EARLY NEOLITHIC PITS AT PRINCIPAL PLACE, SHOREDITCH, LONDON BOROUGH OF HACKNEY

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SUMMARY

A group of four pits excavated in the upper Walbrook valley at Principal Place, Shoreditch by MOLA in 2015 produced the largest assemblage of Early Neolithic Bowl pottery recovered to date from the City of London and its immediate surrounds. The Neolithic pits had been fortuitously preserved within part of the northern extramural Roman cemetery of Londinium and conjoining sherds of Bowl pottery were also recovered from the fill of an isolated late Roman cremation. A range of analyses showed that the vessels – comprising essentially Plain Bowl with some Decorated Bowl, the latter incorporating Peterborough Ware traits – were probably locally made and had been used to process dairy products and to stew beef and mutton (though not pork). Radiocarbon dating of the lipids absorbed within the vessel walls – employing a novel technique developed at the University of Bristol – suggest that the pottery was being used in the mid-fourth millennium cal BC. The pits also contained small assemblages of struck flint, fauna (some burnt) and archaeobotanical remains (some intrusive) and may have been filled using material drawn from a long-vanished 'pre-pit' source, possibly a midden; they presumably represent episodic activity on the part of semi-sedentary Neolithic communities.

INTRODUCTION

An assemblage of Early Neolithic pottery and struck flint was recovered from four small pits excavated by MOLA within a mixed residential/commercial redevelopment at Principal Place, Shoreditch, London Borough of Hackney (Grid Reference (NGR) centred 533377 182130) (Fig 1). The site lies in the upper valley of the Walbrook stream and within an area of the northern extramural cemetery of Roman London. Modern ground level adjacent to the site is at *c.*14–14.5 mOD (above Ordnance Datum).

Other elements of the site sequence, which will be published elsewhere, comprise mixed rite Roman burials, a late Roman coin hoard, exceptionally well-preserved late 17th century buildings and yards, and part of the early 19th century Curtain Road gasworks (Daykin and Hill 2017). The full archive is stored at Eagle Wharf Road under the site code PPL11.

Fig 1 Map showing the location of the Principal Place site at the north-east edge of the modern City of London (scale upper 1:50,000, lower 1:20,000).

The four Neolithic pits were located c 15m to the east of the projected course of one arm of the Walbrook stream at the north-eastern end of the site. The pits were initially assumed to comprise Roman cremation burials and, in line with current MOLA practice, were fully sampled for the recovery of calcined bone and accompanying artefactual and environmental data. Their true significance only became apparent during the post-excavation programme when they were found to contain exclusively sherds of Early Neolithic pottery and pieces of struck flint. In addition, the fill of an isolated Roman cremation burial 12m to the west, which was accompanied by Roman funerary vessels and a 3rd-century AD coin, produced more sherds of Early Neolithic pottery some of which conjoined with those recovered from one of the four pits to the east.

The unusual nature of the discovery, which comprises the largest assemblage of Neolithic pottery recovered from the city of London and its immediate surrounds to date, led to a request from Historic England for MOLA to provide independent scientific dates to confirm the pottery attribution, and to undertake petrographic, geochemical, and absorbed residue analyses. The petrographic and geochemical analyses were carried out at University College London by Patrick Quinn and the absorbed residue analyses were conducted at the University of Bristol by a team comprising Julie Dunne, Emmanuelle Casanova, Tim Knowles, Toby Gillard, Caitlin Walton-Doyle, and Richard P Evershed. The lipids recovered during the latter analyses also furnished a series of absolute dates using compound-specific radiocarbon dating techniques developed at Bristol; these are modelled here by Alex Bayliss.

This article describes the pits and their contents: pottery, struck flint and environmental material – the latter comprising burnt and unburnt bone, mollusca and charred archaeobotanical remains. The ceramic assemblage forms the focus of interest and separate sections examine fabric, form, and cultural affinity; the organic residues absorbed within and burnt onto the vessel walls; and the compound specific radiocarbon dating of these residues.

A final section places the pits within their local and regional lower Thames ('Thames Gateway') context.

THE EARLY NEOLITHIC PITS

Andy Daykin

Four circular or sub-circular features, [5371], [5375], [5377] and [5422], formed a compact group cut into one of several surviving 'islands 'of natural brickearth on the east side of a channel belonging to the Walbrook stream (Fig 2). A short stream with a small catchment (eg, Ranieri and Telfer 2017, 44), the Walbrook flows north to south between Cornhill and Ludgate Hill to join the present course of the Thames at Dowgate some 1600m distant. All four pits contained pottery of Early Neolithic type and fragments of struck flint. Further comparable sherds were incorporated in the fill of a 3rd century Roman cremation burial ([5373]) 12m to the west.

Fig 2 Plan of the Early Neolithic features in the north-east of the site, shown in relation to the Walbrook stream (conjectured) (scale 1:300).

Three of the four Neolithic pits were between 0.60m and 0.90m in diameter. The fourth [5375] was slightly larger and more irregular in shape but may have been over-cut in excavation. Their extreme shallowness (50–380mm) suggests that they had been truncated in antiquity, certainly during the life of the Roman cemetery if not before, which perhaps accounts for the presence of the displaced Early Neolithic pottery within the Roman cremation (Fig 2).

All four pits had broadly vertical sides and flat bases with undifferentiated fills (respectively [5370], [5374], [5376], [5421]) that incorporated pottery, struck flint, small scraps of unidentifiable burnt bone, charred plant remains and wood charcoal. Grains of barley (*Hordeum* sp.) and free-threshing wheat (*Triticum aestivum*) from fill [5421] of pit [5422] all returned dates that fall within the late 13th century AD (Reimer *et al* 2020; Stuiver and Reimer 1986; see Table 8). This has obvious implications for the integrity of the associated charcoal and burnt bone assemblages recovered from the pits and, as a result, these are only briefly considered here (full details are held in the site archive).

In addition to the lithic material recovered from the four pits a handful of other pieces were recovered from a series of otherwise undated stakeholes and brickearth deposit [5226] located a few metres to the north (Fig 2). No struck flint was present in Roman cremation [5373].

THE PIT CONTENTS:

A. EARLY NEOLITHIC POTTERY

Jonathan Cotton and Patrick Quinn

A total of 298 sherds of Early Neolithic pottery weighing just over 6.1 kg were recovered from the four Neolithic pits (Table 1). A further 50 sherds weighing 325 g were recovered from late Roman cremation burial [5373]. The combined total assemblage of 348 sherds represents an estimated minimum number of 28 vessels. The majority comprise medium to large round-based bowls with rim diameters between c 180-280 mm, along with single sherds from three smaller open bowls/cups with rim diameters below c 120-130 mm.

Much of the assemblage comprises featureless body sherds, which often give little clue as to their position or orientation within any given vessel profile. However, a refitting exercise identified direct same-vessel cross-joins between two of the Neolithic pits, and between one of the Neolithic pits and the Roman cremation burial. Typologically the assemblage comprises Plain Bowl and Decorated Bowl pottery, some of which incorporates early Peterborough Ware traits.

Table 1 Early Neolithic pottery from all features, by sherd count (SC), estimated number of vessels (ENV) and weight (Wt g).

Fabric

A restricted range of four fabric types (A–D) was identifiable in hand specimen, based principally on the size and distribution of angular crushed burnt flint inclusions added to the clay matrices. The individual clasts were generally poorly sorted and up to 8mm in size. Thin-sectioning and geochemical analysis of 32 sherds also isolated four sub-fabric types (1–4) although there was little correspondence with the fabrics identified macroscopically beyond the presence of the crushed burnt flint (Table 2).

Table 2 Illustrated and/or analysed ceramics from Principal Place.

The 32 thin-sectioned sherds were classified under a polarising light microscope according to the nature of their inclusions, clay matrix and voids (Quinn 2013, 73–102). The resulting fabric classes were characterised petrographically in terms of their constituent raw materials and the technology of their manufacture. They were also analysed geochemically via inductively coupled plasma atomic emission spectroscopy (ICP-AES) and inductively coupled plasma mass spectroscopy (ICP-MS) recording a total of 32 major and minor elements and monitoring accuracy with international certified reference materials (PPL11 Data Table 1). The multivariate geochemical data were analysed by principal components analysis (PCA) and displayed as scatterplots to examine the geochemical relationships between the various samples analysed. Comparisons were made between the independent macroscopic, petrographic, and geochemical classifications of the pottery sherds.

Under microscopic examination all the sherds are strongly related to one another in thin section due to the presence of angular flint temper added to a non-calcareous, quartz-rich silty or sandy base clay. Despite this homogeneity, the assemblage contained several distinct sub-fabrics, which can be defined by the grain-size characteristics of the quartzose inclusions in the base clay to which flint temper was added (Fig 3). The conspicuous flint inclusions are present within all prepared thin sections although are more abundant in some than others. Most have a fine cryptocrystalline microstructure, but are less commonly characterised by thin, sinuous ribbon-like features and possible relic microfossils, with both types occurring in single samples. Some flint inclusions contain iron-staining within them or around their margins. Chalcedonic quartz occurs, but also infrequently, as does banding. It is likely that the flint material is temper given the large size of many of the inclusions relative to the other grains. The angularity and poor sorting of the material suggests that it was crushed before its addition.

Fig 3 Thin section photomicrographs representative of Early Neolithic ceramics from Principal Place illustrating the four petrographic fabrics detected in this study: a – sub-fabric 1, sample PPL027; b – sub-fabric 2, sample PPL002; c – sub-fabric 3, sample PPL012; d – sub-fabric 4, sample PPL009 (all images taken under crossed polars; image width = 2.9mm).

In 12 of the 32 samples flint temper was added to a non-calcareous, silty, micaceous base clay containing abundant angular to sub-rounded, well-sorted, silt-sized inclusions of quartz, subordinate but significant muscovite mica and rarer chert, opaques, biotite and feldspar (sub-fabric 1) (Fig 3a). Distinct heterogeneity is visible in several of the samples, which takes the form of streaking of darker, inclusion-poor, iron-rich red clay. Such patterning has been reported in clay pastes known to have been produced by the deliberate mixing of two or more compositionally different clay sources (eg Quinn 2013, 170).

Sixteen of the prepared thin sections are related to those above, but also contain rounded sand-sized quartzose inclusions in varying proportions and have a less abundant silt fraction. These have been subdivided into sub-fabrics 2 and 3 (Fig 3b and c) based on the abundance of the rounded sand inclusions, which are composed of quartz, polycrystalline quartz, quartzite and, less commonly, fine sandstone and rounded flint, which can reach over a millimetre in size. The sand is likely to have been naturally occurring in a sandy clay source, although there is possible evidence for the addition of this material as temper in the form of some clay-rich areas without sand in one sample, plus the relationship with sub-fabric 1. Occasional voids with carbonised plant matter are also present but seem to be naturally occurring rather than a result of adding organic temper.

Three sherds could not be placed within sub-fabrics 1, 2 or 3 on account of having fewer silt-sized quartz and mica inclusions than sub-fabric 1 and less sand than sub-fabrics 2 and 3 but do contain small amounts of quartz sand (Fig 3d). This material seems to be less rounded overall than the examples in sub-fabrics 2 and 3 and is thus designated sub-fabric 4.

Several samples exhibit visible post-depositional alteration in thin section in the form of phosphate and calcareous material in voids. Firing was likely to be <850°C on account of the optical activity visible in the clay matrix in crossed polars under the microscope (Quinn 2013, 190–191). The firing atmosphere was generally oxidising, although variable and sometimes oxygen poor to reducing. There does not appear to be any correspondence between fabric and vessel form to suggest that specific raw materials or recipes were preferentially employed.

The elements Ca, Co, Mg, Na and P were left out of the geochemical dataset due to poor accuracy and the alteration mentioned above. Statistical analysis of the multivariate dataset of 32 samples and 24 retained elements revealed that principal components 1 and 2 explained 80% of its total variance. This high percentage means that by plotting the two components against one another it is possible to visualise in two dimensions the geochemical patterning within the assemblage (Fig 4a). The samples group close to each other in a general cloud, indicating that they have a related elemental composition. Labelling the samples in the plot according to the context/pit from which they were recovered at the site does not indicate any correspondence, nor does their shape and decorative characteristics or their macroscopic fabric assignment. However, by highlighting the petrographic sub-fabrics to which the sherds were assigned some correspondence between the thin section petrography and geochemical analysis is revealed (Fig 4a). Although the element Si was not measured, it is likely that the proportion of silica-rich silt and sand inclusions and the amount of flint may have a strong effect on the relative abundance of several other elements and thus the classification via PCA. To counteract this dilution, the values for all samples were normalised to 100%, then subjected once more to PCA. However, a plot of the first two principal components did not reveal any notable groupings.

