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Frontiers and route-ways from Europe: the Early Middle Palaeolithic of Britain

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Abstract
Britain has a rich and well-documented earlier Palaeolithic record, which provides a unique resource to investigate population dynamics and the cultural and geographic links with north-west Europe during the Middle Pleistocene. This paper examines a newly-enhanced dataset for the distribution of finds locations and their geological context. Using artefact types as proxies for different populations it contrasts the Lower Palaeolithic and Early Middle Palaeolithic records. New methods are devised to mitigate for the clear bias towards handaxes in collection history. Taking account of this bias, the results suggest differences in distribution between Lower Palaeolithic and Early Middle Palaeolithic populations, with the latter more heavily concentrated in the lower reaches of large southern and eastern rivers. Drawing on recent studies on the palaeogeography of the Channel and southern North Sea Basin, the paper suggests that this restricted distribution reflects short-lived occupation by small groups of early Neanderthals in late MIS 8, who eventually became locally extinct as a consequence of isolation caused by rising sea-levels in the first warm sub-stage of MIS 7.

Keywords: Early Middle Palaeolithic; Neanderthals; spatial distribution; north-west Europe

Introduction

The Palaeolithic occupation of northern Europe can be seen as a balance between the cyclical changes in climate and the progressive developments in the ability of humans to cope with cool or cold temperatures. The archaeological record starting at over 800 ka suggests repeated colonisations during warmer climates and retreats or local extinctions when temperatures deteriorated (White and Schreve, 2000; Stringer, 2005; Parfitt *et al.,* 2005, 2010). Technological developments to deal with long, cold winters, such as clothing, shelter, fire and more effective hunting, from perhaps c. 500 or 400 ka eventually led to the ability to survive in harsher climates (Ashton and Lewis, 2012; Hosfield, 2016). By the last glaciation humans were able to tolerate these cool to cold conditions other than during the colder periods of MIS 4 or the Last Glacial Maximum of MIS 2 (Roebroeks *et al.,* 2011; Boismier *et al.,* 2012).

As a peninsula or island of north-west Europe, Britain was a *cul de sac* for human movement. Due to the formation of the Strait of Dover at the end of MIS 12, access to Britain became increasingly more difficult at times of high sea-level (Smith, 1985; Gibbard, 1995; White and Schreve, 2000; Gupta *et al.,* 2007; Toucanne *et al.,* 2009). Critical to regional population movement was the changing geography of the southern North Sea Basin, which has been subsiding to its current depths of about -40m. During MIS 11 and possibly up to MIS 7 there may have been a semi-permanent landbridge in the Southern Bight with a watershed between the Rhine and East Anglian rivers flowing to the north and the Thames and the Scheldt flowing to the south (Hijma *et al.,* 2012). This corridor is suggested to have been destroyed during MIS 6, after which time the Rhine flowed south to join the Thames, Scheldt and Channel rivers (Toucanne, 2009; Hijma *et al.,* 2012).

It has been suggested that the changing palaeogeography and increasing difficulties of getting to Britain caused lower human population densities in successive warm periods (Ashton and Lewis, 2002; Ashton and Hosfield, 2010; Ashton *et al.,* 2011; Davis, 2013). This was based on the dwindling numbers of sites and size of assemblages, and more specifically the decreasing artefact densities

from higher to lower terraces of the Middle Thames and Solent rivers. The decline in human populations inferred from these data culminated in a period of apparent human absence from Britain during the last interglacial (MIS 5e). An important criticism of the proposed decline in population was the use of artefacts as a proxy for human population (McNabb, 2007; Pettitt and White, 2012). The assemblages from both river systems are dominated by late 19th and early 20th century collections and largely consist of handaxes and a much smaller number of cores, flakes and Levallois artefacts. The vast majority of handaxes are Lower Palaeolithic in age, most dating from 500 to 300 ka. As they are easily identifiable and impressive tools, it is likely that there was a strong bias towards their collection (Harris *et al.,* in prep.). This was compounded by the focus of collectors on specific sites as they became known for their handaxes, which artificially created 'supersites'. By contrast, Levallois artefacts are by definition Middle Palaeolithic, most seeming to date to the Early Middle Palaeolithic, from c. 300 to 200 ka, and were less easily identified or less favoured by many collectors (White *et al.,* 2006; Scott *et al.,* 2011; Scott, 2011). Therefore the fall in artefact numbers was argued to be a reflection of collecting, rather than population decline.

A further criticism was that changing artefact and landscape use from the Lower to the Middle Palaeolithic would have affected the quantity and distribution of artefact discard locations (Scott, 2011). It was argued that whereas Lower Palaeolithic occupation favoured river valleys, the encroachment of the mammoth steppe into western Europe from MIS 7 enabled a broader use of landscape, in particular areas more distant from the rivers. This, combined with larger territories and a more curated toolkit, resulted in more dispersed discard patterns. As most of the British Palaeolithic record was recovered from fluvial contexts, there is potentially an inherent bias towards recovering more Lower than Middle Palaeolithic material.

These issues were in part addressed by simply using the handaxe, rather than Levallois, record, but also by seeing how the removal of 'supersites' from the study affected the overall results (Ashton and Hosfield, 2010; Ashton *et al.,* 2011). The conclusions were similar – that there was a fall in the density of handaxes through time, in particular from MIS 11 to MIS 9, which was related to the changing palaeogeography of Britain. This did not, however, address the issue of Middle Palaeolithic populations as represented through Levallois artefacts.

In a further attempt to understand spatial changes in population over time, the distribution of handaxes and Levallois artefacts was examined (Ashton *et al.,* 2015). Using the British Museum (BM) collection (see below) as a broadly representative dataset of the British early Palaeolithic record, that paper suggested that the quantities of Levallois material, relative to handaxes, were much higher in Kent and London, but underrepresented elsewhere. Although this was potentially due to better collecting habits around London, or easier access through quarrying to particular Pleistocene sediments in the Thames, it was concluded that there was a real concentration of Levallois sites and artefacts in this region. It was suggested that this might reflect the main routeway into Britain, along the Thames, but also that there was more limited, shorter-term occupation by Early Middle Palaeolithic populations compared to earlier periods.

The present paper arises from the "Mapping Palaeolithic Britain" project which sought to examine the nature of the early Palaeolithic human occupation of Britain in more depth by using more extensive and robust datasets. Britain benefits from having national databases of virtually all Lower and Middle Palaeolithic artefacts and their locations, a situation that is unique to Britain (Roe, 1968; Wessex Archaeology, 1993a,b, 1994, 1996a,b, 1997; Wymer, 1999; ADS website). These datasets have been updated and enhanced, and novel methods have been devised to provide new insights into the spatial and chronological patterns of the Palaeolithic occupation of Britain.

