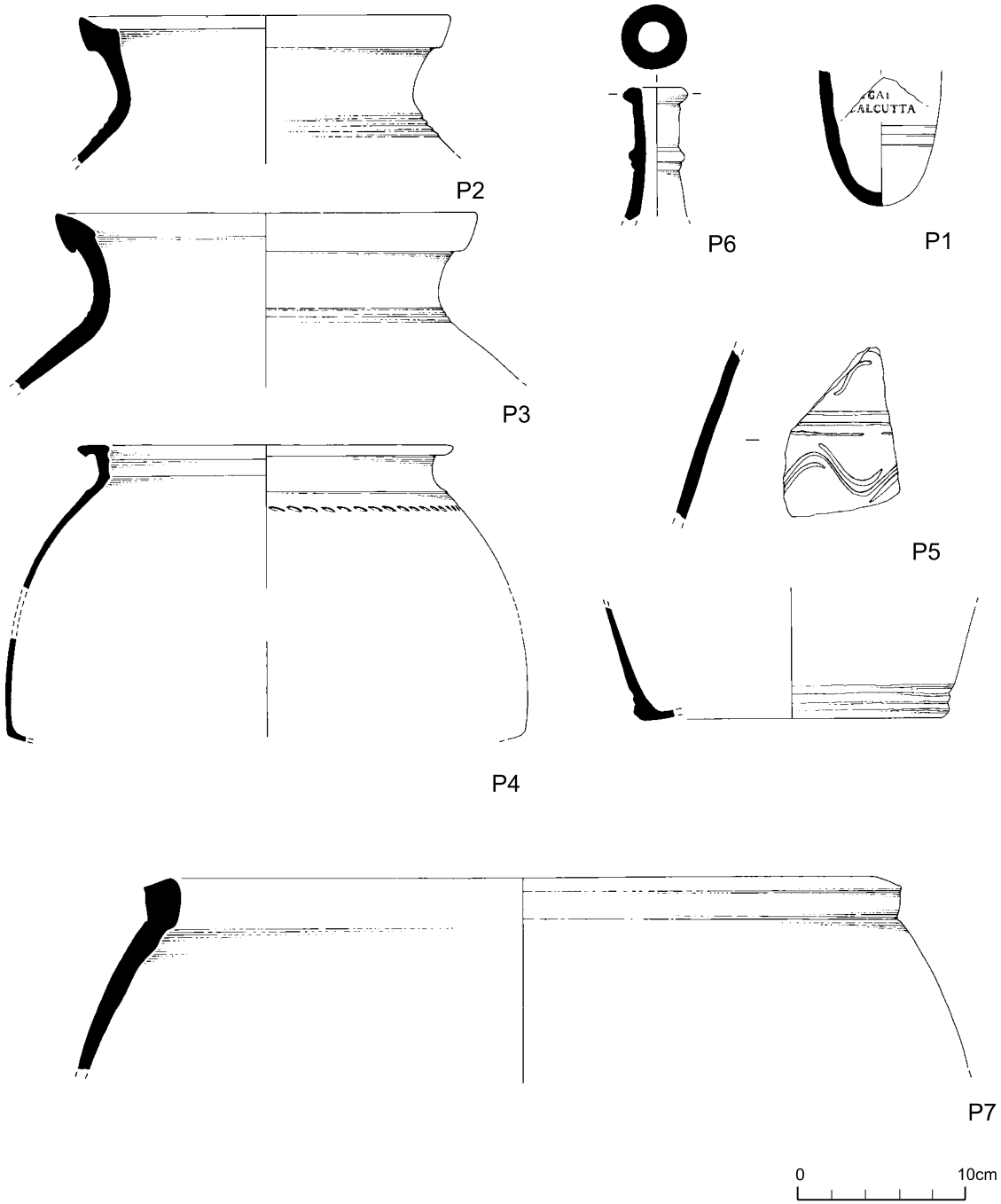

Figure 5. Sherds and profiles of selected pottery found at the site: P1 English export stoneware; P2–P7 possible Iberian imports (scale 1:4).

It has an abraded external surface, and internal sooting. The form is reminiscent of the hollow handles of cooking vessels. The neck shape is similar to those of Portuguese bottles (Baart, 1992: 277), although they are usually dated to the 17th century. The insides of these vessels are heavily sooted, and one has a piece of charcoal wedged in it, suggesting these vessels may have been used as lamps; the tubular forms would thus be part of the chimney of the vessel, although no other sherds have been identified. Other possible functions include grenades or flares, or these may be the chimneys of ceramic lamps (A. Gutiérrez, pers. comm.).