Fig 4 Statistical classification of geochemical data collected on Early Neolithic ceramics from Principal Place in this study: a – principal component scatterplot of the 32 sampled Principal Place sherds differentiated according to their petrographic fabric assignment; b – principal component scatterplot of the 32 Principal Place sherds and six Early Neolithic flint-tempered sherds from Blackwall analysed by Vince (2004) indicating their compositional relationship.

Form

The fragmented nature of much of the material means that rim orientation is often difficult to ascertain and for the most part overall vessel form cannot be reconstructed below the upper body/shoulder area with any degree of certainty either. As noted above, the assemblage comprises sherds belonging to a range of medium to large bowls and single sherds from three small open bowls/cups.

Fig 5 Early Neolithic pottery <P 1>–<P 3> from Principal Place (catalogued in Appendix 2) (scale 1:2).

Fig 6 Early Neolithic pottery <P 4>–<P 8> from Principal Place (catalogued in Appendix 2) (scale 1:2).

Fig 7 Early Neolithic pottery <P 9>–<P 17> from Principal Place (catalogued in Appendix 2) (scale 1:2; detail <P 9> 2:1).

Rim morphology encompasses plain, rolled and heavy types, as follows (Fig 5–Fig 7): plain (<P 13>, <P 14>, <P 16>); plain, everted (<P 2>, <P 4>, <P 12>); plain, pointed (<P

7>, <P 10>); rolled (<P 11>, <P 15>); heavy, externally thickened (<P 3>, <P 6>); and heavy, T-shaped (<P 9>). Shoulders are generally slack or rounded, and several vessels (eg <P 1>, <P 14>) appear to be virtually straight-sided. Three vessels (<P 4>, <P 5>, <P 12>) have rather more pronounced high shoulders, two of which (<P 5> and <P 12>) are slightly accentuated. On one of these (<P 5>) the shoulder angle has been reinforced with a tapering unperforated horizontal lug. A further vessel (<P 17>) has an abrupt ledge shoulder immediately below the rim. In addition, some thicker-walled sherds are markedly curved and presumably represent elements of rounded bases. None of these could be convincingly linked with any of the upper body profiles, however.

No complete vessel profiles could be reconstructed, although three vessels, <P 1>, <P 5> and <P 12> (Fig 5–7) are represented by multiple conjoining sherds. Of these <P 1> comprises a deep bag-shaped vessel with an upright finger-pressed or ‘dimpled’ rim and a horizontal line of fingertip impressions just below. It is made up of 61 sherds from adjacent pits [5371] and [5377], many conjoining, and comprises 17.5% of the overall ceramic assemblage by sherd count and nearly one third by weight. Vessels <P 5> and <P 12> comprise open/neutral vessels with tall necks and light, slightly beaded rims. The shoulder of <P 5> is also accentuated by an elongated unperforated lug and conjoining sherds of this vessel were recovered from pit [5375] and Roman cremation [5373]. A further partial vessel profile could be plausibly reconstructed from five distinctive but non-conjoining sherds of a high-shouldered S-profile bowl <P 4> with an everted rim and tooled and incised stab-and-drag decoration (three sherds are illustrated in Fig 6).

Alongside the medium to large bowls single sherds of three small bowls/cups <P 10>, <P 13> and <P 17> were recovered from separate pits (Fig 7). All three are open and hemispherical in form with simple plain/pointed rims.

Surface treatment and decoration

Where it survives, surface treatment encompasses external smoothing and interior wiping. Most care seems to have been taken over the surface finishes of decorated bowl <P 4> and the otherwise plain lugged bowl <P 5> (Fig 6). There was no evidence for the employment of ripple or fluted surface burnishing.

Seventeen sherds (4.8% of the total assemblage) representing four vessels (14.3% of the ENV) bear traces of incised and impressed surface decoration. This comprises fingerpressing on top of the rim and equidistantly spaced fingertip impressions below the rim on <P 1> (Fig 5); linear tooling and incised stab-and-drag motifs on <P 4> (Fig 6) and on a small sherd from Roman cremation [5373] (not illustrated); and the deep, widely spaced bifurcated impressions on <P 9> (Fig 7). Further decorative features comprise a horizontal lug on <P 5> and perhaps the pre-firing perforations at the base of the neck on <P 8> (Fig 6).

Condition

Surface condition is variable: most sherds appear to have suffered some degree of wear and tear, including the loss of surfaces. A four-tier system of condition appraisal was applied, as at the Eton Rowing Course (Barclay *et al.* 2013, 127, Fig. 5.24): good (unabraded), average (somewhat abraded), average to poor (abraded) and poor (very abraded). On this basis the bulk of the assemblage was found to be in average, ie somewhat abraded, condition with only one group of sherds belonging to lugged vessel <P 5> (Fig 6) scored as good (unabraded).

Nearly a quarter of the sherds in pit [5422] (36 out of 146: 24.6%) were over-fired or re-fired and in abraded to very abraded condition. Many of these are curved and thick-walled and presumably represent rounded basal fragments. Two other sherds in Roman cremation burial [5373] were similarly heat-affected. This damage could have been caused by sitting the vessels in the hot embers of a cooking hearth, although the possibility cannot be ruled out that some sherds were re-fired following breakage. The absorbed residue analyses confirmed that a high proportion of the vessels had seen considerable use (see below).

Distribution of sherds between pits

A refitting exercise identified direct same-vessel sherd linkages between adjacent Neolithic pits [5371] and [5377] and between Neolithic pit [5375] and the Roman cremation burial [5373], some 12m distant (Fig 2; Table 1). The conjoining sherds from pits [5371] and [5377] comprise rim fragments of vessel <P 1>. Those from Neolithic pit [5375] and Roman cremation burial [5373] comprise rim and body sherds belonging to lugged vessel <P 5>.

The average sherd weight of between 14g and nearly 36g (Table 11) for the Neolithic pits is in stark contrast to the average sherd weight of 6.5g for the Neolithic material from Roman cremation burial [5373]. Here the greater fragmentation of the sherds was doubtless accelerated by their physical redeposition and by the brittle nature of the ceramic.

Discussion

The Principal Place assemblage comprises both plain and decorated open/neutral round-based bowls and smaller plain open bowls/cups with plain, rolled and externally expanded rims. Closed vessels are in a minority. Examination of vessel fabric, form and decoration indicates that the Principal Place ceramic assemblage is essentially of Plain Bowl and Decorated Bowl type, though vessels with Ebbsfleet Ware traits suggest that elements of it are likely to fall late within the overall tradition. As such it clearly post-dates the Carinated Bowls, exemplified locally by the vessels from Blackwall (Raymond 2008, Fig 4), Clapham (Densem and Sealey 1982, 179, fig 5 no. 1), Erith (Bennell 1997, 23) and possibly Vauxhall (Milne *et al* 2011, 289, Fig 7).

Plain Bowl and Decorated Bowl material has been recovered from a wide range of depositional contexts within the middle and lower Thames valley (see Fig) and beyond, including Yeoveney Lodge, Staines (Robertson Mackay 1987), Terminal 5, Heathrow (Leivers *et al* 2010), Kew Bridge Road, Brentford (Cotton 2017), Orsett (Kinnes 1978) and Kingsborough K1 (Gibson and Leivers 2008). Further afield, similar assemblages have been noted at St Osyth (Lavender 2007), the Stumble (Brown 2012) and Springfield Lyons (Brown 2013). A small series of radiocarbon dates obtained from the absorbed lipid residues (below) bracket the mid-4th millennium cal BC and are generally in line with others associated with such ceramic assemblages (Whittle *et al* 2011, 759–78; see below Fig 10). On the face of it the latest date would help to account for the observed Peterborough traits, although it is derived from the seemingly early looking vessel <P 12> (Alistair Barclay pers comm).

Despite the general petrographic and geochemical homogeneity of the analysed ceramic sherds, there appear to be several distinct but overlapping sub-fabrics. This may suggest that the assemblage contains pottery made from two or more different but related types of base clay, to which flint temper was added. These could be two layers within a single clay deposit, or two geographically separate deposits. The absence in the analysed assemblage of other deliberate additions such as grog or shell may indicate that the sherds were the products of a group of potters, following a single tradition. While it is not possible to rule out the existence of pottery made with similar raw materials in several places, the assemblage has the compositional characteristics of locally produced ceramics.

Some 5km further down the river at Blackwall (located on Fig), sherds of Early Neolithic Carinated Bowl were analysed petrographically and geochemically by Vince (2004;

2008). He recorded two flint-tempered fabrics that bear some similarities to the sherds analysed in this study. His ‘Group C’ contained abundant silt-sized quartz and muscovite inclusions as per sub-fabric 1 and one thin section from ‘Group B’ was comparable to sandy sub-fabric 2. Shell was present in some of the Blackwall sherds too but was not detected in any of the Principal Place samples. Geochemically, some differences exist between the Blackwall Group B and Group C sherds (Vince 2004, 8–9) and those from Principal Place, as the latter include higher Ba, Fe, La, Sr, Zr and lower Co, Ni and Pb. In a PCA plot of both sets of data, which were collected by the same laboratory and can therefore be directly compared, the six flint tempered Blackwall sherds group separately from the Principal Place ceramics (Fig 4b). This confirms that, despite certain petrographic and technological similarities, they are not likely to have derived from the same clay source, though all were probably made ‘within a few kilometres of the site[s] where they were found’ (Vince 2008, 225).

At other sites where petrographic analyses have been attempted a rather similar picture of local manufacture has tended to emerge, eg Yeoveney Lodge, Staines (Robertson-Mackay 1987, 67), and Abingdon (Avery 1982, 33–5). The differences detected in the suites of fabrics employed at Kingsborough K1 and Kingsborough K2 meanwhile suggested that the users of the two largely contemporaneous enclosures were exploiting different but still probably local clay sources (Gibson and Leivers 2008, 251). At Eton Rowing Course, by contrast, the incorporation of quartzite and shell hinted at the presence of some non-local fabrics of possible Midland origin (Barclay *et al* 2013, 110).

At least four of the 28 Principal Place vessels, comprising just over 14% of the assemblage, feature decorative elements. This is comparable to the figure of *c.*12% quoted for the larger assemblage at Orsett and 16% for Hurst Fen (Kinnes 1978, 264), but rather higher than the 6% for Kingsborough K1 and 6.4% for Kingsborough K2 (Gibson and Leivers 2008, 251), 6% for Heathrow, Terminal 5 (Leivers *et al.* 2010, 9), 4.3% for Yeoveney Lodge, Staines (Robertson Mackay 1987, quoted in Leivers *et al* 2010) and 4% for Kew Bridge Road, Brentford (Cotton 2017, 15). Elements of these various assemblages share affinities with Mildenhall Ware, whose currency in East Anglia has been bracketed to between 3785–3650 cal BC (*95% probability; start Mildenhall Ware*) and 3485–3305 cal BC (*95% probability; end Mildenhall Ware*) (Healy in Hills and Lucy 2013, 15–16, Figs 1.10 and 1.11).

As far as detailed decorative traits are concerned tooled linear decoration combined with incised stab-and-drag motifs as seen on <P 4> has been noted at Etton (Pryor *et al* 1998, 210–11), with a vertical variant being particularly common at Hurst Fen (Clark *et al* 1960) and Kingsborough (Gibson and Leivers 2008). While the overall decorative scheme of the Principal Place vessel is difficult to reconstruct from the few surviving sherds, it may have been arranged in panels and seems to have extended below the shoulder onto the lower pot wall as at Springfield Lyons (Brown 2013, 91, figs 3.16 and 3.17).

The presence of Peterborough Ware traits within the assemblage, including 'closed forms with upright or hollow necks, sometimes with in-turned rims, pits or impressions in the neck' (eg <P 1> and <P 9>) is comparable with elements of the ceramic assemblages from Eton Rowing Course (Barclay in Allen *et al* 2013, 120), Runnymede Bridge (Longworth and Varndell 1996, 100-105), and the causewayed enclosure at Yeoveney Lodge, Staines (Robertson-Mackay 1987, 76 and 84). Finger-pressed 'dimpled' rims were present at Kingsborough K1 (Gibson and Leivers 2008, fig 7 P145) and Yeoveney Lodge, Staines (Robertson-Mackay 1987, fig 43, P76 and fig 49, P149), while fingertip impressions below the rim, as seen at Principal Place (<P 1>), are present amongst the assemblages at the Eton Rowing Course (Barclay in Allen *et al* 2013, 147, Fig 5.36, no 199) and Kingsborough K2 (Gibson and Leivers 2008, fig 9 no. 3) and more generally on Ebbsfleet Ware itself (eg Burchell and Piggott 1939).