The current paper looks at the broad distribution of Early Middle Palaeolithic artefacts across Britain to test previous ideas that route-ways and boundaries can be identified for this period (Ashton *et al.,* 2015). A second paper will examine the biases in collection history and how this has affected the Palaeolithic record (Harris *et al.,* in prep.). A final paper will compare the records from fluvial and non-fluvial contexts to explore the impact of geological and landscape setting on the record and changing patterns of landscape use (Lewis *et al.,* in prep.).

Materials and methods

The main dataset for the study is based on The English Rivers Palaeolithic Survey (TERPS; Wessex Archaeology, 1993a,b, 1994, 1996a,b, 1997; Wymer, 1999). The digital version of this was downloaded from the Archaeology Data Service (ADS website) and thoroughly checked for any inconsistencies, duplications and location errors. Much of the TERPS data is based on Roe (1968). Where possible artefact counts, in particular Levallois, have been checked by going back to the British Museum collections and those from several regional museums. These include the Ashmolean, Cambridge Archaeology and Anthropology Museum, Norwich Castle Museum and Reading Museum. In addition material from Hampshire and Dorset has been added from Davis (2013). Recently excavated sites have also been added, including Boxgrove (Roberts and Parfitt, 1999), High Lodge (Ashton *et al.,* 1992), Barnham (Ashton *et al.,* 1998), Beeches Pit (Gowlett *et al.,* 2005; Preece *et al.,* 2006, 2007), Elveden (Ashton *et al.,* 2006), the Waechter excavations at Swanscombe (Conway *et al.,* 1996), Southfleet Road (Wenban-Smith, 2013) and Red Barns (Wenban-Smith *et al.,* 2000). As the TERPS database was originally based on the fluvial record and does not include caves or rockshelters, those of a Lower Palaeolithic or Early Middle Palaeolithic date have been added. These include Windmill Cave (Brixham) and Kent's Cavern (Torquay), both in Devon, and Pontnewydd Cave in north Wales (Roe, 1968; Aldhouse-Green *et al.,* 2012). As the study concerns Lower Palaeolithic and Early Middle Palaeolithic artefacts there has been an attempt to exclude Late Middle Palaeolithic material from the dataset. This includes sites such as Lynford (Boismier *et al.,* 2012) and many cave and rockshelter sites such as Creswell Crags sites, several Mendip caves and Coygan Cave.

This enhanced dataset is termed TERPS(Mapping Project) or TERPS(MP). There are 3584 finds locations in the TERPS(MP) dataset. Sometimes these will be simply a parish or village name, or at other times a well-known site or specific location. Multiple levels from sites have not been distinguished. The artefact totals in some cases have to be treated with caution. Sometimes with large assemblages that have been based on Roe (1968), TERPS gives minimum numbers, such as 200+. Occasionally, terms such as 'many handaxes' or 'several flakes' have been used, but listed as zero in the artefact totals. For the purposes of this study which requires quantitative artefact counts, 'many' has been given as 25 artefacts, while 'several' has been listed as three artefacts. Experimentation with alternative counts showed that the estimates had little effect on the overall results. With these adjustments, the dataset records a total of 40,840 handaxes, 3,665 Levallois artefacts and 117,091 other artefacts, which include non-Levallois cores, flakes, flake tools and miscellaneous pieces.

Two important assumptions underlie this study. First, it is assumed that virtually all British handaxes are Lower Palaeolithic in age. This is justified through the simple observation of the vast numbers of handaxes that were recovered from the higher terraces of river systems such as the Thames, Solent, Great Ouse and most of the other, or now extinct, river systems of southern and eastern England (Wymer, 1968, 1999; Roe, 1981; Wessex Archaeology, 1993a,b, 1994, 1996a,b, 1997). Many of these sites are dated to MIS 13, 11 or 9 (e.g. Voinchet *et al.,* 2015; Moncel *et al.,* 2015). This record stands in complete contrast to the virtual absence of handaxes from lower terraces. The exception is a very small group of handaxes that have been found in Devensian contexts and are Late Middle Palaeolithic in age. These are predominantly described as 'flat-butted cordiforms' or '*bout coupé*' handaxes (White and Jacobi, 2002), although occasionally other forms have been recovered from

sites such as Lynford (Boismier *et al.*, 2012). Other similar handaxe forms are poorly provenanced and undated and of the 180 described by White and Jacobi (2002), only 66 are from Devensian contexts.

The second assumption is that British Levallois artefacts predominantly date to the Early Middle Palaeolithic, from late MIS 9 to MIS 7, c. 300-200 ka (White and Jacobi, 2002). This is in part based on their occurrence in the middle terraces of various river systems (Wymer, 1968; Roe, 1981; Ashton *et al.,* 2003; Westaway *et al.,* 2005), but more importantly on the dating of several large Levallois sites such as Ebbsfleet (Scott *et al.,* 2010), Crayford (Penkman *et al.,* 2011), Creffield Road (Scott, 2011), various locations in Yiewsley and West Drayton (Scott, 2011) and Pontnewydd Cave (Aldhouse-Green *et al.,* 2012). Some caution is warranted, however, where good dating is lacking.

Although TERPS(MP) provides the most complete dataset for the British Lower and Early Middle Palaeolithic there are still issues with material that was originally identified as Levallois, where in many cases it has not been possible to check. In addition, the dataset only rarely gives an indication of the collector and therefore it is difficult to assess collection biases. The analyses below attempt to minimise the impact that collector bias has on the record (Harris *et al.,* in prep).

The analysis undertaken by Ashton *et al.* (2015) showed the distribution of handaxe sites and findspots, and those that also contain Levallois (Figure 1). Both distributions showed the broad underlying pattern of a concentration of sites in southern and eastern England. As they discussed, this pattern is a reflection of both glacial history and underlying bedrock. Past glaciation, particularly during MIS 12 and MIS 2 (Figure 2), over northern and most western areas clearly affected survival of sediments, but also access to surviving deposits and their contained artefacts. To compound the pattern, the Cretaceous bedrock and flint-rich river gravels of southern and eastern England provided widespread, good-quality raw material for artefact production, that were more easily recognizable by collectors than the generally more intractable rocks in the north and west. Although these factors explain the overall pattern, they do not explain the concentration of Levallois sites in south-east England, particularly in the Lower and Middle Thames, by comparison to handaxe sites with a more widespread distribution. Both artefact categories in these areas were subject to the similar geological influences

This pattern is explored further through three separate analyses (Table 1), using artefact counts rather than sites and findspots. This approach avoids the problem of some sites having thousands of artefacts compared to some findspots that might only have a single handaxe. Some of the major sites and rivers are given in Figure 2. To make regional comparisons, the area has been divided into 20 x 20 km squares based on the UK National Grid. Larger and smaller square sizes were investigated, but smaller dimensions (e.g. 15 x 15 km) reduced many squares to an insufficient sample size, while larger squares (e.g. 30 x 30 km) blurred the resolution of the analysis. The 20 x 20 km resolution was considered to be most appropriate for investigating at a regional scale the spatial patterns in the archaeological data.