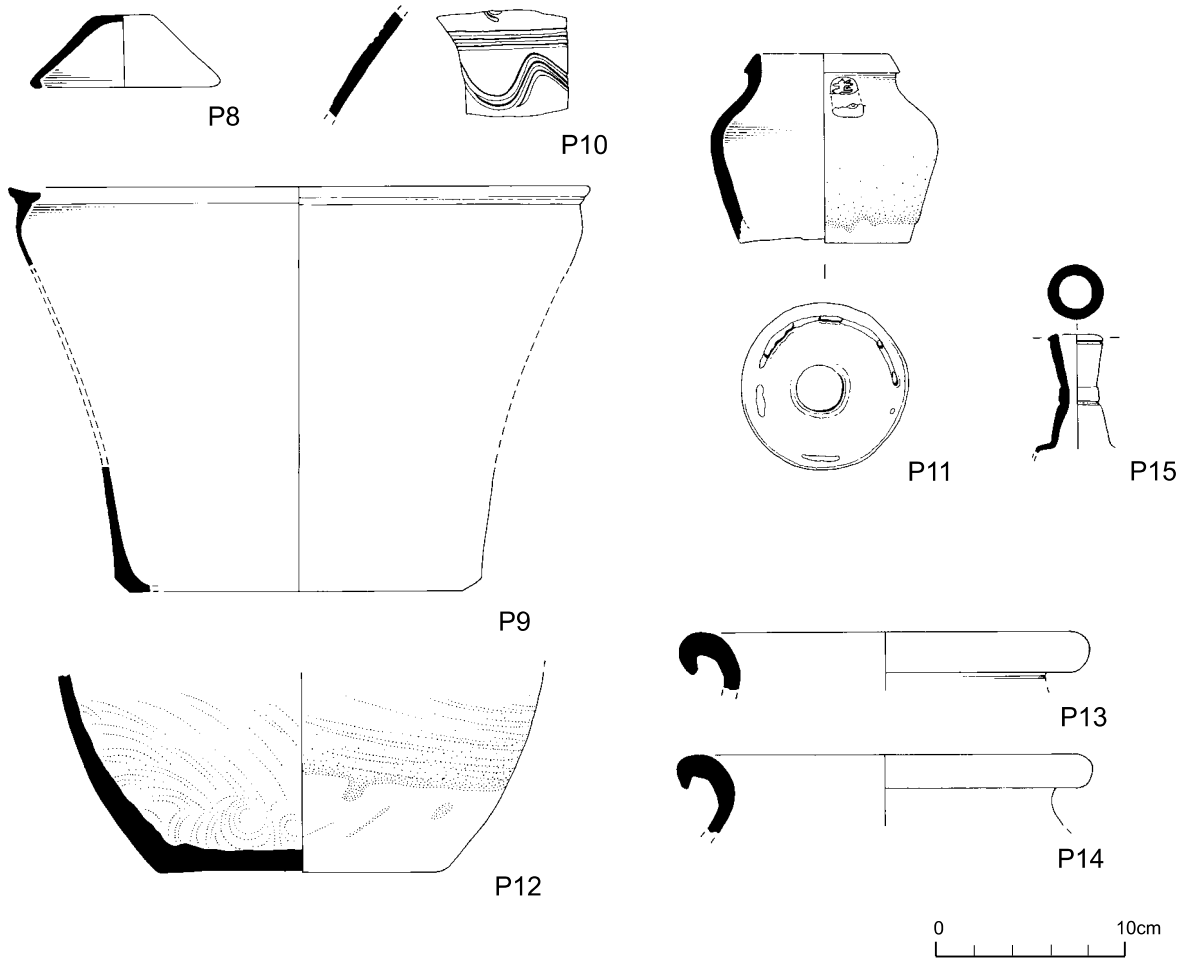

Figure 6. Sherds and profiles of imported pottery found at the site, possibly from Iberia (P8, P10, P15) and the Far East (P9, P11–14) (scale 1:4).

A group of eight small sherds in a reduced and heavily micaceous fabric are from the neck of a costrel or costrels similar to the cylindrical lantern chimney (Fig. 5, P6). A sherd in the same fabric shows the main cylindrical part and a rim of a larger vessel was embellished with very fine burnished lines running around the vessel (Fig. 5, P7). Further micaceous wares include small bowls with inturned rims (for example Fig. 6, P8) with very small base diameters of *c*.30 mm. The fabric is very fine and has sparse quantities of mica and small black inclusions. There are slight traces, under the rim, of the matt glaze associated with the other *terra sigillata*. The small base diameter suggests that these vessels were small domed lids, although there is no handle or knob for lifting. The underside has the characteristic spiral cheese wire marks associated with the removal of the vessel from a still-spinning wheel, an indicator of high volume manufacture. The inward turned, hooked rim is to reduce spillage, which may indicate an industrial function.

The dock infill also produced fragments from a stoneware storage vessel (Fig. 6, P9), the fabric of which is pale grey in section, with numerous small black inclusions accompanied by infrequent large voids. The vessel is fairly thin-walled, and has a flanged flat-topped rim. The internal surface and the upper surface of the body is a dark reddish-purple in colour, the outer surface is pale brown and has distinctive drag marks across the surface. In addition the inner surface is partially coated with an off-white deposit, which may indicate reuse of the vessel as a paint pot. The origin of this vessel is not clear; it is unlike any European stoneware, suggesting it may be of Far Eastern origin.

A domed brick structure 4.2 m in diameter was built to the east of the former timber dock; this

may have been an ice house. Elsewhere dumped deposits of gravel and clay, presumably the upcast from large excavations nearby, sealed the dock structure. Overlying these were deposits of mixed boatyard waste and demolition material, dated *c.*1780 to *c.*1850. These deposits produced one sherd (Fig. 6, P10) from a vessel decorated with incised lines similar to sherds recovered from deposits sealing the timber dry dock structure (for example Fig. 5, P5). This sherd has the same pattern of incised decoration, consisting of wavy lines between parallel horizontal lines. The degree of incision is more pronounced, suggesting the vessel was coated in glaze and then the sgraffito decoration was applied. The fabric is similar to the other sherds, being vitrified, although the matrix of the fabric is paler in colour and includes small black inclusions and sparse large white quartz grains. Another sherd worthy of mention is a Spanish amphora with a thick walled, white-firing body. The internal surface is coated with a thick clear glaze, presumably to prevent the contents seeping away.

The 19th-century shipyard

A second phase of boatyard activity was recorded in the 19th century, after the disuse of the timber dry dock. This activity was concentrated slightly to the north, over the backfilled north edge of the former inlet. Associated with this phase were numerous layers of boat-building and shipyard debris, separated by layers of straw matting and thin bands of gravel which probably represent successive working surfaces in the yard. A north–south aligned decayed timber baseplate and associated uprights may have supported smaller boats dragged up from the water for repair. To the west of this another timber structure (including part of a teak false keel), with a baseplate and two posts, was found; this was possibly the support for a winch. A likely date for these deposits is *c.*1800 to 1870, suggesting this activity was probably associated with Pitcher's yard. The two masonry dry docks which were a part of this yard were located to the south of the area of excavation.