Lugged vessels (cf <P 5>) are well represented in Early Neolithic assemblages and include both perforated and unperforated examples. In the middle and lower Thames lugged vessels are present at, for example, Yeoveney Lodge, Staines (9 examples; Robertson-Mackay 1987, 88), Terminal 5 Heathrow (4 examples; Leivers *et al* 2010, 6, no 27) and Kingsborough K1 and K2 (5 examples; Gibson and Leivers 2008, 246), although none were recorded at Orsett (Kinnes 1978, 263). Rows of pre-firing perforations of invariably small diameter are another common element and considered to be decorative at Staines (Robertson-Mackay 1987, 88), Spong Hill (Healy 1988, 68) and Terminal 5, Heathrow (Leivers *et al* 2010, 6). Multiple examples were recorded at Kingsborough K1 and K2 (14 examples; Gibson and Leivers 2008, 246 and fig 7 P104), Hurst Fen (7 examples; Clark *et al* 1960, 239 and fig 21 P23–P26) and the Eton Rowing Course site (Barclay *et al* 2013, 111 and 133, fig 5.27 P37, and 135, fig 5.28 P54).

The bifurcated impressions on the shoulder of the closed vessel (<P 9>) were possibly made either with the cloven hoof of a roe deer neonate, a small lamb/kid, or a piglet (Alan Pipe pers. comm.). These are without close parallel, though their positions recall the finger impressions below the rim on <P 1> and the deep pits in the necks of Peterborough Ware. Vessels with such atypical decoration are rare but not unknown within Early Neolithic assemblages, as at the Stumble (Brown 2013, 49), for example. Of the three possible identifications listed above, roe deer faun seems the most likely, though not conclusively so. After red deer, roe are the second most frequent wild species recorded in the Early Neolithic faunal record (Serjeantson 2011, 42). Fauns are usually born in May/June but have a high mortality rate and are often left unattended in long grass at the woodland edge to protect them from predators during the day.

The uses to which the various vessels were put is set out in detail below, but here it can be noted that the refiring of some sherds, including many apparently basal pieces, suggests that cooking was achieved by standing the vessels directly in the hearth embers. Nearly 25% of all sherds in pit [5422] were so affected – a figure that compares with those from Kilverstone Areas E, B, and I (27%, 41% and 19%, respectively) (Knight 2006, 31–2). At Kilverstone the refitting of fresh, abraded and burnt sherds suggested that the transformation must have occurred post-breakage but prior to deposition. Similar occurrences were noted in the midden deposits at Eton Rowing Course (Barclay *et al* 2013, 110).

ORGANIC RESIDUE ANALYSIS OF THE PRINCIPAL PLACE EARLY NEOLITHIC POTTERY

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Organic residue analysis has long contributed to a wide range of archaeological questions relating to production, use and technological change in vessels, resource acquisition and exploitation, trade and exchange, but is most notable for its contribution to elucidating prehistoric diet and subsistence practices, and in the reconstruction of animal management practices worldwide (Evershed 2008; Roffet-Salque *et al* 2017). A combined molecular and isotopic approach allows the identification of terrestrial animal fats as proxies for carcass processing and secondary product exploitation (Evershed *et al* 1997a; Dudd and Evershed 1998; Mottram *et al* 1999; Copley *et al* 2003), aquatic products (Copley *et al* 2004, Hansel *et al* 2004; Craig *et al* 2007; Hansel and Evershed 2009; Cramp and Evershed 2014), plant oils and waxes denoting vegetable and plant oil consumption (Evershed *et al* 1991; Dunne *et al* 2016) and beeswax, resins, tars and bitumen (Charters *et al* 1993; Evershed *et al* 1997b; Urum-Kotsou *et al* 2002; Stern *et al* 2008; Brettell *et al* 2014; Roffet-Salque *et al* 2015), used in a wide range of technological and cultural activities.

Results

Lipid analysis and interpretations were performed using established protocols described in detail in earlier publications (eg Dudd and Evershed 1998; Correa-Ascencio and Evershed 2014). A selection of Early Neolithic sherds (*n*=32, including sherds from 16 vessels and 12 unattributed body sherds) comprising fragments of bowls and smaller cups from each of the four pits were selected for analysis (PPL11 Data Table 2). The lipid recovery rate was extremely high at 94% (*n*=29 sherds, 14 vessels and 11 unattributed body sherds), which compares favourably to sherds investigated from other Southern British Neolithic sites, although a similarly high level of lipid preservation is observed at sites in Scotland (89% on average) and on the island of Ireland (*c*.90%), probably due to acidic soils that inhibit the leaching of lipids into the surrounding groundwater (Cramp *et al* 2014; Smyth and Evershed 2015).

The mean lipid concentration from the sherds was 1.6 mg g^{-1}, with a maximum lipid concentration of 16.6mg g^{-1}. A number of the potsherds contained high concentrations of lipids (eg PPL005, 4.1mg g^{-1}, PPL008, 3.0mg g^{-1}, PPL010, 5.1mg $g^{-1,}$ PPL019, 7.1mg g^{-1} and PPL020, 3.7mg g^{-1}), demonstrating excellent preservation. This probably indicates that these were vessels that were subjected to sustained use in the processing of high lipid-yielding commodities. To date, analysis of the total lipid extracts of the 29 sherds, using GC and GC-MS, all contained sufficient concentrations (>5µg g^{-1}) of lipids that can be reliably interpreted (Evershed 2008). These comprised lipid profiles that demonstrated free fatty acids, palmitic (C_{16}) and stearic (C_{18}), typical of a degraded animal fat (Fig 8a and b), were the most abundant components (Evershed *et al* 1997a; Mottram *et al* 1999).

Fig 8 Partial gas chromatograms of trimethylsilylated FAMEs from (upper) PPL002 (<P 1> decorated bowl, Fig 5) and (lower) PPL014 (<P 5> lugged plain bowl, Fig 6); circles, n-

alkanoic acids (fatty acids, FA); triangles, mid-chain ketones; IS, internal standard, C_{34} n-tetratriacontane.

Extracts from all sherds, aside from PPL008, PPL018 and PPL022, include a series of long-chain fatty acids (in low abundance), containing C_{20} to C_{28} acyl carbon atoms (Fig 8a and b). It is thought these LCFAs probably originate directly from animal fats, incorporated via routing from the ruminant animal's plant diet (Halmemies-Beauchet-Filleau *et al.* 2013; 2014). Significantly, in five sherds (three vessels PPL006 (<P 4>), PPL014 and PPL032 (<P 15>), PPL023 (<P 15>) and body sherd PPL027; Fig 8b) odd carbon number ketones were present ($C_{31:0}$, $C_{33:0}$ and $C_{35:0}$, blue triangles), often in high abundance. Experimental analysis has shown these ketones, found in a monomodal distribution, originate from the pyrolysis of acyl lipids and ketonic decarboxylation reactions which occur in unglazed ceramic vessels during cooking, when the temperature exceeds 300°C. These ketones are thought to accumulate gradually with repeated use (Evershed *et al* 1995; Raven *et al* 1997), suggesting that these vessels were used for the sustained processing of animal products.

Analyses of surface or 'burnt-on' residues, evidence of cooking failures, found on PPL016 and PPL018 (PPL11 Data Table 2), also identified palmitic (C_{16}) and stearic (C_{18}) acids, together with a series of long-chain fatty acids (in low abundance), containing C_{20} to C_{26} acyl carbon atoms, probably originating directly from animal fats (Halmemies-Beauchet-Filleau *et al* 2013; 2014)

GC-C-IRMS analyses (PPL11 Data Table 2) were carried out on the sherds (*n*=29) and the surface residues (*n*=2) to determine the $\delta^{13}C$ values of the major fatty acids, $C_{16:0}$ and $C_{18:0}$, and ascertain the source of the lipids extracted, using the $\Delta^{13}C$ proxy. The $\delta^{13}C$ values of the $C_{16:0}$ and $C_{18:0}$ fatty acids reflect their biosynthetic and dietary origin, allowing non-ruminant and ruminant adipose and ruminant dairy products to be distinguished (Dudd and Evershed 1998; Copley *et al* 2003). Here, ten sherds from seven vessels (PPL002 and PPL007 (<P 1>), PPL003 (<P 3>), PPL006 (<P 4>), PPL009 (<P 10>), PPL014 and PPL032 (<P 5>), PPL019 and PPL020 (<P 12>), PPL024 (<P 16>)) and two body sherds (PPL004, PPL011) (*n*=12 sherds, 41%, Fig a) plot within the dairy reference ellipse, suggesting these vessels were solely used to process dairy products. A further six extracts from one vessel and five body sherds (PPL022 (<P 14>), PPL016, PPL018, PPL026, PPL028, PPL031) (*n*=6, 21%, Fig 9a) plot just outside the dairy ellipse, indicative of some mixing of animal products in prehistory, although it is likely that they were predominantly used to process milk products. These data suggest clear vessel specialisation with 62% of vessels being used to mainly process dairy products. Furthermore, the two ‘surface’ or ‘burnt-on’ residues (from body sherds PPL016 and PPL018) plot very closely to their respective absorbed lipid δ^{13}C values, with both plotting just outside the ruminant dairy ellipse, confirming the vessel or vessels were almost wholly used to process dairy products.

Fig 9 Graph a (upper) shows δ^{13}C values for the $C_{16:0}$ and $C_{18:0}$ fatty acids for archaeological fats extracted from Principal Place Neolithic ceramics, with δ^{13}C values for the $C_{16:0}$ and $C_{18:0}$ fatty acids for archaeological fats extracted from surface residues on PPL016 and PPL018 shown in red; the three fields correspond to the P = 0.684 confidence ellipses for animals raised on a strict C_3 diet in Britain (Copley et al 2003); each data point represents an individual vessel. Graph b (lower) shows the Δ^{13}C ($\delta^{13}C_{18:0} – \delta^{13}C_{16:0}$) values from the same potsherds or surface residues; the ranges shown here represent the mean ± 1 s.d. of the Δ^{13}C values for a global database comprising modern reference animal fats from Africa (Dunne et al 2012), UK (animals raised on a pure C3 diet) (Dudd and Evershed 1998), Kazakhstan (Outram et al 2009), Switzerland (Spangenberg et al 2006) and the Near East (Gregg et al 2009) published elsewhere.

Lipid extracts from two vessels and one body sherd (PPL005 (<P 3>), PPL012 (<P 6>) and PPL015) (*n*=3, 10%, Fig 9a) plot within the ruminant adipose ellipse, suggesting those vessels were used solely to process ruminant carcass products, with a further vessel and a body sherd (PPL021 (<P 13>) and PPL017) (*n*=2, 7%) plotting either just on or outside the ruminant carcass ellipse, indicative of some minor mixing of animal products in prehistory, although it is likely that they were predominantly used to process ruminant carcass products. In total, three vessels and two body sherds (17%) were used to process ruminant carcass products. Finally, four vessels (PPL001 (<P 1>), PPL008 (<P 9>), PPL010 (<P 11>), PPL023 (<P 15>) and two body sherds (PPL027, PPL029) (total 21%) plot between the ruminant (cattle, sheep or goat) and non-ruminant (pig) adipose product ellipses, suggesting some mixing of these animal products, although at minor levels. Interestingly, no vessels were dedicated solely to porcine product processing.

Ruminant dairy fats are differentiated from ruminant adipose fats when they display Δ^{13}C values of less than −3.1 ‰, known as the universal proxy (Dunne *et al* 2012; Salque 2012). Significantly, lipid residues from a total of 18 sherds (11 sherds from eight vessels and seven body sherds) plot within the ruminant dairy region (Fig 9b) confirming that these vessels were used to process dairy products, such as milk, butter, and cheese. The two 'surface' or 'burnt-on' residues (PPL016, PPL018), had $\Delta^{13}C$ values of −3.6 ‰ and −3.6 ‰, respectively; this is in good agreement with the $\Delta^{13}C$ values of the absorbed residues from the same sherds at −3.2 ‰ and −3.5 ‰, respectively. Eight sherd extracts plot within the ruminant adipose region with two further vessels plotting on the borderline between ruminant and non-ruminant adipose, although both were predominantly used to process ruminant products (in total, seven vessels and three body sherds). The one remaining body sherd plots on the borderline between dairy and ruminant adipose (Fig 9b).