A four figure coordinate has been given for each square, based on the coordinates of its south-western corner (Figures 3-5). Out of over 450 20 x 20km grid squares encompassing England and Wales, 211 contain listed artefacts. However, of these there are only 65 with 100 artefacts or more. To make more statistically robust comparisons between grid squares, only these 65 squares have been used in the analyses below. These analyses are not necessarily sequential, but take different views of the data to address different aspects of the research question.

Analysis of the TERPS(MP) dataset

Analysis 1: Distribution of handaxe and Levallois artefacts

The full dataset has been used to compare the relative proportion of Levallois artefacts to handaxes across the study area. The relative proportion has been used in order to compare areas with a high or low intensity of collecting, although raw artefact counts have been given in SI Table 1. There are only 51 grid squares that contain more than 100 handaxes and Levallois artefacts, limiting the study to these squares. The ratio is expressed as the percentage of Levallois artefacts to the total of handaxes and Levallois. For the full dataset this figure is 8.3%, which can be used as the expected percentage against which the values for each grid square can be compared (see SI Table 1 for raw data). As the data is heavily skewed towards low percentages and is not a normal distribution, a pragmatic approach, that is based on the data, has been adopted by dividing into three categories of high, medium and low (see SI Figure 1). High is taken as >15%, medium as 5-15% and low as <5% (Figure 3, Table 2).

There are nine squares that are graded high and most of these contain well-known Levallois sites. There are five squares that have a medium grade and 37 that have a low grade. The remaining 14 squares are ungraded as there are no Levallois artefacts in these squares. Other than noting the large number of squares with a low grade, little can be said about these areas as the grade may simply reflect a bias in collecting habits towards handaxes. This is investigated further in Analysis 2.

As expected most of the nine squares graded high reflect the well-known Levallois sites, particularly in the Thames Valley. These include square 50,16 with the Levallois sites around Yiewsley and West Drayton in west London, square 50,18 with sites around Acton, in particular Creffield Road, and sites in the Lower Thames such as Crayford and Purfleet (square 54,16) and the rich Levallois sites of Baker's Hole and Ebbsfleet (square 56,16) (Scott, 2011). Further east in square 58,16, Bapchild to the south of the Thames is responsible for the high value. The site is in a complex sequence of colluvial and loess sediments just to the south of the Swale, but little is known about its age (Dines, 1929; Scott, 2011).

Away from the Thames, square 50,20 which covers much of the Dunstable Downs, includes Site C at Caddington (Smith, 1894, 1916; Bradley and Sampson, 1978). Site C is probably a mix of different assemblages collected by Worthington Smith at the turn of the 19th century from pits working brickearth deposits infilling dolines in the Cretaceous Chalk. Although the age of the formation and infill of these dolines is unknown, the dominance of Lower Palaeolithic handaxes in the same set of sediments as Levallois artefacts, suggests that the dolines may have formed between MIS 11 and 7 and may represent multiple phases of infilling and collapse over several climatic cycles as has been suggested for artefact-bearing dolines on the North Downs (Bailiff *et al.,* 2013).

To the north around Peterborough (square 50,28) the Levallois artefacts were found with handaxes and derive from pits dug into gravels beneath Terrace 3 of the River Nene. These gravels overlie the Woodston Beds which have been variously interpreted as MIS 11 or MIS 9, suggesting that the overlying Terrace 3 gravels could be of MIS 10 or MIS 8 age (Horton, 1992; Maddy, 1999; Penkman *et al.,* 2012).

In East Anglia, the terraces of the River Gipping, which flows through Ipswich (square 60,24) have yielded artefacts from gravel pits on the floodplain terrace near Bramford Road and Hadleigh Road, though little is known about the context of the artefacts. All the artefacts from the large gravel pit near Bramford Road were recovered by a large suction pump and included a mix of Levallois, a series of small handaxes, but also Upper Palaeolithic material. There is a similar mix of material from Hadleigh Road (Wymer, 1985). The Upper Palaeolithic material suggests that the gravels are Devensian in age and the handaxes have been suggested to be Late Middle Palaeolithic. However, it is not clear whether all the material can be attributed to the Devensian, or whether there has been

reworking of some elements from older sediments. Downstream in the same square there are the sites of Stoke Tunnel and Maidenhall, which underlie a higher terrace of the Gipping with a surface height of c. 12-14 m (OD). A rich faunal assemblage, together with a small collection of Levallois material, was excavated from the 'Stoke Bone Bed' (Wymer, 1985). The faunal assemblage has been attributed to MIS 7 (Schreve, 2001).

Finally, Pontnewydd Cave in north Wales accounts for the high value in this region (square 30,36). There are 93 Levallois artefacts recorded alongside a handaxe assemblage from a brecciated debris flow. It is not clear whether the Levallois material and handaxes are contemporary, but dating of the site suggests an MIS 7 age (Aldhouse-Green *et al.,* 2012).

Analysis 2: Distinguishing good collecting areas through the handaxe record

Analysis 1 identifies those areas with a higher than expected proportion of Levallois artefacts. However, it does not distinguish areas that are genuinely poor in Levallois from those where the paucity of Levallois artefacts is the result of poor collection practices. Analysis 2 seeks to assess biases in the collection of handaxes over other artefacts by examining handaxes as a percentage of all artefacts (handaxes, Levallois, cores and flakes). High handaxe percentages are interpreted as indicating areas where poor collection habits, with a preference for collecting predominantly handaxes, may account for low Levallois artefact numbers. Conversely low percentages should show good collecting areas and in so doing indicate areas with a genuinely low Levallois presence, or alternatively highlight areas with a high Levallois presence that were not recognized in Analysis 1.

The problem of using cores and flakes in the analysis is that the excavated assemblages include large numbers of these artefact types and therefore skew the analysis. For example, Boxgrove alone has an estimated 50,000 cores and flakes, which means that when this location is included in the analysis, that grid square shows an excellent collecting area, but this result masks the contribution of earlier, less systematic collecting. All recently excavated sites have therefore been excluded from Analysis 2. This removes all those sites that were added to form TERPS(MP): Boxgrove, Barnham, Beeches Pit, Elveden, the Waechter excavations at Swanscombe, Southfleet Road and Red Barns and also excavated sites listed in TERPS; the Clacton Golf Course excavations (Singer *et al.,* 1972), Hoxne (Singer *et al.,* 1994) and the Wymer excavations at Swanscombe (Ovey *et al.,* 1964). As an excavated assemblage Pontnewydd is also excluded, but is returned to later as a highly significant outlier to the main Levallois site distribution.