Pottery assemblages from these deposits included a near-intact vessel which appears to be a small storage jar possibly derived from or inspired by the Martabani type tradition (Fig. 6, P11). It appears as a white-firing body, with an internal red slip. The exterior has a clear lead glaze, which has largely flaked away. On the shoulder of the vessel is an impressed pictogram seal consisting of two Chinese characters one above the other; these have been obscured by the glaze flaking away. The base has obviously been removed from a very fast spinning wheel, and in addition there is a centrally placed kiln scar underneath. This is an unusual practice as vessels that have not been placed in an overlapping fashion are harder to prise apart if fusing occurs during firing. These two factors undoubtedly indicate high volume production.

Among this material is a sherd of stoneware from a Martabani type vessel (Fig. 6, P12); this sherd is paler in colour, but has the distinctive drag marks on the external surface, and a thin coating of internal slip, with a slight dribble of glaze. Other sherds derived from the Martabani tradition include two hooked-rim storage jars. While both of these vessels have the same form and are distinctly stoneware, one (Fig. 6, P13) is a dense matt brown coloured fabric, whereas the other (Fig. 6, P14) has a pale body coated externally with a clear glaze. There is also a further example of the *terra sigillata* tubular form with internal sooting (Fig. 6, P15); found with the tubular vessel was a further rim sherd from another mica-tempered amphora fragment.

Located to the south-west was a robber cut for a basement with a decayed timber raft at its base. Cutting this to the west was a brick-vaulted cellar complete with stone slab shelving; an entrance was found to the north with steps down into it. No superstructure survived to what was presumably underground storage with bays off corridors; it appeared to extend west beyond the limits of excavation. A map of 1834 shows the area of the entrance as 'Pitch and Tar Furnaces. Store Cellar under' (Port of London Authority (PLA) Engineering Drawings Collection, drawing no. 6050038). The remains of several abandoned late 19th-century oak casks were found on some of the store shelves. Clipping the eastern edge of this basement was a large feature containing piles or posts and a reused timber thought to be part of a winch, possibly the remains of a crane base associated with the dry docks to the south. Over the whole area were various dumped deposits representing disuse of the boatyard and make-up to modern ground level at 5.05 m OD, this level being out of reach of all but the most exceptional tides by the 20th century.

The maritime industrial debris

Work in and around any shipbuilding, repair, or breaking yard in the age of great wooden ships

produced many types of debris or diagnostic waste. There are several reasons why the quantity of debris material in the timber dry dock backfill was generally small. The larger shipyard offcuts were treated as a perk (the 'privaledge of the chip': Lavery, 1996) by shipwrights which may explain why there were few large offcuts found. In repair and breaking the vast majority of timber elements were recycled, for building new ships, other structural use, or simply for fuel. By the beginning of the 19th century ship breaking and recycling of the timber and fittings was a major Thames-side industry (Tait & Tait, 2000). Many excavated instances of the recyling of medieval and later nautical timbers in the London region have been published (for example Goodburn, 1991; Marsden, 1996).

Private shipyards, such as Pitcher's at Blackwall, would have kept substantial stores of metal materials, especially fixings and copper sheeting, on site. These would have been found in the various storehouses, carefully sorted on shelves, and in shelf bins, for ease of use. The smiths' shop at the yard would have made many of the specialist wrought-iron fittings, although most of the standard nails and spikes would have probably been brought in. It is likely, however, that most of the bolts—which varied in length according to need—would have been finished at the shop. As well as metal fixings and materials used in the building and repair of ships, it is also likely that the yard may have kept supplies of materials used to replenish ships' stores during re-fitting. Many ships carried their own carpenters, smiths and sailmakers, and they all held substantial stores, as did ships' bosuns.

The smaller types of waste of a range of maritime-related ancillary crafts as well as of ship repairing and building are represented in the maritime industrial debris sampled from the backfill of the timber dry dock and these are outlined below.

Fastenings of wood and metal

The most common types of fastening found were sections of used and unused oak treenails (Fig. 7). None was smoothed with a rounder or 'moot' and neither were they turned. They appear to have been split out of billets of straight grained, fairly fast-grown, oak, which is much stronger, denser and harder than slower-grown material, the reverse of the tendency in softwoods. After drying, the treenail blanks were probably roughly trimmed with an axe to a square section, followed by shaving with a drawknife to a standard size. This left a multi-faceted rather than perfectly rounded shank. Treenails of this form were found in the, probably English-built, vessel of the 1830s (SL4 wreck) found during the Slufter excavations at the mouth of the Rhine (Adams *et al.*, 1990: 114–16). Usually a square head was left to draw the timbers together initially; this was then cut off. The treenails were cut slightly larger than the hole drilled for them. After driving and cutting off any excess length the ends were usually split in a variety of ways to expand them, making them totally watertight and hold like a rivet (Milne *et al.*, 1998: 62).

Other ship fastenings found were of metal and included occasional wrought-iron, square-shank spikes and a variety of round-headed nails, together with longer chisel-pointed iron nails, or short bolts (Fig. 7). Long bolts and through bolts were also found, with round cross sections, together with a variety of fixing washers. Long iron bolts were used to secure the scarves of the keel and kelson. They were also used to secure the scarves and butts of the futtocks and frames, and to fix the composite stern and stem sections. Rather surprisingly, the excavation revealed no forelock bolts, or any fixings with special eyes. A few shaved softwood bungs were also found which were probably used to block old fastening holes in repairs such as laying new decks.

Distinctive turned wooden plugs or covers

Clear evidence of highly standardized, very accurate turning was found applied to the production of plugs or covers to set over the heads of countersunk iron deck spikes or bolts. This material consisted of small cylinders of cross-grained softwood turned to two precise diameters of either 29 mm (1 1/8 in) (see the example on Fig. 7) or 45 mm (1 3/4 in). Each cylinder had precisely-cut grooves at regular intervals roughly the same distance as the diameter. It is clear that the plug cylinders could be easily broken with a slight chisel cut into what was end grain, guided by the regular scores. Two different types of lathe centre marks were recorded. In some cases the ends of the cylinder had a three-pointed mark distinctive of the active, 'drive' end of a flywheel, treadle or power-driven lathe (R. Wood, pers. comm.).