Compound-specific radiocarbon analyses

Compound-specific radiocarbon analyses of organic residues extracted from archaeological pottery sherds were performed using protocols described in detail in recent publications (Casanova *et al* 2017; 2018; 2020). Here, we report compound-specific radiocarbon measurements on absorbed food lipids extracted from five vessels and one body sherd.

All radiocarbon determinations were performed on a MICADAS AMS (Synal *et al* 2007) by the Bristol Accelerator Mass Spectrometer (BRAMS) facility at the University of Bristol. Data reduction was performed using the software package BATS (Wacker *et al* 2010) and measurements on fractions of different fatty acids from the same sherd were combined as described by Casanova *et al* (2020). The chronological modelling was undertaken using OxCal v4.2 (Bronk Ramsey 2009) and the currently internationally agreed radiocarbon calibration curve for the northern hemisphere, IntCal20 (Reimer *et al* 2020).

Absorbed $C_{16:0}$ and $C_{18:0}$ fatty acids extracted from five sherds of undecorated bowls (PPL05 (<P 3>), PPL010 (<P 11>), PPL012 (<P 6>), PPL015, PPL020 (<P 12>) and one sherd from a plain cup PPL021 (<P 13>) were dated; of these, four vessels provided radiocarbon results that pass the quality assurance criteria employed to ensure accurate dating (Table 3; Casanova *et al* 2020). Two vessels represented by only single sherds (PPL012, <P 6> and PPL015) come from pit [5375]. The combined results on these two sherds are not statistically consistent (T'=23.6, T'(5%)=3.8, ν=1; Ward and Wilson, 1978). PPL012 <P6> is clearly residual, and PPL015 provides a *terminus post quem* for the cutting of pit [5375] of 3635–3380 cal BC (95% confidence; BRAMS-2479; Reimer *et al.* 2020; Stuiver and Reimer 1986). The other two vessels represented by multiple refitting sherds from <P 12> (PPL020) and a single sherd from <P 13> (PPL021), come from pit [5422]. The combined results on these two samples are also not statistically consistent (T′=5.6, T′(5%)=3.8, ν=1; Ward and

Wilson 1978). In this case, PPL021 is probably residual and PPL020, since it comes from a vessel that is represented by multiple conjoining sherds, provides a date for the cutting of pit [5422] of 3520–3360 cal BC (95% confidence; BRAMS-2483; Reimer *et al.* 2020; Stuiver and Reimer 1986). It should be noted that the combined measurements from PPL015 and PPL020 are also not statistically consistent (T′=7.0, T′(5%)=3.8, ν=1; Ward and Wilson 1978), which means either that pits [5375] and [5422] are not contemporary or, perhaps more likely, that worn sherd PPL012 is also residual and both pits date to the time when PPL020 was deposited. Unfortunately, the sherds from pits [5371] and [5377] did not produce radiocarbon measurements that pass the quality assurance criteria employed in this study and so are undated by radiocarbon. The presence of conjoining sherds from vessel <P 1> in both features, however, strongly implies that they were contemporary. If the fragments of polished flint axe, three from pit [5371] and one from pit [5422], are from the same object, then it is also possible that all four Neolithic pits were cut in one episode. In the absence of radiocarbon dates on samples that were undoubtedly freshly deposited in each pit, however, this can only be suggested, not demonstrated.

Table 3 Radiocarbon determinations on lipids extracted from pottery vessels from Principal Place.

The range of dates of the sherds from pits [5375] and [5422], and the presence of clearly earlier material in both features, raises the question of the source of the artefacts deposited in these pits. On the basis of the refitting sherds from vessels <P 1>, <P 5> and <P 12>, some of the material was probably freshly deposited in the pits, although there are clearly also sherds from earlier vessels. One possibility is that the material deposited was drawn both from assemblages in contemporary use and from artefacts that had previously been deposited in middens.

Fig 10 places the combined dates for the four sherds that produced reliable measurements from Principal Place in a chronological model for the currency of vessels in the Plain Bowl and Decorated Bowl traditions from the Thames Gateway (from Thanet to the Blackwater Estuary and upriver as far as Staines/Eton, including sites from tributaries such as the Medway and Lea) (PPL11 Data Table 3). Only radiocarbon dates directly associated with the relevant ceramics have been included (Table S2), and dates from samples that may have an old-wood offset have been modelled using the charcoal outlier model proposed by Dee and Bronk Ramsey (2014; Outlier Model (“Charcoal”, Exp (1-10, 0), U (0,3), “t”).

Equivalent models for the currency of Carinated Bowl and Peterborough Ware in the same area are provided in Supplementary Information (Figs S1 and S2). Modelled date ranges are given *in italics* in the text and tables, with calibrated radiocarbon date ranges in normal type.

Fig 10 Probability distributions of dates associated with the use of early Neolithic Plain and Decorated Bowl pottery in the Thames Gateway. Each distribution represents the relative probability that an event occurs at a particular time. For each date, two distributions are plotted: one in outline, which is the result of simple radiocarbon calibration, and a solid one, based on the chronological model used. Distributions other than those relating to particular samples correspond to aspects of the model. The large square brackets down the left-hand side, along with the OxCal keywords, define the overall model exactly.

Further, the pits from Principal Place are put in their contemporary, regional context in Fig 11. This provides a schematic illustration of the currency of different ceramic types derived from the models defined in Fig 10 and Figs S1 and S2, and compares this to key parameters from monuments, timber structures, and other activity that occurred in the Thames Gateway in the early and mid-fourth millennium cal BC (PPL11 Data Table 4).

Fig 11 Schematic diagram illustrating the periods of use of different ceramic types in the Thames Gateway in the early and middle fourth millennium cal BC (derived from the models defined in Figs 10, S1 and S2), and key parameters of dates associated with other contemporaneous activity. Distributions derive from the models defined by Whittle et al *(2011; fig 7.6 (St Osyth), fig 7.15 (Kingsborough), fig 7.17 (Kingsborough 2), fig 7.26 (White Horse Stone), fig 7.27 (Coldrum), fig 8.3 (Staines), and fig 8.5 (Eton Wick)) reprogrammed in OxCal v4 and recalculated using IntCal20, except for those for Chalk Hill (Clark* et al *2019, fig 46, recalculated using IntCal 20), Orsett (Fig S3), and for the wooden structures from Belmarsh, the Olympic Park, and Runnymede Bridge Area A (Figs S4 and S5). Other distributions are calibrated radiocarbon dates (Stuiver and Reimer 1993).*

Discussion

The Principal Place ceramic assemblage provided a unique opportunity for a programme of organic residue analysis, using a combined molecular and isotopic approach, to determine whether absorbed food residues could be extracted from these Neolithic ceramic vessels. In the event the assemblage yielded the highest known lipid recovery (94%) retrieved to date from a British Neolithic site. The results, determined from GC, GC-MS and GC-C-IRMS analyses, demonstrate that 18 sherds (62% of lipid-containing extracts, 11 sherds from eight vessels and seven body sherds), with $\Delta^{13}C$ values of less than −3.1 ‰, were routinely used to process dairy products, such as milk, butter, and cheese. This is comparable to a study of 438 potsherds from six southern British Neolithic sites, where dairy products were observed in approximately 57% of the lipid-containing extracts and 25% of all the sherds, although this varied across sites (Copley *et al* 2005). These sites include domestic and non-domestic contexts (causewayed enclosures) and it seems that generally higher abundances of dairy product processing are noted at domestic sites. An overwhelming predominance of dairy product processing (80%) was associated with Neolithic pottery throughout the north-east archipelago of the British Isles (Cramp *et al* 2014) and from the island of Ireland (89%; Smyth and Evershed 2015).

Extracts from a further ten sherds suggest these were used routinely to process mainly ruminant animal carcass products, with one sherd belonging to a vessel used to process both ruminant and minor amounts of non-ruminant (porcine) products. However, no vessels were used solely to process the latter. The overall absence of pig product processing at Principal Place is comparable to results from the Eton Rowing Course and Hambledon Hill (Copley *et al* 2005), although this might suggest that porcine products were processed in other ways (eg, spit roasting).

Interestingly, two sherds from <P 1> (PPL002 and PPL007) display $\Delta^{13}C$ values of −5.0 and −4.3 ‰, respectively (denoting dairy product processing), whereas sherd PPL001, from the same vessel, has a $\Delta^{13}C$ value of −1.0 ‰, suggestive of ruminant carcass product processing. This raises the possibility of the secondary use of broken vessels in the Neolithic. For example, the pot may have been used to process dairy products and once broken, a slab was ‘recycled’ to burn animal tallow, possibly as some sort of lamp. Alternatively, the vessel was used for cooking ruminant adipose products (beef or sheep meat); then, once broken, one of the remaining parts of the pot was used as a spoon, scoop, or bowl for dairy products (milk, butter, or cheese).

As discussed, the pottery comprises Plain Bowl and Decorated Bowl of Early Neolithic type, consisting of thin-walled medium-sized open/neutral bowls, together with several smaller open bowls/cups. There does not appear to be any relationship between vessel types and commodities processed; for example, both the Decorated and Plain bowls were used to process dairy products (n=3 Decorated, n=15 Plain) and ruminant adipose (n=2

Decorated, n=8 Plain). A Plain Bowl with a rolled rim <P 11> was used to process mixed ruminant and minor amounts of non-ruminant (porcine) products.

The new statistical model (Fig 10) places the Principal Place material within the Plain Bowl and Decorated Bowl pottery tradition of the Thames Gateway. The dates indicate that the pottery was used over a relatively lengthy period spanning the middle centuries of the fourth millennium cal BC, although it may have been deposited in the pits from which it was recovered in *3520-3435 cal BC (95% probability; BRAMS-2483;* Fig 10). There is little doubt that the compound-specific dating of absorbed lipids represents something of a game changer for British prehistoric ceramic studies. It offers a way forward to researchers looking at the directional spread and chronological development of certain pottery styles and promises to provide reliable chronologies at sites where other organic material does not survive or is demonstrably intrusive, as at Principal Place.

B. STRUCK FLINT

Jonathan Cotton

A combined total of 200 pieces of struck flint was recovered from the four Early Neolithic pits (Table 4; Fig 12). Of this, 120 pieces came from pit [5375], 62 from pit [5422], 15 from pit [5371] and three from pit [5377] (Fig 2). A further 14 pieces were recovered from other contexts to the north; these include a handful of post- and stake-holes and the brickearth deposit into which they had been driven.

The assemblage is in feather-sharp condition with no hinge or step terminations or signs of surface re-cortication; none had been burnt. The raw material mostly comprises water-rolled flint cobbles presumably obtained from the local terrace gravels and river foreshores. Nearly a quarter of the total is made up of Bullhead Bed flint with its characteristic greenish cortex and orange sub-cortical band. This too would have been locally obtained. At least four fragments of opaque pale grey flint struck from one or more polished flint axes may have a more distant origin.

Table 4 Struck flints from the four Neolithic pits; the total (n=200) represents 93% of the struck flint recovered from the site.

Fig 12 Early Neolithic flint <F 1>–<F 11> from the pits and brickearth deposit [5226] at Principal Place (catalogued in Appendix 1) (scale 1:2).

The modest lithic assemblage is dominated by debitage in the form of unmodified flakes, narrow blade-like flakes, spalls (<10mm), a single core rejuvenation tablet and irregular knapping waste. No usable cores were present; these had presumably been removed for further reduction elsewhere. Many of the blanks are small and the high number of spalls (>45% of the assemblage) is probably accounted for by the 100% sampling of the pit fills. Tools are few but comprise two short end scrapers improvised on secondary flakes <F 2> and <F 6>, together with four micro-denticulates on broken blade-like flakes <F 4>, <F 9>, <F 10> and <F 11>. In addition, several pieces show macroscopic traces of marginal use wear: these include a broad flake detached from a polished flint axe <F 1> from the fill of pit [5371].

The Bullhead Bed flint appears to have been preferentially selected for the production of narrow blade-like flakes; the single core-rejuvenation tablet <F 7> is of this material too. Moreover, it is possible that the four fragments of polished flint axe of pearl-grey flint, three from pit [5371] and a fourth <F 5> from pit [5422], originated from the same artefact. Several other pieces of opaque grey flint from pits [5371] and [5375] are seemingly of axe quality but lack the tell-tale areas of surface polish.

C. ENVIRONMENTAL MATERIAL

Alan Pipe and Karen Stewart

In addition to the pottery and struck flint, a range of environmental data was retrieved from the sieved samples taken from the four Early Neolithic pits. This comprised small assemblages of animal bone, unattributable burnt bone, mollusca and charred archaeobotanical remains composed of unidentified wood charcoal and seeds. The attributions listed in the Tables below are based on those contained within the initial assessments: no detailed analyses were undertaken. Given the clear presence of medieval cereal grains in these deposits (Table S1), some or all this material may be intrusive.