With this analysis there are 64 grid squares that have 100 or more artefacts. Taking the TERPS(MP) dataset without the excavated assemblages shows that 46% of artefacts are handaxes. This can be used as the expected value against which each grid square can be compared. As with Analysis 1, the grid squares have been placed into one of three categories based on an assessment of the overall distribution (SI Table 2, SI Figure 2). Squares with more than 55% handaxes are shown as poor collecting areas, squares with between 35% and 55% as average collecting areas, while squares with less than 35% are shown as good collecting areas (Figure 4, Table 2).

There are 18 squares that can be classed as good collecting areas, five of which reflect the well-known Levallois sites highlighted in Analysis 1 (Table 2; SI Table 2). A further three squares show a notable Levallois presence, but did not feature in Analysis 1 due to low handaxe numbers. Square 58,24 is dominated by Brundon (Suffolk), which was a gravel pit on a terrace of the River Stour. Levallois artefacts and handaxes were found in association with a mammalian assemblage that has been attributed to MIS 7 (Wymer, 1985; Schreve, 2001; White *et al.,* 2006). A series of gravel pits near Huntingdon (square 52,26) have also produced a significant number of Levallois artefacts. The pits were dug into the gravels from Terraces 1 and 2 of the Great Ouse. The terraces probably fall into the age range of MIS 8-2 and the square therefore provides a further location of high Early

Middle Palaeolithic activity. Finally, in square 58,30 there are 12 Levallois artefacts listed for Bartholomew's Hills, Southacre, but from a head gravel of unknown age (Sainty and Watson, 1944; Wymer, 1999).

The remaining ten squares classified as good collecting areas either have low Levallois numbers according to Analysis 1, or have insufficient handaxe and Levallois pieces to feature in that analysis. The question is whether they genuinely reflect low Levallois discard. This is examined in more detail as part of Analysis 3.

Analysis 3: Distinguishing Levallois 'hotspots' from the non-handaxe record

An alternative way to remove the biases that handaxes introduce into the record is by removing them from the analysis. This can be achieved by looking at the percentage of Levallois in the non-handaxe element. It should minimize the impact of poor collecting practices as Levallois artefacts are not overwhelmed by the handaxe record and will therefore identify Levallois hotspots as well as areas of low discard compared to the overall background of flake and core collection. The database has 53 squares with more than a 100 Levallois artefacts, cores, flakes and other non-handaxe material. Taking the TERPS(MP) dataset without the excavated assemblages, the average Levallois percentage of all non-handaxe material is 7.7%, which again provides an expected value against which each square can be assessed. Using a pragmatic approach, the 53 squares have been classified into 'high' (nine squares), 'medium' (eight squares) or 'low' (36 squares) based on their Levallois percentage, with those with greater than 10% classed as high, those with 10 to 5% as medium and squares with less than 5% as low (Figure 5, Table 2, SI Table 3, SI Figure 3).

Most of the Levallois 'hotspots' revealed in this analysis have already been discussed, but there are three additional squares that have not featured previously. Around Aylesford (square 56,14) there are several sites that contain Levallois, with most coming from the New Hythe Pits. These pits were dug into Terrace 3 of the Medway, the date of which is unclear. However, the comparatively low height of the terrace and the association of Lower Palaeolithic handaxes with the Levallois material suggests a late Middle Pleistocene age, perhaps between MIS 9 to 7. Square 60,14 is centered on the River Stour in Kent around Canterbury, where Levallois material has been recovered from slope deposits overlying the gravel of Terrace 2 (Wymer, 1999). The age of Terrace 2 is unclear, but the mix of Lower Palaeolithic handaxes with Levallois material suggests that they are late Middle Pleistocene in age.

A final hotspot is square 44,10 which is the lower reaches of the Test Valley. The high Levallois percentage is caused by the pits around Warsash, where Levallois material was recovered from brickearths overlying Terrace 3 gravels (Burkitt *et al.,* 1939; Davis *et al.,* 2016; Hatch *et al.,* 2017). The age of the gravels is probably MIS 10-8 and the brickearths have been suggested to immediately post-date them, being perhaps of late MIS 8 or MIS 7 age.

Analysis 3 can also be used to examine squares with a low Levallois percentage to ascertain whether there is a real pattern of low Levallois discard in the areas. There are a total of 36 squares which are classified as 'low'. Two of these (squares 50,20 and 54,16, containing Caddington and Crayford respectively) are classed as low, despite having significant Levallois sites. This is due to the assiduous collecting across those areas by Worthington Smith and Spurrell respectively, who also amassed large numbers of non-Levallois flakes and cores.

A further 21 squares have major sites or are dominated by Pleistocene deposits that fall outside the age bracket of MIS 10-6. A low Levallois presence would inevitably be expected for these areas and therefore the squares are excluded from the study (Table 2; SI Tables 2-3). For older deposits, good example are square 60,20 on the Essex coast, where artefacts from Thames deposits of MIS 11 age

at Clacton dominate this area, or square 60,26 where the major location is the MIS 11 site of Hoxne. There are also squares where the deposits or sites are too young to expect Levallois, such as square 42,12, which is dominated by La Sagesse on Terrace 1 of the Test Valley. For other squares, there are Devensian sites, which include derived material; the collections from the foreshore at Watchet in Somerset constitute nearly all the artefacts for square 30,14, which seem to originate from the Doniford Gravel of probable Devensian (MIS 4-2) age. Although the assemblage includes handaxes and one Levallois artefact, too little is known about the origin of the material to include it in the analysis. Therefore all 21 of these squares are rejected from further analysis.

The remaining 13 squares are of more interest and may indicate a genuine pattern of low Levallois discard. Starting with the Thames there are three squares in the middle to upper reaches that seem to have significantly low Levallois numbers. In squares 48,18 and 46,16 around Reading, Maidenhead and Slough there are a large number of sites with significant quantities of artefacts from a diverse range of Thames deposits. This reflects the good collection habits of individuals such as A.D. Lacaille, Llewellyn Treacher and George Smith. Significantly, many of the sites are mapped as Lynch Hill Gravel, which provides an analogous situation to that immediately to the east in Yiewsley, West Drayton and Acton, where by contrast there were significant Levallois percentages. There are several gaps in the record upstream, but square 44,20 near Oxford has material from the Summertown-Radley Terrace of the Upper Thames. The lower part of the terrace probably dates to MIS 7-6, but there is no Levallois material recorded.