Thus it is clear that the plug makers supplying this yard did not use the simpler older styles of lathe but one of the continuous-rotating later forms, possibly an early power lathe. Presumably the turners started with strips of wood sawn from slightly oversized sawn planks of pine, which may have been slightly bevelled before setting on the lathe. The weak cross-grained structure of the

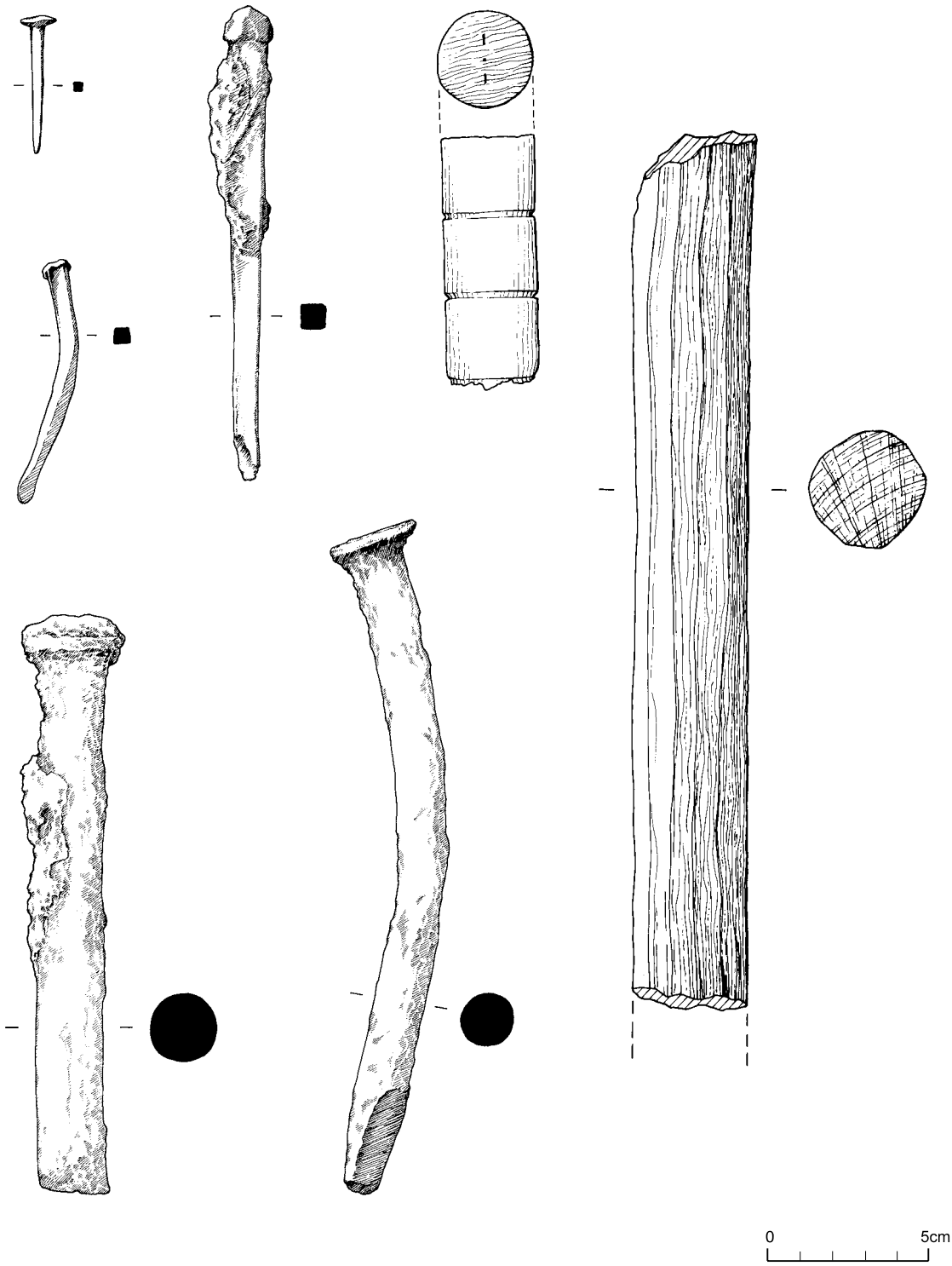

Figure 7. A selection of fastenings, including copper sheathing nail (top left), a turned softwood plug cylinder (top centre), round-headed nails and square-shank spikes, and an oak treenail (right) (scale 1:2).

blanks must have required careful work and this may have been virtually impossible on a form of lathe where the drive cord pulls on the work, as in a pole lathe. However, the cross-grained orientation was essential in use for the plug to wear down evenly with the surrounding deck planking which

had grain running in the same direction. Turning in the normal orientation would have resulted in the plugs slowly protruding above the surrounding planking. This highly specialized form of wooden shipbuilding debris has not yet been recognized on other London region shipyard excavations, and may have been a specialized product.

Offcuts and evidence for the use of exotic timbers

Many small offcuts were found in the various organic layers of the backfill sequence. Surprisingly the majority of the material was either imported softwood or teak, but adze or axe chips and occasional offcuts of native timbers such as oak and elm were also found. Several distinctive offcuts indicate that curved ship elements were pit-sawn from hewn baulks of imported teak (Fig. 8). No clearly machine-sawn material was found, even though steam-powered circular sawing was known from as early as 1777 (Edlin, 1949: 17).

Evidence for re-sheathing hulls

It is well known that hulls of ocean-going ships were usually protected from marine borers by sheathing in either thin sacrificial planking or copper sheet. Small sections of sacrificial softwood hull sheathing planks were found heavily eroded and pierced by many small iron nail shanks. The fragments were typically between about 20 and 25 mm (3/4 to 1 in) thick. Copper sheathing nails (Fig. 7) and fragments of copper sheet sheathing were also found. Clearly re-sheathing was taking place in or close to the dry dock. Obviously the removal of sheathing would also have been required for any hull planking repairs below the waterline.