Small quantities of fragmented animal bone were present in pits [5370], [5376] and [5421] (Table 5). Most comprised pieces of otherwise unidentifiable medium sized mammal bone, together with common periwinkle (*Littorina littorea*) from [5374] (sample {515}) and low numbers of fish bones from [5370], [5376] and [5421], one of which (sample {518}) was identified as a cod (family) vertebra. The presence of cod in an Early Neolithic context is intriguing as it is a deep-sea marine fish. It could represent a line caught individual, though the rarity of any fish (freshwater or marine) in Neolithic contexts is now well attested (eg Serjeantson 2011, 47-49). That said a cod vertebra associated with Ebbsfleet Ware sherds was present at the eponymous Ebbsfleet site itself (Wenban-Smith *et al* 2020, 357–9, Pl 21.4). Fish bones retrieved from samples taken from the Early Mesolithic site on the river Colne at Three Ways Wharf, Uxbridge included both herring and cod and were regarded there as intrusive (Lewis with Rackham 2011, 29-30), and – given the demonstrably intrusive cereal grains from Principal Place – this is on balance also likely to be the case here.

Table 5 Animal bone and mollusca from samples {516}-{518}.

Five contexts containing burnt bone were identified at assessment: these comprised the four Neolithic pits and Roman cremation burial [5372]. Only small quantities of burnt bone were present in the Neolithic pits, each with a total weight of less than 10 grams (Table 6). The bone was heavily fragmented and lacked identifiable morphological features, making it impossible to determine whether it was of animal or human origin.

Table 6 Summary of the burnt bone from samples {515}-{518}.

Charred botanical samples were retrieved from each of the four Neolithic pits and comprised low concentrations of unidentified wood charcoal along with occasional charred seeds and grains (Table 7). Charred grains of free-threshing wheat (*Triticum aestivum*) and barley (*Hordeum* sp) from Neolithic pit [5421] (sample {518}) returned radiocarbon dates that fell within the 13th century AD, confirming that all were intrusive (Table 8). This occurrence has been widely observed (eg Pelling et al 2015), though many such instances date to the Middle rather than the Early Neolithic (eg Powell et al 2015, 297; Roberts and Marshall 2020, 25-6 and Table 11). Charred seeds of fumitory (*Fumaria* sp) were also present in pit [5370] (sample {516}) alongside free-threshing wheat (*Triticum* sp). Fumitory is a scrambling weed of broken ground which could fit within an Early Neolithic context, though its association here with free-threshing wheat suggests that it too may be intrusive.

Table 7 Summary of botanical remains from samples {515}-{518}.

Table 8 Radiocarbon dates from charred grains in pit [5421].

CONCLUSION: PRINCIPAL PLACE AND ITS EARLY NEOLITHIC CONTEXT

Jonathan Cotton

Principal Place lies within the Walbrook valley, just outside the Roman and modern City of London. Previous work has drawn attention to the attritional level of Roman and later truncation and has sought to reconstruct a prehistoric topographic template for the area later occupied by Londinium and its immediate hinterland (Holder and Jamieson 2003). While still evolving and in many respects deficient, these data do allow the site to be placed within a broad landscape setting (Fig 13).

Fig 13 A distribution map of Neolithic finds and features in and around the City of London (after Merriman 1987; Holder and Jamieson 2003; with additions), showing a 'best-estimate' approximation of the Neolithic topography including minor tributary streams, with the floodplain based on the modelled surface of the Pleistocene gravel and 'dryland' derived from the Environment Agency LIDAR digital terrain model, where the 12 m contour roughly approximates the edge of the Taplow Gravel Terrace (contains public sector information licensed under the Open Government Licence v3.0) (scale 1:30,000).

Immediately north of the area occupied by the Roman town, the Walbrook valley took the form of a shallow basin drained by a network of subsidiary streams. It was in or close to this shallow basin and adjacent to an active stream channel that the Early Neolithic activity was focused (Fig 2). Work at Liverpool Street Station some 500 m to the south recorded Roman flooding and truncation episodes relevant to understanding the taphonomy of the Principal Place deposits (Ranieri and Telfer 2017, 46–50). Although samples taken from low down in channel deposits here were only broadly datable to the later prehistoric period (Virgil Yendell, pers. comm.), these contained plant types that grow in or near fresh water, including rushes and crowfoots, together with low levels of charcoal likely to indicate anthropogenic activity, while scaraboid dung-beetles suggested the presence of grazing herbivores (Ranieri and Telfer 2017, 48–9). Work on several other sites further down the Walbrook indicates that during later prehistory the middle section of the valley was dominated by open lime woodland on the valley sides, with mixed oak/hazel on the lower slopes and alder in the valley floor (eg, Hill and Rowsome 2011, 254–6). This broadly corresponds with the wider emerging regional picture (eg Stastney *et al* forthcoming).

The small group of Early Neolithic pits located at Principal Place invites comparison with pit-dominated East Anglian sites, such as those at Hurst Fen in Suffolk and Spong Hill and Kilverstone in Norfolk (Garrow *et al* 2006, 82–3). The significance of pit deposits has been widely debated (eg, Anderson-Whymark and Thomas 2012) with a range of explanations offered, many going ‘beyond the mundane’. At Principal Place there is no compelling evidence to indicate that any of the buried material was specially selected for deposition, however; rather it seems to represent a random accumulation of variably worn pottery and struck flint generated by quotidian activity (as Saville 2002). This is not to deny a spiritual, customary, or performative motivation behind the physical acts of digging and infilling the features: such acts could simply have been a normal and unquestioned feature of everyday living.

The linear arrangement of the Principal Place features (Fig 2) may be compared with sites such as Kilverstone, where the disposition of multiple pits suggested successive rather than simultaneous episodes, although the incorporation of fragments of the same vessels in each was taken to indicate that they had been drawn from a common source (Garrow *et al* 2006, 76). The undifferentiated nature of the pit fills at Principal Place and the presence of a mix of variously sized and worn sherds, including substantial conjoining fragments of individual vessels spread across several pits could indicate that here too the fills were drawn from a pre-existing source or sources such as occupation surfaces, or middens that had accumulated over a relatively extended period (as Needham and Spence 1997). No physical traces of these posited pre-pit sources survived or could be expected to survive, however, as such fragile and ephemeral deposits would have been highly susceptible to seasonal flooding within the valley floor (for which there is good evidence at the Crossrail Broadgate/Liverpool Street Station site further downstream (Ranieri and Telfer 2017)), as well as to disturbance during the development of the area as a Roman cemetery – a point reinforced by the re-deposition of the Early Neolithic sherds in Roman cremation [5373].

Whether the pits were associated with other structures remains an open question. It is possible that the various post- and stake-holes cutting into the surviving expanses of brickearth to the north may be relevant here (Fig 2), although these are not closely dateable, and no meaningful distribution pattern could be discerned either. Pits and house structures are sometimes found together but nothing approaching such a structure was noted at Principal Place, and it may be that it was a long-established midden that drew people cyclically to the spot, as has been argued for the midden deposits at Eton Rowing Course (Allen *et al* 2013, 497–8). The close juxtaposition of the pits rather suggests that they were at least broadly contemporary with one another, if backfilled with a range of earlier material drawn from elsewhere. As such they may have marked the periodic (re)commencement of activity, punctuated episodes of use, or represented acts of closure. Significantly, the latest radiocarbon date (BRAMS-2483; Fig 10) derives from a vessel represented by multiple sherds (PPL020 <P 12>), one of two dated from pit [5422], while an earlier date (BRAMS-2479) was returned from worn singleton PPL012 (<P 6>). This suggests that the latest deposition in the pits is likely to be most reliably dated by vessels comprising multiple refitted sherds and not by worn singletons, and secondly could be taken to support the suggestion that the ceramics derived from a pre-pit source.

Turning to the contents of the pits themselves, the ceramics were probably manufactured using locally available raw materials as at Blackwall (Vince 2008), although the homogenous nature of the local geology means that no specific clay source(s) could be identified. The pottery comprises Plain Bowl and Decorated Bowl and includes elements with early Peterborough Ware traits. Fig 10 shows that all the PPL11 dates fit very happily within the currency of Bowl pottery and that, if we are correct in interpreting the pits as a single event best dated by BRAMS-2483, then this falls at the transition to Ebbsfleet Ware. This radiocarbon date offers a plausible horizon for the transition, though it was obtained from a ceramically ‘early-looking’ vessel <P 12> (Alistair Barclay pers. comm.).

Decorative novelty is to be expected amongst these Early Neolithic assemblages, as Healy (1988, 71) and others have pointed out, but the repetitive use of a small, bifurcated hoof to create impressions on the shoulder of vessel <P 4> – if correctly identified as such – seems to be unique. Whether roe deer faun, young sheep/goat, or piglet remains an open question, though the former is here considered the likeliest (Alan Pipe pers comm). Roe deer are the second most frequent wild species recorded in Early and Middle Neolithic faunal assemblages after red deer (eg, Serjeantson 2011, 42). At the Coneybury Anomaly a mixed faunal assemblage dominated by domesticated cattle and wild roe deer was interpreted as the outcome of a meeting between local farmers and hunter-gatherers (Gron *et al* 2018).

Fig 14 Selected Early Neolithic sites in the middle and lower Thames (scale 1:800,000).

The lipid recovery rate at Principal Place compares favourably with that of other contemporary assemblages. There is clear evidence in over 90% of the samples for the processing of dairy products such as milk, butter, and cheese, and for the processing of ruminant products from cattle and sheep. In this respect it conforms to the picture emerging from other sites further up the Thames valley (Copley *et al* 2005). There does not appear to be any correspondence between vessel types and the uses to which they were put, however, and some of the vessels had probably seen repeated use. Despite the presence of non-ruminant (porcine) products recovered from one sherd, no vessels were used solely to process the latter. This compares with the assemblages from Eton Rowing Course and Hambledon Hill (Copley *et al* 2005) and might suggest that porcine products were being processed in other ways, such as spit roasting. That said, pig is not generally well represented within Early Neolithic faunal assemblages compared to cattle (eg Serjeantson 2011, 28).

The Principal Place lipid data are particularly welcome in view of the paucity of good faunal assemblages from the region, excepting the midden assemblages from Runnymede (where pig *is* present in some quantity, eg Serjeantson 2006, 118–9) and the Eton Rowing Course (Needham and Trott 1987; Allen *et al* 2013). The presence of dairy products and ruminant adipose fats suggests an economic strategy incorporating a mixed meat/fat and milk output (as Copley *et al* 2005, 528). Grains of free-threshing wheat from pit [5422] were taken to be intrusive as only hulled varieties were available in the Neolithic, and this was confirmed by radiocarbon dates that centred on the later 13th century AD (Table 8). Intriguingly this phenomenon has been repeatedly noted elsewhere in relation to Middle Neolithic pits (eg Roberts and Marshall 2020, Table 11), where the absence of cereals has been interpreted as representing a significant decline in arable agriculture later in the Neolithic. Local Early Neolithic communities were certainly cultivating cereals, however, for charred chaff has been recovered from Blackwall (Robinson 2008, 228–9) together with a cache of emmer wheat and chaff from Woolwich Manor Way at East Ham on the A13 (Pelling 2012, 250). Moreover, cereal impressions on Early Neolithic sherds have been recorded locally at Launders Lane, Rainham (Howell *et al* 2011, 34) and from the Thames foreshore at Vauxhall (Milne *et al* 2011, 288).

The accompanying lithic assemblage also reflects the exploitation of local resources, with Bullhead Bed flint seemingly preferentially selected for blades and narrow flakes. This type of flint is well represented at other Early Neolithic sites within the middle and lower Thames (eg Cramp and Leivers 2010, 11; Bishop *et al.* 2017, 18–19; Butler and Leivers 2008, 253). Moreover, its distinctive greenish cortex is readily identifiable in the hand and the colour may have been particularly resonant for Neolithic communities – many of whose stone axes derived from rock sources of greenish hue, including the Alpine jades and Groups

I (Cornwall, Mounts Bay) and VI (Great Langdale). Opaque pearl grey flint seems to have been preferred for polished axes at this time, and the four flakes from two of the Principal Place pits could well derive from a single implement. A mined, possibly South Downs origin for this type of flint has been suggested (eg, Bradley 2015, 182) – although other unlocated surface sources may also have been exploited (eg, Whittle *et al* 2011, 783–4).