Beyond London the south-bank tributaries of the Thames also record little Levallois. Square 48,14 covers the Farnham area, where Terraces A to E were exploited for gravel. The terraces probably encompass deposits of pre-Anglian to Devensian age. A large number of handaxes and flakes was recovered, but very little Levallois.

The north-bank tributaries of the Lower Thames also show low Levallois counts. Square 54,18 covers the east London-Essex border, where there are a combination of Lower Thames terraces and those from the rivers Roding and Ingrebourne. Of perhaps more interest is square 52,18 which encompasses the lower reaches of the River Lea and includes the London suburbs of Stoke Newington, Clapton and Stamford Hill. Substantial collections were recovered by Worthington Smith (Smith, 1882a, 1882b, 1883, 1894) during house-building in the late 19th century. The area is partly mapped as Hackney Gravel, a terrace deposit of the River Lea, which may be broadly equivalent to the Lynch Hill Gravel of the Middle Thames, probably dating to between MIS 10 to 8. The low count in Stoke Newington therefore might be significant and is discussed further below.

Immediately to the north square 52,20 covers an upstream section of the Lea Valley in Hertfordshire. The square is dominated by artefacts from a pit behind the former White Horse Inn in Cheshunt. Worthington Smith collected a small assemblage of 65 flakes, three handaxes and a Levallois core from deposits that are mapped as Taplow Gravel of the River Lea. If this is an equivalent age to the Taplow Gravel of the Middle Thames, then it might date to between MIS 8 and 6. Other than the one core, there seems to be a low Levallois presence in the square.

There are several areas outside the Thames catchment that also have significantly low Levallois counts. In the Breckland on the Suffolk-Cambridgeshire border, square 56,26 has the major site of Warren Hill (accounting for 38% of non-handaxe material) and High Lodge (30%) both of which date to MIS 13. However, there are over 600 other flakes and cores that come from a variety of different deposits. The terraces of the rivers Lark and Kennett are not well understood, but there are gravel pits excavated into terraces mapped as 2, 3 and 4, which are likely to have covered at least the time range between MIS 8 to 6. To this can be added the large surface collections of Dr Allen Sturge.

Despite extensive collecting from a range of deposits, there is very little Levallois material recorded from the area.

The adjacent square (58,26) also has a low Levallois presence. This area has produced far less material, with over 87% coming from Barnham Heath. Here a series of gravel pits, mainly dug in the 1950s, exploited deposits of at least two terraces of the Little Ouse, which probably encompass the period MIS 10 to 6. There are several Levallois artefacts recorded from here, but the Levallois index is still very low.

In the Hilton area of Derbyshire (square 42,32), there are several sites where material was recovered from pits dug into the Etwall Sand and Gravel of the Lower Dove and Trent rivers. The terrace is interpreted as broadly MIS 8 in age (Maddy, 1999). If there was Early Middle Palaeolithic activity in this area, then some Levallois material would have been expected either within or on the terrace gravel.

The final three squares are predominantly on downland or interfluve areas in southern England. Square 62,14 in eastern Kent, includes the sites of Whitfield and Wood Hill. Both assemblages were collected by the Dover Archaeological Group, who have also worked extensively elsewhere in the area. Given the systematic searching that has taken place and the recovery of a significant assemblage of Lower Palaeolithic material, the low Levallois presence in this square is of particular interest. If Lower Palaeolithic material is visible on the surface, there ought to be representation from all later periods if that landscape had been used and material discarded. The absence of Levallois might be significant, although it should be noted that Levallois artefacts have been more recently recorded from Finglesham, which does not appear in the TERPS database (Scott pers. comm.)

Square 54,14 covers the Ightham area of Kent, further to the west on the North Downs. Many of the artefacts come from Oldbury Rock Shelter, which is probably Devensian in age (Cook and Jacobi, 1998). However, much of this area was scoured by Benjamin Harrison, who collected both surface finds and material from pits. Despite his assiduous researching, there is very little Levallois material from this square.

Finally, square 46,14 in Hampshire is an area of predominantly chalk downland. The Hampshire Field Club collected much of the material from the surface, including from sites such as Ellisfield and Holybourne Down. Despite assiduous field-walking and collecting over large areas of downland, very little Levallois material was collected. If Levallois artefacts had been discarded in the area, they should have been collected alongside the other Palaeolithic collections. It is collection by groups such as this that produce the most robust patterns for identifying genuine areas of low quantities of Levallois material.

Summary of results

The three analyses described above provide a means of assessing the British Lower and Middle Palaeolithic record and investigate the spatial patterns in the data. The coarse resolution employed in the analyses inevitably masks local-scale variation, but it enables broader spatial patterns to be identified. The results of each analysis have been considered in turn as they highlight slightly different aspects of the dataset. It is also possible to integrate the results of these analyses and make a qualitative assessment of the results to derive an overall assessment of the patterns identified for each square, the Levallois Significance grade, in which each square rates high, medium or low, on the basis of interpretation of the results of analyses 1-3 (Table 2; Figure 6).

The significant Levallois hotspots seem to be in the lower reaches of eastern and some southern rivers. These include the middle to lower reaches of the Thames, the Medway and Stour in Kent, the Gipping and Stour in Suffolk, the Great Ouse in Cambridgeshire, and the lower reaches of the Test or Solent in Hampshire. There are two important exceptions. The Levallois assemblage from Caddington was associated with a doline on Dunstable Downs and is one of the few locations to produce Levallois in an interfluve location. The most notable outlier is Pontnewydd Cave in north Wales, again in an upland location.

Of equal interest are the areas with significantly low Levallois counts. These seem to be in the middle to upper reaches of rivers, in particular the Thames and its tributaries, such as the Wey, the Lea and the possibly the Roding. Some of the middle to upper reaches of East Anglian rivers or smaller tributaries also show low counts. These include short tributaries of the Great Ouse, such as the Lark and Little Ouse. With the exception of Caddington, several areas of downland have significantly low counts in parts of Kent and Hampshire.

The patterning is particularly marked to the north and west of London. In the Yiewsley, West Drayton and Acton areas of west London, Levallois artefacts were recovered from the top of the Lynch Hill Gravel, usually sealed by slope and aeolian deposits, collectively termed Langley Silt (Brown, 1887, 1895; Ashton *et al.,* 2003; Scott, 2011). The work of John Allen Brown in the latter part of the 19th century ensured the collection of both handaxes and non-handaxe material. There is a marked drop in the Levallois counts upstream, from Slough through to Reading and beyond. Lynch Hill Gravel is widespread in these areas with large sites such as Baker's Farm and Furze Platt. These gravels were often sealed by slope deposits (Lacaille, 1940; Wymer, 1968). Yet, despite the good collecting in these areas by A.D. Lacaille, George Smith and Llewellyn Treacher (Hosfield, 2009) little Levallois material was recovered. There might be localised depositional or taphonomic reasons for this stark difference, but these adjacent areas certainly deserve further investigation.