Evidence of shoring materials

In any building and docking procedure much temporary timberwork was required to support the vessels or individual hull elements. Many of these were pole shores, which were tightened by driving pairs of opposed hardwood wedges. A great number of carefully-made oak wedges were found in the lower organic backfills of the timber dry dock which probably derive from this activity (Fig. 8). The upper ends of shores were sometimes lodged against a temporary, nailed-on, wedge-shaped chock, examples of which were also found (Fig. 8).

Blockmaking debris

The principal moving parts of a large sailing vessel, after the rudder assembly, were the various rigging blocks, of which any large vessel of the late 18th to early 19th centuries would have had as many as 1000 of several varieties (Lavery, 1991: 153). Blockmaking was a fairly repetitive, laborious, and specialized craft which some in mid 18th-century London considered rather lowly: 'It requires no great ingenuity, nor is there much to be got by it' (Cambell, 1747: 301). However, by the 1770s power in the form of water, and steam or horse engines, and large-scale industrial organization were being applied at several sites, most famously at W. Taylor's blockmaking mills at Southampton (Horsley, 1978: 220; Steel, 1818: 137). It should be noted that blockmakers sometimes also made other ship's rigging fittings and other equipment including pumps (Steel, 1818: 118).

The body or 'shell' of a block of *c.* 1800 was usually made of tough, split-resistant elm (*Ulmus* sp.) or ash (*Fraxinus excelsior*), according to a broadly contemporary source (Steel, 1818: 138). Fragments found included up to half an elm block shell (Fig. 9). The turned pulley wheel (Fig. 9) was another key element and Steel suggests that it was usually made of the hard dense tropical wood, lignum vitae. Several similar pulley wheels were recovered and an analysed sample was shown to be of the expected lignum vitae. The pins on which the wheels turned were also supposed to be generally made of imported tropical wood (Steel, 1818: 138) (Fig. 9). A considerable number of pins could be seen in the lower organic dry dock backfills; several were taken as a sample and a sub-sample identified as lignum vitae. They were all very carefully turned to be 2.5 mm (1/10th in) larger than the standard pin hole (Steel, 1818: 151). One end was left a little larger to jam in the hole in the block shell (Fig. 9). Some examples from this site were actually tapered slightly, and others were still slightly faceted as if they were unfinished. Clearly a blockmaking shop must have been working nearby.

A form of cleat

A number of damaged, nailed-on, handle-like objects were found in the lower organic fills. These were rather crudely carved from manually-sawn planks of hard tropical timber and around 240 mm long by 40 mm thick. They were originally fastened to something else with two iron spikes at each end. It was not clear what their original function was. Initially it was thought that they were handles to crates or other containers. However, they have a broad similarity to what are termed 'comb cleats' in