The Principal Place pit group joins an expanding range of Early Neolithic sites in the middle and lower Thames (Fig 14), many of which are now secured by radiocarbon dates (see Fig 11). These point to a pioneering phase of activity characterised by Carinated Bowl pottery, followed by a broader based mature phase of interventions characterised, as at Principal Place, by Plain Bowl and Decorated Bowl pottery. Sites encompass the early grave at Blackwall (Coles *et al* 2008), midden deposits, house structures (eg, Barclay and Chaffey 2014) and wooden trackways (Hart 2015; Crockett *et al* 2002) alongside earthen monuments of varied size and form ranging from large causewayed enclosures (eg, Hedges and Buckley 1978; Robertson-Mackay 1987), to smaller horseshoe-shaped enclosures (eg, Ford and Pine 2003; Framework Archaeology 2006, 72–80) and ring ditches (eg, Carew *et al* 2006; Jones 2008; Howell *et al* 2011, 24–34). Finds of flint and stone axes (including several early jadeitite examples) from the Thames and its foreshores have long been a notable feature of the region too (eg, Lawrence 1929; Adkins and Jackson 1978), to which trove can now be added an independently dated alder wood club from Chelsea and several human crania from Putney (eg, Webber and Ganiaris 2004; Schulting and Bradley 2013, table 6; Stuart Wyatt pers. comm.). Excepting the early burials from Blackwall and from Coldrum in the Medway valley (Fig 11), most of the available dates fall later and within the mature Early Neolithic. Contrary to expectation these include the causewayed enclosures at Orsett, Staines, and Eton Wick, which appear to date to the 35^{th} century cal BC rather than the 37^{th} century cal BC (Alex Bayliss *pers comm*), and as such are broadly contemporary with the infilling of the Principal Place pits.

Historically, stratified prehistoric contexts from the area of Roman London and its immediate environs are few and Neolithic contexts even rarer (eg, Merriman 1987, 322–4 and fig 1; Holder and Jamieson 2003, 36 and illus 10). Principal Place is a notable first. Hitherto, only scraps of impressed Middle Neolithic Peterborough Ware have been recorded from within the Roman town and from several other locations on the north bank just beyond (eg, Thompson 2007; Powell and Leivers 2012, 27–9), along with small assemblages of struck flint, most of which appear to be residual in much later, often early Roman contexts.

Most eye-catching are a series of *ex situ* Neolithic flint and stone axes from Roman and later contexts just within and without the walled area (Celoria and Macdonald 1969, 34), to which can now be added a diminutive unsourced stone example from an early Roman context on the Bloomberg site in the middle Walbrook valley (Bowsher and Marshall 2013), and a polished flint axe from the medieval cemetery levels at Spitalfields some 250 m or so to the south east of Principal Place (Bradley 2002, SRP98 <2518>). Merrifield (1987, 9–16) argued plausibly that such objects circulated as protective amulets amongst Roman and later Londoners. The unexpected survival *in situ* of Early Neolithic pits in the upper Walbrook valley containing a pottery assemblage rich in absorbed lipids offers the first unequivocal evidence for the presence of Neolithic communities hereabouts and provides a firm background against which some of these *ex situ* pieces might be set.

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APPENDICES

Appendix 1 Catalogue of illustrated pottery (see ***Fig 5 Fig 6 Fig 7)***

See Table for ceramic concordance, including fabric identifications, condition and sampled sherds 'individual accession and sample numbers; all illustrated vessels sampled except <P 8>.

<P 1> [5370] (n=37, Wt 1418 g) and [5376] (n=24, Wt 623 g) <1807>
At least 61 sherds weighing 2041 g (nearly 32% of the entire assemblage) comprising substantial conjoining portions of a thin-walled (9mm) deep bag-shaped bowl *c.*200–220mm in diameter with a slightly incurving and finger-pressed rim, with a row of worn fingertip impressions just below. Traces of perfunctory external smoothing and wiping on the interior.

<P 2> [5370] <1808>
Single sherd of thin walled (7mm) open bowl with a concave neck and gently expanded rim. The sherd appears to have been overfired or refired.

<P 3> [5370] <1809>
Single sherd of neutral thick-walled (10mm) bowl *c.*280mm in diameter with externally thickened rim and traces of surface wiping.

<P 4> [5370] <1810>
Five non-conjoining sherds of thin-walled (6mm) S-profile open bowl with concave neck and gently carinated shoulder. Angled stab-and-drag decoration has been incised within zones of horizontal and vertical tooled lines applied with a rounded ?bone point on the exterior; the interior features two horizontal rows of angled stab-and-drag incisions at the rim.

<P 5> [5372] (Roman cremation burial fill) and [5374] <1817>
Multiple conjoining rim and body sherds of a thin walled (7mm) open bowl with a slightly beaded rim, concave neck and gently carinated shoulder, the latter emphasised by the addition of a low elongated unperforated lug. There are traces of a smoothed exterior surface and interior wiping.

<P 6> [5374] <1814>
Single sherd of a thin-walled (7–8mm) open bowl with an externally thickened square rim.

<P 7> [5374] <1815>
Single sherd of a small thin-walled (8mm) open hemispherical bowl/cup with a simple pointed rim.

<P 8> [5374] <1816>
Single small sherd of thin walled (7–8mm) open bowl with two small perforations (4mm in diameter) pierced through the base of the neck prior to firing.

<P 9> [5376] <1811>
Three non-conjoining sherds (body x 2, rim x 1) of a closed, thin-walled (7mm) bowl *c.*280mm in diameter with an expanded rim and rounded shoulder featuring a pair of deep

bifurcated impressions at the base of the neck below the rim. The impressions may have been formed using the cloven hoof of a stillborn animal such as a roe deer neonate (Alan Pipe pers. comm.).

<P 10> [5376] <1812>
Single sherd of a small open, thin-walled (6–7mm) bowl/cup with a simple slightly thickened rim *c.*180mm in diameter.

<P 11> [5376] <1813>
Two conjoining sherds of a thin-walled (9mm) open bowl *c.*260mm in diameter with an externally expanded, rolled rim.

<P 12> [5421] <1818>
Multiple sherds of a thin-walled (7mm) open bowl 250mm in diameter with a slightly beaded rim, concave neck and gently carinated shoulder (similar in form to **Error! Reference source not found.**> above but in a different fabric).

<P 13> [5421] <1819>
Single sherd of a thin walled (8mm) open hemispherical bowl/cup *c.*150mm in diameter with traces of external smoothing.

<P 14> [5421] <1820>
Single sherd of thin walled (7mm) upright/neutral bowl *c.*250mm in diameter with slight external thickening.

<P 15> [5421] <1821>
Single small sherd of closed bowl with externally expanded, rolled/flattened, rim.

<P 16> [5421] <1822>
Single sherd of thick walled (8–10mm) upright/neutral bowl with simple slightly thickened rim.

<P 17> [5421] <1823>
Two non-conjoining sherds of a thin walled (5–6mm) upright/neutral open bowl with a slightly expanded rim and a low ledge shoulder below.

Appendix 2 Catalogue of illustrated flint (Error! Reference source not found. Fig 11)

<F 1> <1859> [5370]
Large flake from a polished flint axe of opaque pearl grey flint with traces of edge wear/use at its distal end. L. 68mm; W. 37mm.

<F 2> <1860> [5374]
End scraper improvised on the distal tip of a narrow blade-like primary flake of semi-translucent grey-brown flint with thin water rolled grey cortex. L. 67mm; W. 26mm.

<F 3 <1861> [5374]

Robust snapped tertiary flake of semi-translucent smoky grey-brown flint (?Bullhead Bed) with traces of use wear along one margin. L. 50mm; W. 40mm.

<F 4 <1862> [5374]
Microdenticulate on one edge of a snapped broad tertiary flake of Bullhead Bed flint. L. 50mm; W. 40mm.

<F 5> <1863> [5421]
Edge fragment from a polished flint axe of opaque pearl-grey flint. L. 36mm; W. 17mm.

<F 6> <1864> [5421]
Irregular end scraper worked on the distal end of a secondary flake of opaque grey-brown flint with smooth buff-grey cortex. L. 44mm; W. 30mm.

<F 7> <1865> [5421]
Small core-rejuvenation flake (tablet) of Bullhead Bed flint. L. 35mm; W. 23mm.

<F 8> <1866> [5421]
Broad secondary flake (hard hammer mode) with traces of edge wear/utilisation. L. 55mm; W. 40mm.

<F 9> <1867> [5421]
Microdenticulate on a narrow blade-like flake of pale grey-brown flint. L. 43mm; W. 13mm.

<F 10> <1868> [5421]
Microdenticulate on the distal end of a narrow blade-like flake of Bullhead Bed flint. L. 20mm; W. 19mm.

<F 11> <1869> [5226] (brickearth)
Microdenticulate on a broken narrow blade-like flake of semi-translucent grey-brown flint. L. 57mm; W. 13mm.

BIBLIOGRAPHY

Adkins, R, & Jackson, R, 1978 *Neolithic Stone and Flint Axes from the River Thames: An Illustrated Corpus* British Museum Occas Pap 1

Allen, M, Leivers, M, & Ellis, C, 2008 'Neolithic causewayed enclosures and later prehistoric farming: duality, imposition and the role of predecessors at Kingsborough, Isle of Sheppey, Kent, UK' *Proc Prehist Soc* 74, 235–322

Allen, T, Barclay, A, Cromarty, A M, Anderson-Whymark, H, Parker, A, Robinson, M, & Jones, G, 2013 *Opening the wood, making the land: The Archaeology of a Middle Thames Landscape: The Eton College Rowing Course Project and the Maidenhead, Windsor and Eton Flood Alleviation Scheme, Vol 1: Mesolithic to early Bronze Age* Oxford Archaeol Thames Valley Landscapes Monogr 38

Anderson-Whymark, H, & Thomas, J, 2012 *Regional Perspectives on Neolithic Pit Deposition: Beyond the Mundane* Neolithic Stud Group Seminar Pap 12

Avery, M, 1982 'The Neolithic causewayed enclosure, Abingdon' in H J Case & A W R Whittle (eds), 1982 *Settlement Patterns in the Oxford Region: Excavations at the Abingdon Causewayed Enclosure and Other Sites*, Counc Brit Archaeol Res Rep 44, 10–50

Barclay, A, & Chaffey, G, 2014 'Horton's Neolithic houses' *Current Archaeol* 292, 24–30

Barclay, A and Stafford, E, 2008 A Radiocarbon-Dated Ebbsfleet Bowl from North Kent, *PAST* 60, 5-6 (PPL11 Data Tables 3 and 4)

Barclay, A, with Doherty, C, Copley, M, & Evershed, E, 2013 'Early Neolithic pottery from Area 6' in Allen *et al* 2013, 106–148

Bates, M and Stafford, E, 2013 *Thames Holocene. A Geoarchaeological Approach to the Investigation of the River Floodplain for High Speed I, 1994-2003*, Oxford Wessex Archaeology (PPL11 Data Tables 3 and 4)

Bennell, M, 1998 *Under the Road: Archaeological Discoveries at Bronze Age Way, Erith*, Bexley

Bishop, B, Cotton, J, & Humphrey, R, 2017 'Mesolithic Activity and Early Neolithic Earthworks at 41–42 Kew Bridge Road, Hounslow' *Trans London Middlesex Archaeol Soc* 68, 1–40

Bowsher, J, & Marshall, M, 2013 'A first glance at two prehistoric objects from Roman London' *Lucerna* 45, 14–16

Bradley, P, 2002 *Worked flint and burnt unworked flint assessment from Spitalfields (SRP98)* unpub Museum of London rep

Bradley, P, 2015 'Worked flint' in A Powell, A J Barclay, L Mepham & C J Stevens 2014 *Imperial College Sports Ground and RMC Land, Harlington: The development of prehistoric and later communities in the Colne Valley and on the Heathrow Terrace* Wessex Archaeol Rep 33, 181–201

Brettell, R C, Stern, B, Reifarth, N, & Heron, C, 2014 'The 'semblance of immortality'? Resinous materials and mortuary rites in Roman Britain' *Archaeometry* 56(3), 444–59

Bronk Ramsey, C, 2009 'Bayesian analysis of radiocarbon dates' *Radiocarbon* 51(1), 337–60

Brown, N, 2008 'Prehistoric pottery', in C Clarke & N Lavender 2008 *An Early Neolithic Ring-ditch and Middle Bronze Age Cemetery: Excavation and Survey at Brightlingsea, Essex* East Anglian Archaeol Rep126, 29–43

Brown, N, 2012 'Neolithic pottery', in Wilkinson, T J, Murphy, P L, Brown, N, & Heppell, P N, 2012 *The Archaeology of the Essex Coast, Volume II: Excavations at the Prehistoric Site of the Stumble*, East Anglian Archaeol Rep 144, 45–62