In the Lea Valley, the area around Stoke Newington was assiduously collected by Worthington Smith with large assemblages recovered during house-building in the late 19th century (Smith, 1894). He described many of the artefacts as coming from a 'floor' within brickearth above gravel. The area is mainly mapped as Hackney Gravel (Strange, 1992), which seems to be broadly equivalent to the Lynch Hill Gravel of west London. At the northern and western edge of the Hackney Gravel, fine-grained deposits are mapped and some of the Palaeolithic artefacts found in association with the 'Palaeolithic floor' may have come from these fine-grained sediments (Smith, 1882a, 1882b, 1883, 1894). They have been variously classified as the Langley Silt Complex (cf. Gibbard, 1985), Highbury Silts and Sands (Gibbard, 1994) and the Stoke Newington Sands (Harding and Gibbard, 1984; Green *et al.,* 2006). If they are equivalent to the Langley Silts, they are likely to overlie the Hackney Gravel and may therefore represent an analogous situation to that found in west London. However, Green *et al.* (2006) suggested that these fine-grained deposits predate both the Hackney Gravel and the Highbury Silts and Sands at Hackney Downs, the latter being attributed to MIS 9 (Green *et al.,* 2004), and reverted to the term Stoke Newington Sands (cf Harding and Gibbard, 1984). If correct the archaeology found associated with the 'Palaeolithic floor' may predate that overlying the Lynch Hill Gravel in west London. There is virtually no Levallois material recorded in the Stoke Newington area. One exception is a small collection of 11 artefacts collected by H.G. Mantel in 1923, simply labelled 'Stoke Newington', now housed in the British Museum (Roberts, 1999). There is no further provenance, but they are in very fresh condition and may be part of an undisturbed knapping scatter. The condition and technology are similar to Crayford (Scott, 2011) and the group includes five Levallois artefacts. Other than this enigmatic evidence, the overall Levallois count for this square is surprisingly low, but might be explained through further investigation of the geology.

The overall pattern from the analyses of artefact distribution seems to show significantly higher Levallois concentrations in the lower reaches of rivers in south-east England. This pattern has several implications for the interpretation of the Early Middle Palaeolithic occupation of Britain, which are discussed below.

Discussion

The pattern of Levallois artefact discard can be used to assess the Early Middle Palaeolithic occupation of Britain in comparison to earlier periods. The pattern might reflect differences in landscape use, extent of population dispersal into Britain and the nature of land connections to mainland Europe. However, first the issue of dating of Levallois technology needs to be more fully addressed.

Dating Levallois technology and the Early Middle Palaeolithic

The identified pattern is based on the assumption that most, if not all, Levallois artefacts in Britain reflect Early Middle Palaeolithic, rather than Late Middle Palaeolithic, activity. As discussed above, this assumption is mainly based on good dating of all the major sites to between MIS 9-6, such as Ebbsfleet (Scott *et al.,* 2010); Crayford (Penkman *et al.,* 2011); Creffield Road (Scott, 2011), various locations in Yiewsley and West Drayton (Scott, 2011), Warsash (Davis *et al.,* 2016; Hatch *et al.,* 2017) and Pontnewydd Cave (Aldhouse-Green *et al.,* 2012). Many other locations occur on the middle terraces of rivers (Wymer, 1999), or otherwise on poorly-defined terraces on some of the lowland rivers, such as the Great Ouse or the Nene.

By contrast the evidence of a Devensian age for Levallois sites is limited. There might be one or two exceptions where Levallois artefacts have been recovered from Devensian sediments, such as Great Pan Farm on the Isle of Wight or Bramford Road, Ipswich (see above and Table 2; Shackley, 1973; Wenban-Smith and Bates, 2005; Wymer, 1985, 1999). However, both these sites have adjacent higher terraces, so it is possible that there has been reworking of material from older sediments into Devensian terrace gravels. For well-dated Devensian sites in caves or undisturbed sediments, there is virtually no evidence of Levallois. This is the case for the Late Middle Palaeolithic assemblages from Creswell Crags (Pettitt and White, 2012) and also from the *in situ* Late Middle Palaeolithic site at Lynford, Norfolk (Boismier *et al.,* 2012). It seems overall that the vast majority of Levallois material is Early Middle Palaeolithic in age, although possible exceptions should be borne in mind.

Landscape use

There have been suggestions over the last two decades that one of the characteristics of the Early Middle Palaeolithic compared with earlier periods was the broader and more logistical use of landscapes by early Neanderthal populations (White *et al.,* 2006; Scott, 2011). It has been argued that Levallois technology was both planned in its manufacture, but also in its use, being curated across greater distances. The more expansive use of landscapes has been linked to the encroachment of the mammoth-steppe into western Europe from MIS 8-7 (Gamble and Roebroeks, 1999; Scott *et al.,* 2011). The arguments followed that with the emergence of steppic grasslands and larger herds, there was an expansion of Neanderthal territories where with better equipment they developed more skilled and specialised hunting. Hafted Levallois points provided the tools for more effective hunting, while the pursuit of specific herds can be seen at sites such as La Cotte de St Brelade, La Borde, Mauran, Coudoulous and Orgnac (Callow and Cornford, 1986; Jaubert *et al.,* 1990; Farizy *et al.,* 1994; Brugal *et al.,* 1998; Moncel *et al.* 2013; Scott *et al.,* 2015). The interpretation of broader, more logistical landscape use can be examined as three distinct aspects: habitats; strategic use; and territory size.

It has been suggested that as part of a broader use of landscapes there was an expanded use of new habitats beyond the river valleys with increased foraging and hunting on the interfluves (White *et al.,* 2006; Scott, 2011). This interpretation is not supported by the British evidence where the current analysis shows that the distribution of Levallois artefacts was concentrated on the larger river systems, with a paucity of material in the upper reaches of rivers and on the interfluves. The exception is Caddington on Dunstable Downs, where one of a complex series of doline sites contained Levallois artefacts (Bradley and Sampson, 1978). However, the neighbouring dolines are dominated by Lower Palaeolithic handaxes, which suggests that there was little change in landscape use in this area during the Early Middle Palaeolithic. This may also be reflected by the overall analysis of the British data with a small, but persistent signature of handaxes found in interfluve areas.