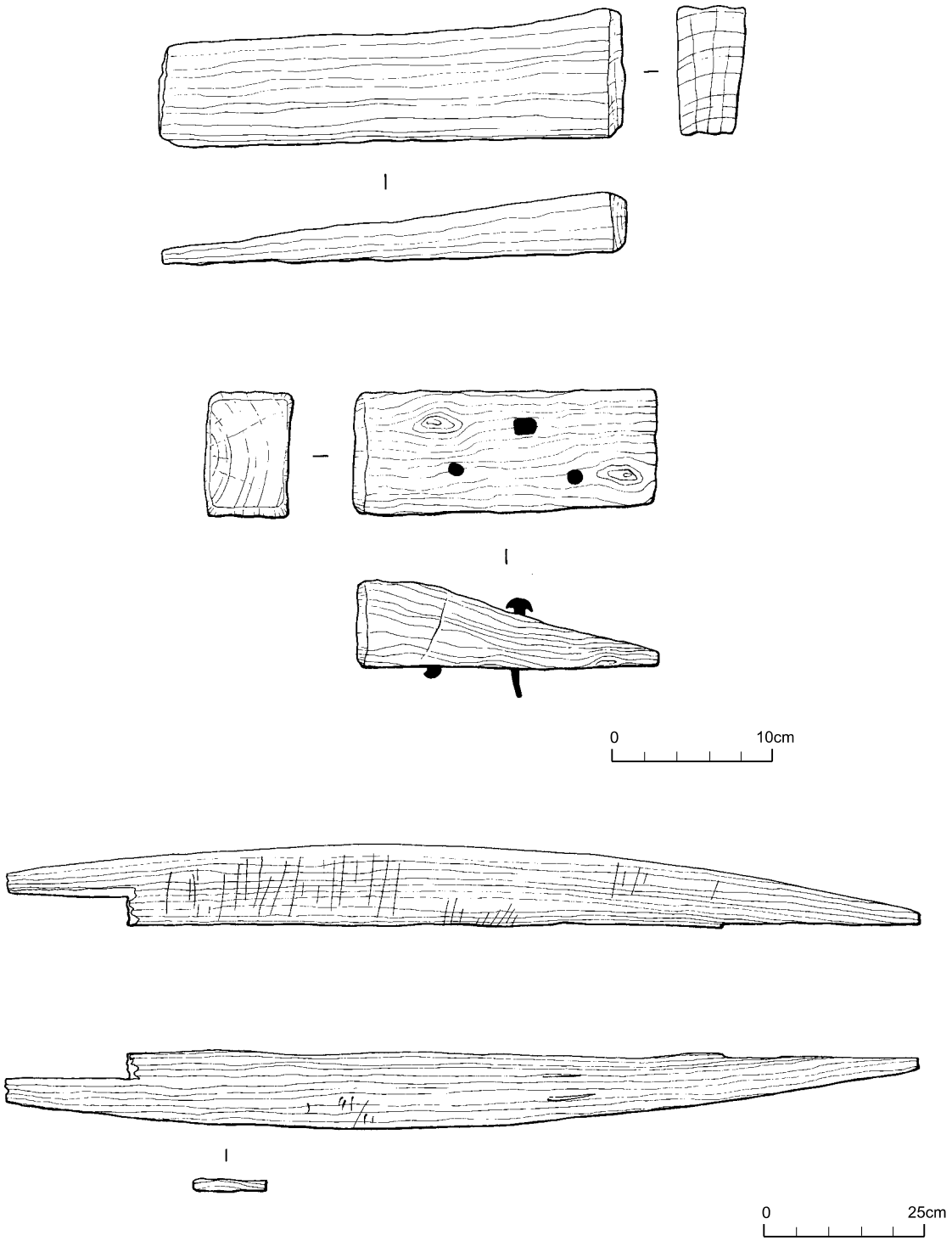

Figure 8. A typical oak shoring wedge (top) and a nailed-on softwood chock for a shore end (centre) (scale 1:4); (bottom) a curved pit-sawn teak offcut (scale 1:10).

Steel's manual (Steel, 1818: 152). These fittings were probably employed to guide rope runs much like the plastic equivalent used on modern sailing yachts.

Cooperage materials found and evidence of a novel recycling trade

As casks and other stave-built vessels were common shipboard containers, parts of such containers

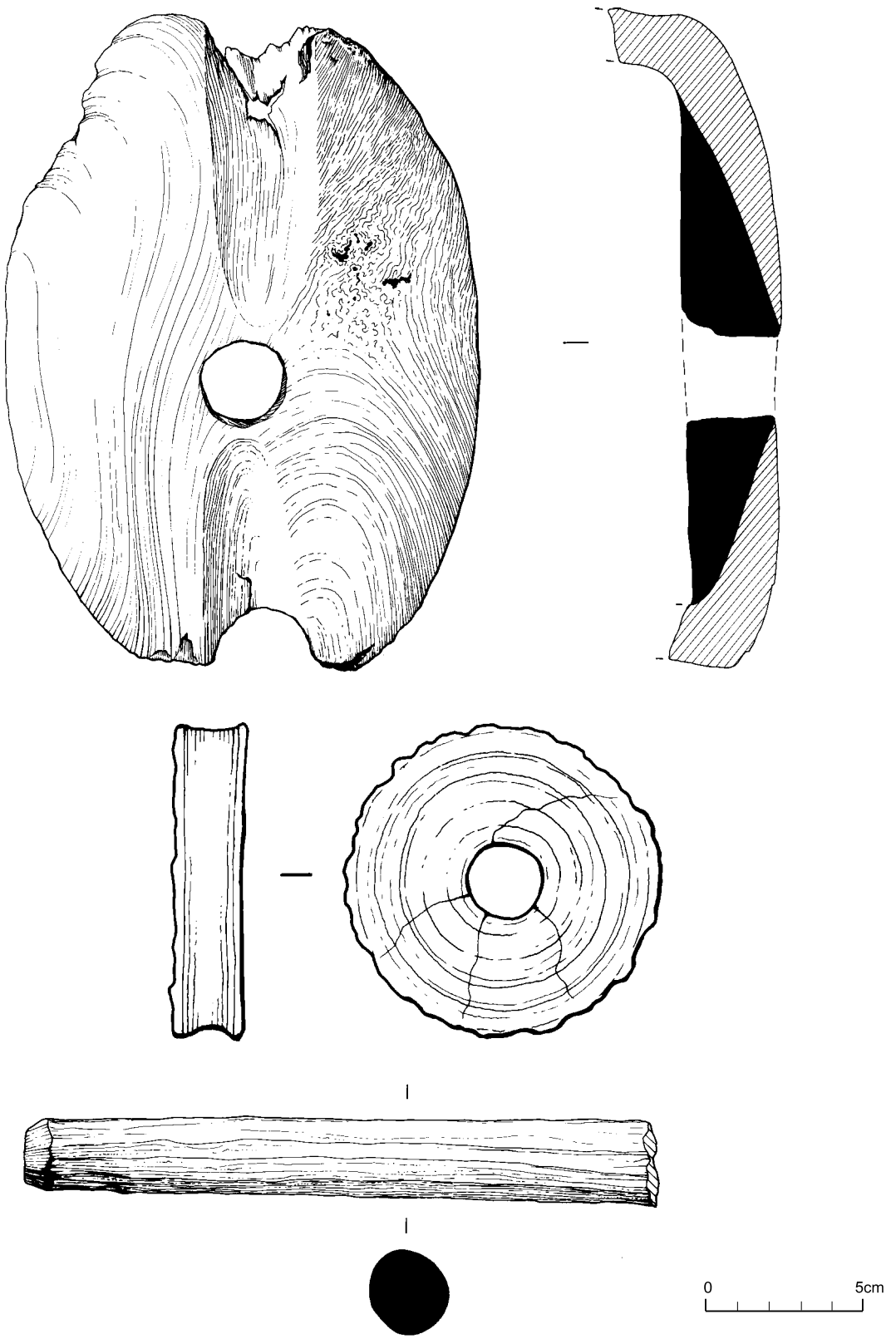

Figure 9. Elm block shell (top), turned pulley and pin of dense tropical wood (centre and bottom) (scale 1:2).