Brown, N, 2013 'Neolithic pottery', in Brown, N, & Medlycott, M, 2013 *The Neolithic and Bronze Age Enclosures at Springfield Lyons, Essex: Excavations 1981–1991* East Anglian Archaeol Rep 149, 90–98

Burcell, J P T & Piggott, S, 1939 'Decorated Prehistoric Pottery from the Bed of the Ebbsfleet, Northfleet, Kent' *Antiq Journ* 19, 405–420

Butler, C, & Leivers, M, 2008 'Flint' in Allen *et al* 2008, 253–62

Carew, T, Bishop, B, Meddens, F, & Ridgeway, V, 2006 *Unlocking the landscape, archaeological excavations at Ashford Prison, Middlesex* Pre-Construct Archaeol Monogr 5

Casanova, E, Knowles, T D J, Williams, C, Crump, M P, & Evershed, R P, 2017 'Use of a 700 MHz NMR microcryoprobe for the identification and quantification of exogenous carbon in compounds purified by preparative capillary gas chromatography for radiocarbon determinations' *Analytical Chemistry* 89(13), 7090–8

Casanova, E, Knowles, T D J, Williams, C, Crump, M P, & Evershed, R P, 2018 'Practical considerations in high-precision compound-specific radiocarbon analyses: eliminating the effects of solvent and sample cross-contamination on accuracy and precision' *Analytical Chemistry* 90(18), 11025–32

Casanova, E, Knowles, T D J, Bayliss, A, Dunne, J, Baranski, M Z, Denaire, A, Lefranc, P, di Lernia, S, Roffet-Salque, M, Smyth, J, Barclay, A, Gillard, T, Clasen, E, Coles, B, Ilett, M, Jeunesse, C, Krueger, M, Marciniak, A, Minnitt, S, Rotunno, R, van der Velde, P, van Wijk, I, Cotton, J, Daykin, A & Evershed, R P, 2020 'Accurate compound-specific radiocarbon dating of archaeological pottery vessels' *Nature* (published online 8 April 2020) https://doi.org/10.1038/s41586-020-2178-z

Celoria, F S C, & Macdonald, J, 1969 'The Neolithic Age' in J S Cockburn, H P F King & K G T McDonnell (eds) *A History of the County of Middlesex (VCH): Vol I*, 29–35

Charters, S, Evershed, R P, Goad, L J, Heron, C, & Blinkhorn, P, 1993 'Identification of an adhesive used to repair a Roman jar' *Archaeometry* 35, 91–101

Clark, J G D, Higgs, E S, & Longworth, I H, 1960 'Excavations at the Neolithic Site at Hurst Fen, Mildenhall, Suffolk (1954, 1957 and 1958)' *Proc Prehist Soc* 26, 202–45

Clark, P, Shand, G & Weekes, J, 2019 *Chalk Hill: Neolithic and Bronze Age discoveries at Ramsgate, Kent*, Leiden: Sidestone Press

Coles, S, Ford, S, & Taylor, A, 2008 'An Early Neolithic grave and occupation, and an Early Bronze Age hearth on the Thames foreshore at Yabsley Street, Blackwall, London' *Proc Prehist Soc* 74, 215–33

Cooke, N, Brown, F, and Phillpotts, C, 2008 *From hunter gatherers to huntsmen: a history of the Stansted landscape*, Framework Archaeol Monogr, 2 (PPL11 Data Table 3)

Copley, M S, Berstan, R, Dudd, S N, Docherty, G, Mukherjee, A J, Straker, V, Payne, S, & Evershed, R P, 2003 'Direct chemical evidence for widespread dairying in prehistoric Britain' *Proc National Academy Sci United States of America* 100(4), 1524–9

Copley, M S, Berstan, R, Mukherjee, A J, Dudd, S N, Straker, V, Payne, S, & Evershed, R P, 2005 'Dairying in antiquity III: Evidence from absorbed lipid residues dating to the British Neolithic' *J Archaeol Sci* 32(4), 523–46

Copley, M S, Hansel, F A, Sadr, K, & Evershed, R P, 2004 'Organic residue evidence for the processing of marine animal products in pottery vessels from the pre-colonial archaeological site of Kasteelberg D east, South Africa' *South African J Sci* 100(5–6), 279–83

Correa-Ascencio, M, & Evershed, R P, 2014 'High throughput screening of organic residues in archaeological potsherds using direct acidified methanol extraction' *Analytical Methods* 6(5), 1330–40

Cotton, J, 2017 'The Neolithic Pottery', in Bishop *et al* 11–17

Craig, O E, Forster, M, Andersen, S H, Koch, E, Crombe, P, Milner, N J, Stern, B, Bailey, G N, & Heron, C P, 2007 'Molecular and isotopic demonstration of the processing of aquatic products in northern European prehistoric pottery' *Archaeometry* 49, 135–52

Cramp, K, & Leivers, M, 2010 'The flint' in Framework Archaeology, *Landscape Evolution in the Middle Thames Valley Heathrow Terminal 5 Excavations Vol 2* Freeviewer CD-ROM, section 4

Cramp, L, & Evershed, R P, 2014 'Reconstructing aquatic resource exploitation in human prehistory using lipid biomarkers and stable isotopes' in H D Holland & K K Turekian (eds) *Treatise on Geochemistry (2nd edn)*, Oxford, 319–39

Crockett, A D, Allen, M J, & Scaife, R G, 2002 'A Neolithic trackway within peat deposits at Silvertown, London' *Proc Prehist Soc* 68, 185–213

Daykin, A, & Hill, J, 2017 *Principal Place London EC2, London Borough of Hackney: Updated project design*, Museum of London Archaeology

Dee, M W & Bronk Ramsay, C, 2014 'High-precision Bayesian modelling of samples susceptible to inbuilt age' *Radiocarbon* 56, 83–94

Densem, R, & Sealey, D, 1982 'Excavations at Rectory Grove, Clapham, 1980–81' *London Archaeol* 4(7), 177–84

Drury, P J, 1978 *Excavations at Little Waltham 1970-71*, CBA Research Report 26 (PPL11 Data Table 3)

Dudd, S N, & Evershed, R P, 1998 'Direct demonstration of milk as an element of archaeological economies' *Science* 282(5393), 1478–81

Dunne, J, Evershed, R P, Salque, M, Cramp, L, Bruni, S, Ryan, K, Biagetti, S, & di Lernia, S, 2012 'First dairying in green Saharan Africa in the fifth millennium BC' *Nature* 486(7403), 390–4

Dunne, J, Mercuri, A M, Evershed, R P, Bruni, S, & Di Lernia, S, 2016 'Earliest direct evidence of plant processing in prehistoric Saharan pottery' *Nature Plants* 3, 1–6

Evershed, R P, 2008 'Organic residue analysis in archaeology: the archaeological biomarker revolution' *Archaeometry* 50(6), 895–924

Evershed, R P, Heron, C, & Goad, L J, 1991 'Epicuticular wax components preserved in potsherds as chemical indicators of leafy vegetables in ancient diets' *Antiquity* 65(248), 540–4

Evershed, R P, Mottram, H R, Dudd, S N, Charters, S, Stott, A W, Lawrence, G J, Gibson, A M, Conner, A, Blinkhorn, P W, & Reeves, V, 1997a 'New criteria for the identification of animal fats preserved in archaeological pottery' *Naturwissenschaften* 84(9), 402–6

Evershed, R P, Stott, A W, Raven, A, Dudd, S N, Charters, S, & Leyden, A, 1995 'Formation of long-chain ketones in ancient pottery vessels by pyrolysis of acyl lipids' *Tetrahedron Letters* 36(48), 8875–8

Evershed, R P, Vaughan, S J, Dudd, S N, & Soles, J S, 1997b 'Fuel for thought? Beeswax in lamps and conical cups from Late Minoan Crete' *Antiquity* 71(274), 979–85

Ford, S, & Pine, J, 2003 'Neolithic ring ditches and Roman landscape features at Horton (1989–1996)', in S Preston (ed), *Prehistoric, Roman and Saxon Sites in Eastern Berkshire* Thames Valley Archaeol Services Monogr 2, 13–85

Framework Archaeology 2006 *Landscape Evolution in the Middle Thames Valley: Heathrow Terminal 5 Excavations Vol 1, Perry Oaks*, Framework Archaeol Monogr 1

Garrow, D, Lucy, S, & Gibson, D, 2006 *Excavations at Kilverstone, Norfolk: An Episodic Landscape History: Neolithic Pits, Later Prehistoric, Roman and Anglo-Saxon Occupation, and Later Activity* East Anglian Archaeol Rep 113

Gibson, A, & Leivers, M, 2008 'Neolithic pottery', in Allen *et al* 2008, 245–53

Gregg, M W, Banning, E B, Gibbs, K, & Slater, G F, 2009 'Subsistence practices and pottery use in Neolithic Jordan: molecular and isotopic evidence' *J Archaeol Sci* 36(4), 937–46

Gron, K J, Rowley-Conwy, P, Fernandez-Dominguez, E, Gröcke, D R, Montgomery, J, Nowell, G M, & Paterson, W F, 2018 'A meeting in the forest: hunters and farmers at the Coneybury "Anomaly"', Wiltshire *Proc Prehist Soc* 84, 111–44

Halmemies-Beauchet-Filleau, A, Vanhatalo, A, Toivonen, V, Heikkilä, T, Lee, M, & Shingfield, K, 2013 'Effect of replacing grass silage with red clover silage on ruminal lipid metabolism in lactating cows fed diets containing a 60: 40 forage-to-concentrate ratio' *J Dairy Sci* 96(9), 5882–900

Halmemies-Beauchet-Filleau, A, Vanhatalo, A, Toivonen, V, Heikkilä, T, Lee, M, & Shingfield, K, 2014 'Effect of replacing grass silage with red clover silage on nutrient digestion, nitrogen metabolism, and milk fat composition in lactating cows fed diets containing a 60: 40 forage-to-concentrate ratio' *J Dairy Sci* 97(6), 3761–76

Hansel, F A, Copley, M S, Madureira, L A S, & Evershed, R P, 2004 'Thermally produced [omega]-(*o*-alkylphenyl)alkanoic acids provide evidence for the processing of marine products in archaeological pottery vessels' *Tetrahedron Letters* 45(14), 2999–3002

Hansel, F A, & Evershed, R P, 2009 'Formation of dihydroxy acids from Z-monounsaturated alkenoic acids and their use as biomarkers for the processing of marine commodities in archaeological pottery vessels' *Tetrahedron Letters* 50(40), 5562–4

Hart, D, 2015 'Early Neolithic trackways in the Thames floodplain at Belmarsh, London Borough of Greenwich' *Proc Prehist Soc* 81, 215–37

Healy, F, 1988 *The Anglo-Saxon Cemetery at Spong Hill, North Elmham, Part VI: Occupation during the Seventh to Second Millennia BC*, East Anglian Archaeol Rep 39

Healy, F, 2013 In the shadow of hindsight: pre-Iron Age Spong Hill viewed from 2010, 12–21, in C Hills and S Lucy, *Spong Hill*, part IX: *Chronology and Synthesis*. Cambridge: McDonald Institute for Archaeological Research

Hedges, J, & Buckley, D, 1978 'Excavations at a Neolithic Causewayed Enclosure, Orsett, Essex, 1975' *Proc Prehist Soc* 44, 219–308

Hill, J, & Rowsome, P, 2011 *Roman London and the Walbrook Stream Crossing: Excavations at 1 Poultry and Vicinity, City of London* Museum of London Archaeol Monogr 37

Holder, N, & Jamieson, D, 2003 'The prehistory of the City of London: myths and methodologies' *Archaeol J* 160, 23–43

Howell, I, Swift, D, & Watson, B, with Cotton, J, & Greenwood, P, 2011 *Archaeological Landscapes of East London: Six Multi-period Sites Excavated in Advance of Gravel Quarrying in the London Borough of Havering* Museum of London Archaeol Monogr 54

Jones, P, 2008 *A Neolithic Ring Ditch and Later Prehistoric Features at Staines Road Farm, Shepperton* SpoilHeap Publications Monogr 1

Kinnes, I, 1978 'The earlier prehistoric pottery', in Hedges & Buckley 1978, 259–68

Knight, M, 2006 'Mildenhall pottery', in Garrow *et al* 2006, 29–53

Lavender, N, 2007 'Prehistoric pot', in M Germany, *Neolithic and Bronze Age Monuments and Iron Age Settlement at Lodge Farm, St Osyth, Essex* East Anglian Archaeol Rep 117, 62–76