There is better support for the increased use of interfluves in neighbouring mainland Europe during the Early Middle Palaeolithic, although the archaeological signatures are more complex. Many of the sites include handaxes and do not necessarily contain Levallois, and the sites cover a broader time-range from MIS 9 through to early MIS 6 (Scott and Ashton, 2011). In north-west Europe the sites of Gouzeaucourt, Le Pucheuil, Gentelles and Oisiers à Bapaume are found in dolines (Tuffreau and Bouchet, 1985; Ropars *et al.,* 1996; Tuffreau *et al.,* 1999; Koehler, 2008). Other sites are in alluvial situations, such as Maastricht-Belvedere, Biache, Salouel or valley edge as at Therdonne (Roebroeks, 1985; Tuffreau and Sommé, 1988; Amerloot-van der Heijden *et al.,* 1996; Locht *et al.,* 2000). In central and southern France a wider range of locations can be identified, including caves (Jaubert *et al.,* 1990; Farizy *et al.,* 1994; Brugal *et al.,* 1998; Fernandes *et al.,* 2008; Moncel *et al.,* 2013). The current study suggests that the British data does not reflect that of mainland Europe.

Previous studies have suggested a more structured use of landscape and for Britain this can be shown at Creffield Road in west London. It is interpreted as a provisioning site where the different knapping stages of Levallois point production and repair show the complex export and import of artefacts (Scott, 2011). Unfortunately, most other British Early Middle Palaeolithic sites lack the representative assemblages or the contextual detail to enable this type of analysis. However, supporting evidence for structured landscape use comes from several sites where their location is on an older terrace, just above the floodplain. This is the case for the west London sites of Creffield Road and other locations in West Drayton and Yiewsley, and also Warsash at the Solent/Test confluence (Ashton *et al.*, 2003; Davis *et al.*, 2015; Hatch *et al.*, 2016). These positions would have provided good views across the valleys, but still in close proximity to a wide range of resources by the river and above the floodplain. In mainland Europe a more logistical site use can also be identified at sites such as La Cotte de St Brelade (Shaw *et al.,* 2017) and Orgnac (Moncel *et al.,* 2013).

The evidence for increased territory size in the Early Middle Palaeolithic is largely dependent on raw material studies where the use of exotic rocks have been suggested to reflect group seasonal range (e.g. Geneste, 1988; Roebroeks *et al.,* 1988; Féblot-Augustins, 1999). However, for Britain and much of north-west Europe the widespread occurrence and use of Cretaceous flint makes use of this method of analysis problematic. Despite these difficulties, the current study hints at comparatively limited territories for the British Early Middle Palaeolithic. The concentration of Levallois artefacts in the lower reaches of larger rivers suggests that much of Early Middle Palaeolithic activity was focused on these locales. The apparent decrease in Levallois artefacts in the Lea Valley and in the Thames beyond London shows more limited forays into these zones or indeed onto the surrounding higher ground. The same is perhaps the case with the lower reaches of the Solent and some of the larger East Anglian rivers.

In other parts of Europe, outside the areas of flint-rich gravels from Cretaceous bedrock, several sites show raw material transport over moderate distances of up to 30 km. These sites include La Cotte de St Brelade on Jersey (Callow and Cornford, 1986; Shaw *et al.,* 2017) or the southern French sites of Orgnac (Moncel *et al.,* 2012) and Payre (Fernandes *et al.,* 2008). Exceptionally Sainte Anne I in the Massif Central has several artefacts that come from over 60 km and one artefact from over 100 km (Fernandes *et al.,* 2008). However, this limited record is not so different from that of the Lower Palaeolithic with for example raw material transport of 20 km for Menez Dregan (Ravon, 2017), over 30 km for L'Arago (Barsky, 2013) and at least 60 km for Waverley Wood (Keen *et al.,* 2006).

It can be concluded that the issue of landscape use in the Early Middle Palaeolithic is complex. A more structured use of landscape is supported by import and export studies of different technological stages of artefacts from sites and also the positioning of sites in strategic positions above the floodplains of rivers. However, with the current data there is little evidence of larger territories, while the wider use of habitats is only supported by the evidence from mainland Europe, rather than Britain.

Britain and routeways from north-west Europe

The British Early Middle Palaeolithic record provides some similarities with the rest of Europe, but also has some marked differences. The sites that are found in the south and east of England have a more limited range of habitats and more limited distribution than their continental counterparts. They also display a more restricted technology with the use of Levallois, and the virtual exclusion of handaxes. As human populations must have originated in north-west Europe, can these apparent differences reflect the nature of occupation of Britain at this time?

The changing island to peninsula status of Britain has long been recognized to have had an effect on human population (Preece, 1995; White and Schreve, 2000; Ashton and Lewis, 2002; Stringer, 2006; Ashton *et al.,* 2011, 2015, 2016; Ashton 2017). It is widely accepted that the initial breach of the chalk to form the Strait of Dover was during MIS 12 and this provided the potential to make Britain an island during periods of high sea-level (Smith, 1985; Gibbard, 1995; Toucanne *et al.,* 2009). It is also likely that Britain's island status after this breach is complex in part due to subsidence of the floor of the North Sea Basin from approximately modern-day sea-level during MIS 11 to its maximum depth now of c. -40 m (Ashton and Hosfield, 2010; Ashton *et al.,* 2011). More recently it has also been suggested that until MIS 6 a landbridge may have persisted in the area of the Southern Bight (Hijma *et al.,* 2012), which formed an interfluve between the Rhine to the north, and the Thames and Scheldt to the south. This could have provided a narrow routeway into Britain during higher sea-levels from MIS 11 to 7, until the Strait was further enlarged during MIS 6 (Gupta *et al.,* 2007, 2017; Toucanne *et al.,* 2009).

Although physical evidence for a landbridge in the Southern Bight is lacking, due to its eradication probably in MIS 6, its former existence may be inferred from the first appearance of Lusitanian marine molluscs in the North Sea Basin from further south during MIS 5e (Preece and Meijer, 1995). The topography of this landscape is unknown, but if this interpretation is correct, access to Britain from north-west Europe during the later Middle Pleistocene may have occurred across an area that varied from being predominantly dry or semi-submerged land, to being completely inundated during the highest sea-levels. Motivation for human groups to traverse the landbridge could have been pursuit of migratory herds or larger shifts in prey distribution as climate changed.

It has been suggested that most of the Thames Levallois sites date to the end of MIS 8 and beginning of MIS 7 (Ashton *et al.,* 2003; Scott, 2011). An interpretation can be put forward that as climate warmed at the end of MIS 8 a small human population colonised south-east England. The high sea

levels recorded for MIS 7e (Waelbroeck *et al.,* 2002; Roucoux *et al.,* 2006, 2008) may have drowned the Southern Bight interfluve. As a small and isolated population, their survival in south-east England could have been short-lived and without population pressure, or a driver for northwards or westwards migration, they could have simply colonised areas that provided an adequate array of resources, such as the lower reaches of rivers (Ashton *et al.*, 2006; Parfitt *et al.*, 2010; Brown *et al.*, 2013). This interpretation would explain both the very specific technology and also the limited distribution that is seen in south-east England.