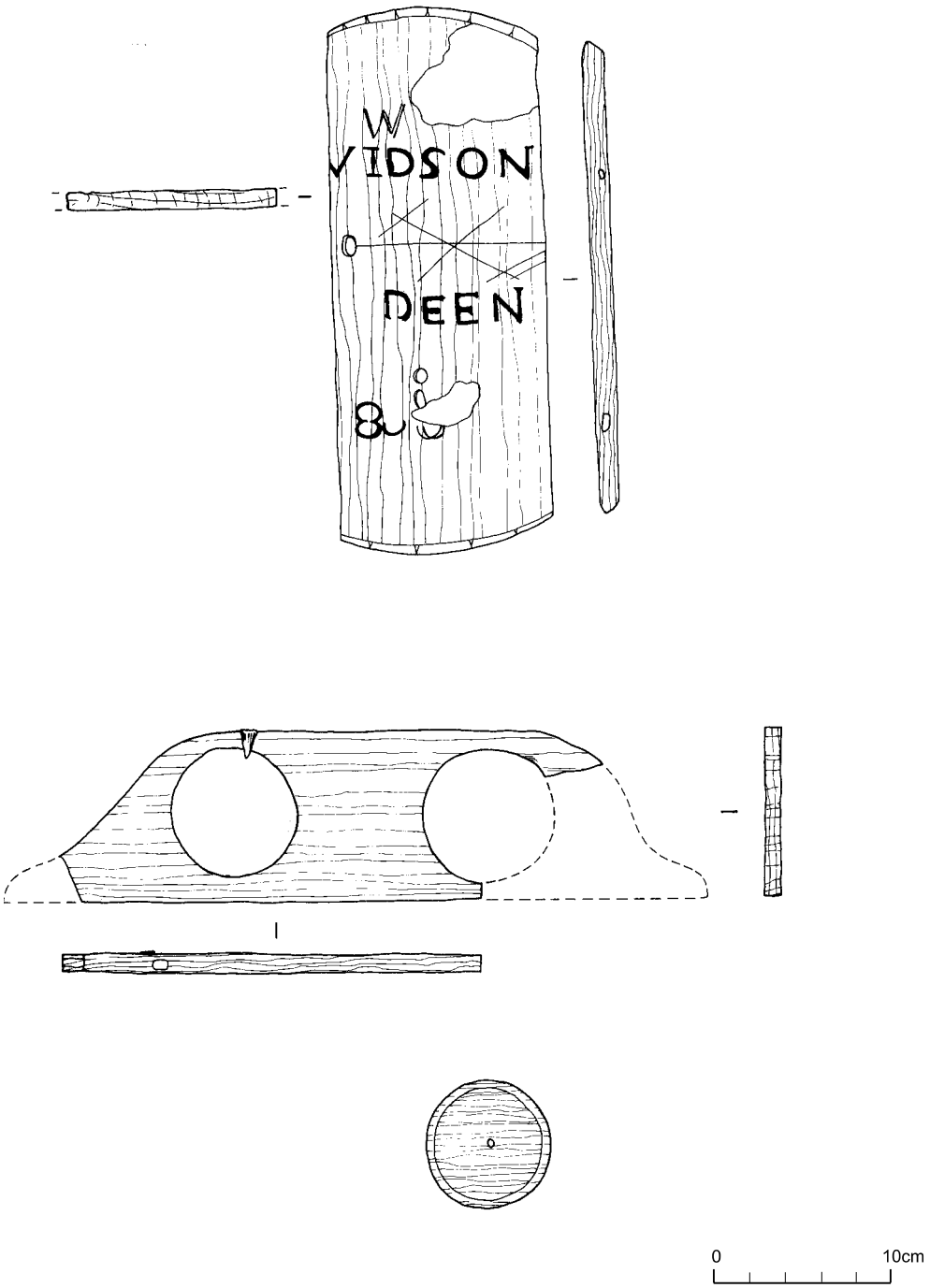

Figure 10. A radially split oak head piece from a cask with inscription (top), a broken oak fiddle (centre) and an offcut from fiddle making (bottom) (scale 1:4).

are to be expected in shipyard land-fill deposits. All the pieces recovered derived from rather small containers. Nearly all the staves and headpiece elements were of radially-cleft oak, and some were branded or engraved with marks or lettering including a headpiece which appears to read 'W. [Da]vidson [Aber]deen' (Fig. 10). The cooperage resembles medieval cooperage more closely than modern work. An exception (as teak was not used in earlier times) was a crudely-worked teak stave that may have derived from a bucket.

It was clear that some of the cask elements were being recycled close by into 'fiddles' (ship's shelves) with circular recesses for bottles, cups or glasses.

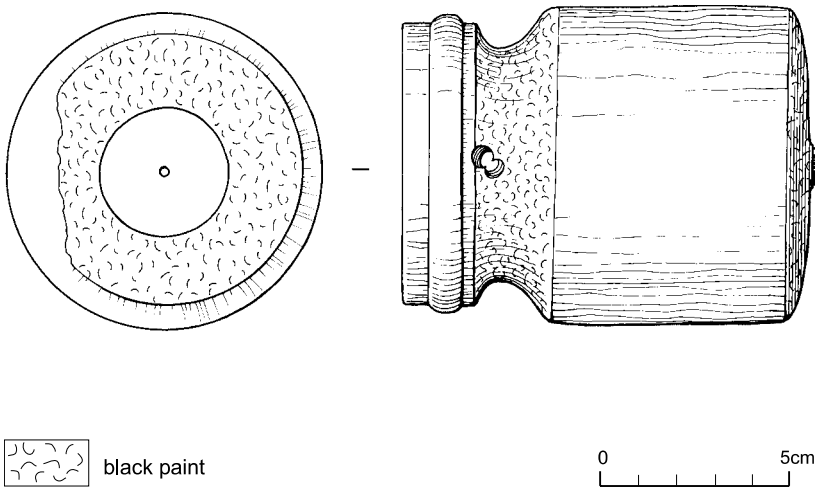

Figure 11. Turned tropical hardwood rammer-head (scale 1:2).

The edges of the barrel parts still retained the edge pegs left from use in cask ends. Both a finished (but broken) fiddle, and the circular offcuts from making such a fiddle, were found (Fig. 10). The tool used to cut such wide holes was in effect a form of cylindrical saw.

Part of a gunner's kit

A carefully-made, turned tropical hardwood object was found (Fig. 11) whose function was not at first recognized. It was clearly recessed for a handle and appears to have been the head of a rammer, a tool used to push home the charge of a cannon before firing. The maximum diameter was *c*. 83 mm (*c*. 3 3/8 in).