Lawrence, G F, 1929 'Antiquities from the Middle Thames' *Archaeol J* 86, 69–98

Leivers, M, with Every, R, & Mepham, L, 2010 'Prehistoric pottery' in Framework Archaeology, *Landscape Evolution in the Middle Thames Valley Heathrow Terminal 5 Excavations Vol 2* Framework Archaeology Monogr 3, CD-ROM, section 1

Lewis, J S C with Rackham, J, 2011 *Three Ways Wharf, Uxbridge. A Lateglacial and Early Holocene hunter-gatherer site in the Colne valley*, MOLA Monograph 51

Marciniak, A, Barański, M Z, Bayliss, A, Czerniak, L, Goslar, T, Southon, J, & Taylor, R, 2015 'Fragmenting times: interpreting a Bayesian chronology for the late Neolithic occupation of Çatalhöyük East, Turkey' *Antiquity* 89(343), 154–76

Merrifield, R, 1987 *The Archaeology of Ritual and Magic* London: Guild Publishing

Merriman, N, 1987 'A prehistory for central London?' *London Archaeol* 5(12), 318–26

Milne, G, Cohen, N, & Cotton, J, 2011 'London's top secret' *London Archaeol* 12 (11), 287–9

Mottram, H R, Dudd, S N, Lawrence, G J, Stott, A W, & Evershed, R P, 1999 'New chromatographic, mass spectrometric and stable isotope approaches to the classification of degraded animal fats preserved in archaeological pottery' *J Chromatography A* 833(2), 209–21

Needham, S, & Spence, T, 1997 'Refuse and the formation of middens' *Antiquity* 71, 77–90

Needham, S P, & Trott, M R, 1987 'Structure and sequence in the Neolithic deposits at Runnymede' *Proc Prehist Soc* 53, 479–83

Outram, A K, Stear, N A, Bendrey, R, Olsen, S, Kasparov, A, Zaibert, V, Thorpe, N, & Evershed, R P, 2009 'The earliest horse harnessing and milking' *Science* 323(5919), 1332–5

Pelling, R, 2012 'Charred and waterlogged plant remains', in E Stafford with D G Goodburn & M Bates 2012 *Landscape and Prehistory of the East London Wetlands: Investigations along the A13 DBFO Roadscheme, Tower Hamlets, Newham and Barking and Dagenham, 2000–2003* Oxford Archaeol Monogr 17, 244–59

Pelling, R, Campbell, G, Carruthers, W, Hunter, K and Marshall, P, 2015 'Exploring contamination (intrusion and residuality) in the archaeobotanical record: case studies from central and southern England', *Vegetation History and Archaeobotany* 24, 85-99

Poulton, R, Hayman, G and Marples, N, 2017 *Foragers and Farmers. 10,000 years of history at Hengrove Farm, Staines. Excavations between 1997 and 2012*, SpoilHeap Publications Monograph 12 (PPL11 Data Table 3)

Powell, A B, 2012 *By River, Fields and Factories: The Making of the Lower Lea Valley*, Wessex Archaeology Report No 29 (PPL11 Data Tables 3 and 4)

Powell, A B, & Leivers, M, 2012 'Mesolithic, Neolithic and Bronze Age Activity on an Eyot at Addington Street, Lambeth' *Trans London Middlesex Archaeol Soc* 63, 19–32

Powell, A B, Barclay, A J, Mepham, L & Stevens, C J, 2015 *Imperial College Sports Ground and RMC Land, Harlington. The development of prehistoric and later communities in the Colne Valley and on the Heathrow Terrace,* Wessex Archaeology Report 33

Pryor, F, with Cleal, R, & Kinnes, I, 1998 'Discussion of Neolithic and earlier Bronze Age pottery', in F Pryor, *Etton: Excavations at a Neolithic Causewayed Enclosure near Maxey, Cambridgeshire, 1982–7* English Heritage Archaeol Rep 18, 209–13

Quinn, P S, 2013 *Ceramic Petrography: The Interpretation of Archaeological Pottery and Related Artefacts in Thin Section*, Oxford

Ranieri, S, & Telfer, A, with Walker, D, & Yendell, V, 2017 *Outside Roman London: Roadside Burials by the Walbrook Stream* MOLA and Crossrail Ltd

Raymond, F, 2008 'The pottery', in Coles *et al* 2008, 219–23

Raven, A M, van Bergen, P F, Stott, A W, Dudd, S N, & Evershed, R P, 1997 'Formation of long-chain ketones in archaeological pottery vessels by pyrolysis of acyl lipids' *J Analytical Applied Pyrolysis* 40–41(0), 267–85

Reimer, P J, Austin, W E N, Bard, E, Bayliss, A, Blackwell, P, Bronk Ramsey, C, Butzin, M, Cheng, H, Edwards, R L, Friedrich, M, Grootes, P M, Guilderson, T P, Hajdas, I, Heaton, T J, Hogg, A G, Hughen, K A, Kromer, B, Manning, S W, Muscheler, R, Palmer, J G, Pearson, C, van der Plicht, J, Reimer, R W, Richards, D A, Scott, E M, Southon, J R, Turney, C S M, Wacker, L, Adolphi, F, Büntgen, U, Capano, M, Fahrni, S, Fogtmann-Schultz, A, Friedrich, R, Kudsk, S, Miyake, F, Olsen, J, Reineg, F, Sakamoto, M, Sookdeo, A & Talamo, S, 2020, The IntCal20 Northern Hemispheric radiocarbon calibration curve (0-55 kcal BP), *Radiocarbon* 62, 725–57

Roberts, D & Marshall, P, 2020 'Pit digging and lifeways in Neolithic Wiltshire', *Wilts Archaeol Nat Hist Mag* 113, 16-34

Robertson-Mackay, R, 1987 'The Neolithic causewayed enclosure at Staines, Surrey: excavations 1961–63' *Proc Prehist Soc* 53, 23–128

Robinson, M, 2008 'Charred plant remains', in Coles *et al* 2008, 228–9

Roffet-Salque, M, Dunne, J, Altoft, D T, Casanova, E, Cramp, L J E, Smyth, J, Whelton, H & Evershed, R P, 2017 'From the inside out: upscaling organic residue analyses of archaeological ceramics' *J ArchaeolSci: Reports* 16, 627–40

Roffet-Salque, M, Regert, M, Evershed, R P, Outram, A K, Cramp, L J E, Decavallas, O, Dunne, J, Gerbault, P, Mileto, S, Mirabaud, S, Pääkkönen, M, Smyth, J, Šoberl, L, Whelton, H L, Alday-Ruiz, A, Asplund, H, Bartkowiak, M, Bayer-Niemeier, E, Belhouchet, L, Bernardini, F, Budja, M, Cooney, G, Cubas, M, Danaher, E M, Diniz, M, Domboróczki, L, Fabbri, C, González-Urquijo, J E, Guilaine, J, Hachi, S, Hartwell, B N, Hofmann, D, Hohle, I, Ibáñez, J J, Karul, N, Kherbouche, F, Kiely, J, Kotsakis, K, Lueth, F, Mallory, J P, Manen, C, Marciniak, A, Maurice-Chabard, B, Mc Gonigle, M A, Mulazzani, S, Özdoğan, M, Perić, O S, Perić, S R, Petrasch, J, Pétrequin, A -M, Pétrequin, P, Poensgen, U, Joshua Pollard, C, Poplin, F, Radi, G, Stadler, P, Stäuble, H, Tasić, N, Urem-Kotsou, D, Vuković, J B, Walsh, F, Whittle, A, Wolfram, S, Zapata-Peña, L, & Zoughlami, J, 2015, 11/12/print 'Widespread exploitation of the honeybee by early Neolithic farmers' *Nature* (retrieved 7577, 527, from http://dx.doi.org/10.1038/nature15757)

Salque, M, 2012 *Regional and chronological trends in milk use in prehistoric Europe traced through molecular and stable isotope signatures of fatty acyl lipids preserved in pottery vessels* unpub PhD thesis Univ Bristol

Saville, A, 2002 'Lithic artefacts from neolithic causewayed enclosures: character and meaning', in G Varndell & P Topping (eds), *Enclosures in Neolithic Europe: Essays on Causewayed and Non-Causewayed Sites* Oxford, 91–105

Schulting, R J, & Bradley, R, 2013 '"Of Human Remains and Weapons in the Neighbourhood of London": new AMS 14C dates on Thames "River Skulls" and their European context' *Archaeol J* 170, 30–77

Serjeantson, D, 2006 'Food or Feast at Neolithic Runnymede?', in D Serjeantson & D Field, (eds), *Animals in the Neolithic of Britain and Europe*, Neolithic Studies Group Seminar Papers 7, 113–34

Serjeantson, D, 2011 *Review of Animal Remains from the Neolithic and Early Bronze Age of Southern Britain (4000 BC–1500 BC)*, English Heritage Res Dept Rep Ser 29–2011

Smyth, J R, & Evershed, R P, 2015 ‘Milking the megafauna: using organic residue analysis to understand early farming practice’ *Environmental Archaeol* 21(3), 214–29

Spangenberg, J E, Jacomet, S, & Schibler, J, 2006 ‘Chemical analyses of organic residues in archaeological pottery from Arbon Bleiche 3, Switzerland – evidence for dairying in the late Neolithic’ *J Archaeol Sci* 33(1), 1–13

Stafford, E, 2012 *Landscape and Prehistory of the East London Wetlands*, Oxford Archaeology Monograph No 17 (PPL11 Data Tables 3 and 4)

Stastney, P, Scaife, R, Gonzales Carretero, L, Whittaker, J, Cameron, N & Ellison, E, forthcoming, ‘Modelling prehistoric topography and vegetation in the Lower Thames Valley, UK: palaeoenvironmental context for wetland archaeology and evidence for Neolithic landnám from North Woolwich’, *Environmental Archaeology*

Stern, B, Connan, J, Blakelock, E, Jackman, R, Coningham, R A E, & Heron, C, 2008 ‘From Susa to Anuradhapura: reconstructing aspects of trade and exchange in bitumen-coated ceramic vessels between Iran and Sri Lanka from the third to the ninth centuries AD’ *Archaeometry* 50, 409–28

Stuiver, M, & Reimer, P J, 1986 ‘A computer program for radiocarbon age calibration’ *Radiocarbon* 28(2B), 1022–30

Stuiver, M, & Reimer, P J, 1993 ‘Extended 14 C data base and revised CALIB 3.0 14C age calibration program’ *Radiocarbon* 35(1), 215–230

Sumbler, M G, Bridgland, D R, Wymer, J J, & Balson, P S, 1996 ‘Quaternary’ in M G Sumbler (ed) *British Regional Geology: London and the Thames Valley (4th edn)* London, 110–36

Synal, H-A, Stocker, M, & Suter, M, 2007 ‘MICADAS: a new compact radiocarbon AMS system’ *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms* 259(1), 7–13

Thompson, C, 2007 ‘Excavations at Buckle Street/Leman Street’ *Trans London Middlesex Archaeol Soc* 58, 1–3

Urem-Kotsou, D, Stern, B, Heron, C, & Kotsakis, K, 2002 ‘Birch-bark tar at Neolithic Makriyalos, Greece’ *Antiquity* 76(294), 962–7

Vince, A, 2004 *Characterisation studies of Neolithic pottery from Yabsley Street, Tower Hamlets (YAB02)*, unpub rep Alan Vince Archaeological Consultancy, 2004/6

Vince, A, 2008 'Characterisation studies of the Neolithic pottery', in Coles *et al* 2008, 223–5

Wacker, L, Christl, M, & Synal, H A, 2010 'Bats: a new tool for AMS data reduction' *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms* 268(7), 976–9

Ward, G K, & Wilson, S R, 1978 'Procedures for comparing and combining radiocarbon age determinations: a critique' *Archaeometry* 20(1), 19–31

Webber, M, with Ganiaris, H, 2004 'The Chelsea club: a Neolithic wooden artefact from the River Thames in London' in J Cotton & D Field (eds), *Towards a New Stone Age: Aspects of the Neolithic in South-east England* Counc Brit Archaeol Res Rep Ser 137, 124–7

Wenban-Smith, F, Stafford, E, Bates, M & Parfitt, S, 2020 *Prehistoric Ebbsfleet. Excavations and Research in Advance of High Speed 1 and South Thameside Development Route 4, 1989–2003*, Oxford Wessex Archaeology Monograph 7

Whittle, A, Healy, F, & Bayliss, A, 2011 *Gathering Time: Dating the Early Neolithic Enclosures of Southern Britain and Ireland*, Oxford