Draught mark numbers and a stair tread

Among the more significant sheet metal finds are several large metal draught marks: a copper number 'XVII', a lead number 'XII' and a smaller copper number 'I'. These all contain nail holes, or nails, and have clearly been removed from the hulls of ships. Draught marks like these were used to mark the loading draughts on the stemposts and sternposts of vessels. Sutton (1981) cites an agreement, dated 1747, with Blackwall yard for the building of an East Indiaman, which contained a clause 'To marke the ship fore and aft with Lead'.

Another interesting find is the square-punched section of brass or copper sheeting which probably formed part of a tread for a wooden stairway.

Discussion

The presence of a natural inlet at this site made it an ideal location for a shipyard. The three north–south aligned reused carvel ship timbers found perpendicular to the 18th-century dry dock revetment could possibly be remains of a 17th-century yard known as Rolt's yard. The first datable activity on the site occurred in the late 18th century with small-scale reclamation along the edges of the inlet and the construction of a timber dry dock shortly after. The life-span of this timber dock appears to have been fairly short, with the construction of two masonry dry docks, to the south of the archaeological excavation, in 1806 by Thomas Pitcher. It is probably to Pitcher's yard that the major phase of shipyard and other maritime debris found on the site belongs.

The quantity and range of shipyard debris recovered during this excavation has added greatly to the reference collection of the Museum of London, and the newly-opened Museum in Docklands. The structures and deposits of woodworking debris found date from the period preceding the better-documented mid to late 19th-century industrial shipyard activity on the Thames (Banbury, 1971). However, the material does also clearly show signs of the new technologies of the industrial age, such as evidence of highly specialized, possibly powered, wood turning. Some of the activities indicated were carried out by hand with native materials that would have been familiar to earlier shipwrights, while others would have seemed very new and exotic, such as the working of imported tropical teak timber.

Iron fixings for wooden boats and ships date back to antiquity and there are many examples from London. By the early 17th century, iron fixings were extensively used in shipbuilding, for

example to supplement the wooden treenails, which formed the main method of fixing planks to frames, especially outboard and below the waterline (Saxby & Goodburn, 1998). During the 18th and early 19th centuries the use of metalwork on board wooden ships became even more widespread. Iron, and later copper, bolts were extensively used in framing-up and planking ships. Likewise, they were also used to fix the hanging and lodging knees to the frames and cross-beams. A number of examples of metal fastenings used in London around 1800 were found here to contrast with earlier material (see Marsden, 1996; Milne *et al.*, 1998)

Wooden ships consumed a significant amount of iron and other metals at this time. In 1819, the contributor for the chapter on 'Shipbuilding' in Abraham Rees's *Cyclopaedia* (Rees, 1819) estimated that a 74-gun naval ship carried the following: over 20 tons of ironwork in her knees, bolts and nails; over 20 tons of copper bolts and rudder braces; over 11 tons of copper sheathing; over 1 ton of copper sheathing nails; over 1 ton of lead work. Of the 400 metal objects retrieved from the excavation, the largest group comprised iron nails, spikes and bolts used as fixings on wooden ships. Other groups included copper sheathing, lead and tin sheeting, cut copper and lead numerals, copper sheathing nails, thimbles and shackles.

The debris illustrates the increasing use of exotic materials, mirroring the expanding British Empire. Samples of the woodwork were taken for possible tree-ring dating and sourcing (softwood and oak: Boswijk & Tyers, 1997) and also to check identifications made in the field of less familiar timbers (tropical material). The tropical timber samples were identified microscopically at Kew Gardens, London (T. Lawrence, pers. comm.). These identifications confirmed those made in the field, of teak and lignum vitae (*Tectona* sp. and *Guaiacum* sp. respectively). The tree-ring specialists identified the softwood as of the pine family (*Pinus* sp.). It is most likely that at this date the timber came from either Scandinavia or north-east Russia but an origin in north-eastern North America is also possible. Some of the pine timber had over 190 tree rings and therefore the sequences measured may be datable in future as chronologies are enlarged for such timber. The oak and elm timber found is currently assumed to have been local although some documentary sources, such as ship contracts, show that even these species were being widely imported to some British shipbuilding yards as early as the mid 18th century (for example Lavery, 1991: 63). However, the oak and elm recorded on site was not particularly slow-grown as is commonly the case in known imported oak derived from more or less natural wildwood forests in eastern Europe or north-eastern North America. So far the medium- and fast-grown oak found on London post-medieval waterfront sites seems to have derived from more open, faster-growing, managed woodland, parkland and hedgerows in England.

Pine from North America or the Baltic region was used in the construction of the 18th-century dry dock and tropical hardwood in the shipwrights', blockmakers' and some coopers' work. The pottery assemblage (805 sherds) is also interesting in this context. Principally domestic wares, presumably dumped from nearby habitations, the types of pottery present included commonly-occurring types such as black basalt ware, Chinese (export) porcelain, mocha decorated ware, Nottingham stoneware, pearlware, refined white earthenware, transfer-printed ware and Staffordshire white salt-glazed stoneware. However, apparently mixed with this domestic pottery is pottery that is imported and some of which appears to be directly connected with 19th-century shipping. These wares appear to fall into two broad groups, either Iberian or Far Eastern in origin. The Iberian wares are characterized by the presence of mica tempering and other inclusions possibly volcanic in origin. The Far Eastern wares are mostly stonewares and are assumed to be part of the Martabani tradition of large water or oil containers known to have been produced at Martaban in Burma, and also in south China, Indo-China, other parts of Burma and Siam (Thailand); production is also known to have been carried out in Indonesia (Hurst et al., 1986: 11). The evidence of foreign trade from this site is considerable.

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Note

[1] Further details can be found in the site archive lodged with the Museum of London and may be consulted by prior arrangement at the Museum's London Archaeological Archive and Research Centre (LAARC), Mortimer Wheeler House, 46 Eagle Wharf Road, London N1 7ED.