There is, though, some evidence of Early Middle Palaeolithic occupation beyond southern and eastern England. Most consists of isolated finds, but Pontnewydd Cave in north Wales is a clear outlier to the main distribution (Aldhouse-Green *et al.,* 2012). Pontnewydd is unusual in being the only cave site with evidence of Early Middle Palaeolithic occupation, which may simply reflect a lack of preservation of late Middle Pleistocene sediments in other cave systems, such as Creswell Crags, and those in the Mendips, Gower and south-west England.

The Pontnewydd assemblage is also different in character to those in southern and eastern England as it contains both Levallois artefacts and handaxes. It has been suggested that in fact there is a mix of two assemblages (Pettitt and White, 2012), which may be the case, but there is little evidence to support it. An alternative interpretation might be that the Neanderthals of Pontnewydd stem from a different incursion into western Britain. There is some evidence for handaxe-making populations in western England at Harnham in Wiltshire during MIS 8 (Bates *et al.,* 2014) and possibly at Broom (Hosfield and Green, 2013). Both assemblages lack good evidence of Levallois technology, although it has been suggested that they could be MIS 9 in age (Pettitt and White, 2012). It has been argued that the apparent late occurrence of handaxes might be related to Early Middle Palaeolithic populations in western France which also have handaxes as the dominant technology with occasional use of Levallois (Scott and Ashton, 2011; Ashton and Scott, 2015). At present the evidence is thin, but it seems that there is a different pattern in the west of Britain compared to southern and eastern areas and this possibly reflects a different population incursion from western France or even British residual groups, some of whom adopted Levallois technology. From the record, these populations seem to have been dispersed and possibly isolated. It is worth noting that at Pontnewydd the Neanderthal fossil evidence suggests that they suffered from disease or starvation with indications of hypoplasia in the teeth (Stringer, 2012; Crompton and Stringer, 2012). The only girl represented died aged nine, while the teeth from three male adolescents are also thought to reflect time of death, rather than tooth-loss. One male survived into adulthood. Although based on a small data set, it does hint at struggling populations on the north-western edge of the Neanderthal world.

Conclusion

This paper has analysed the spatial distribution of the most complete dataset of British Lower and Early Middle Palaeolithic artefacts and findspots. Differences in distribution show a wider geographic spread of Lower Palaeolithic handaxes, in contrast to the more concentrated distribution of Early Middle Palaeolithic Levallois artefacts to the south and east of England, particularly in the lower reaches of larger rivers. Their distribution and dating, together with recent analysis of the southern North Sea Basin, suggest that early Neanderthals colonised south-eastern England from north-west Europe via a narrow landbridge in the Southern Bight towards the end of MIS 8 or early MIS 7. It is suggested that subsequent drowning of the landbridge led to an isolated and small population that occupied optimum foraging and hunting grounds in large lowland valleys, but which ultimately succumbed to a dwindling gene pool and isolation.

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Figure captions

Figure 1. A. Distribution of handaxe sites and finds locations in England and Wales, B. Distribution of Levallois sites and finds locations in England and Wales. Distributions based on British Museum collections after Ashton *et al.*, 2015.

Figure 2. Location of main rivers and sites in England and Wales showing the limits of glaciation during the Anglian (MIS 12) and the Late Devensian (LGM, MIS 2). Glacial limits based on Chiverrell and Thomas 2010.

Figure 3. Results of Analysis 1 showing 20 x 20 km grid squares in England and Wales with high, medium or low Levallois percentages.

Figure 4. Results of Analysis 2 showing 20 x 20 km grid squares in England and Wales with good, average or poor collection.

Figure 5. Results of Analysis 3 showing 20 x 20 km grid squares in England and Wales with high, medium or low Levallois percentages.

Figure 6. Summary results of Analyses 1-3 showing 20 x 20 km grid squares in England and Wales with significantly high, medium or low Levallois percentages.

Table 1. Summary of Analyses 1-3 showing number of squares used, expected value for whole dataset, classification and rationale behind the analyses.

Analysis	No. of squares	Whole Dataset	Classification	Rationale
1. Levallois artefacts as a percentage of total handaxes and Levallois artefacts. Lx100/(L+H)	51	8.3%	High >15% Medium 5-15% Low <5%	• Identifies squares based on their proportion of Levallois artefacts, • compares the percentage of Levallois in each square against that for the whole dataset, which can be taken as an 'expected' proportion, • High indicates more Levallois than expected, low indicates less Levallois than expected, • Provides a basic measure of spatial variation in Levallois occurrence but does not account for variation in collection history.
2. Handaxes as a percentage of total artefacts. Hx100/(L+H+FC)	64	46%	Good <35% Average 35-55% Poor >55%	• Identifies squares based on the dominance of handaxes, • Compares the percentage of handaxes in each square with the expected proportion for the whole dataset, this is taken as a measure of the quality of collecting activities, • Low value indicates low handaxe dominance and therefore good collecting, a high value indicates a bias towards handaxes and therefore poor collecting.
3. Levallois artefacts as a percentage of total non-handaxe artefacts. Lx100/(L+FC)	53	7.7%	High >10% Medium 5-10% Low <5%	• Identifies squares based on the occurrence of Levallois as a percentage of total non-handaxe artefacts, • Compares percentage of Levallois to all non-handaxe artefacts against the expected proportion for the whole dataset, this is taken as a measure of the quality of collecting, • High values indicate more Levallois than expected and better collection, low indicates less Levallois than expected and therefore poor collection.

For formulae: L=Levallois; H=handaxes; FC=Flakes, flake tools, cores and miscellaneous material.

Table 2. Results for each square of Analyses 1-3 showing squares with a dominance of sites or deposits that are not of Early Middle Palaeolithic age (MIS 10-6). A preferred interpretation is given with an explanation of the overall assessment of whether the square is rejected from the analyses or has a significantly high, medium or average Levallois count. Most data is derived from TERPS, except where alternative references are given.

NG Sq	A1	A2	A3	Dom. non EMP age deposits	Interpretation	Signif. Levall.
30,14		G	L	Y	Square dominated by well-collected assemblage from foreshore at Watchet. Artefacts derive from Donniford Gravel of probable Devensian age (Campbell *et al.*, 1999)	X
30,36	H				Pontnewydd Cave is only site in square. Significant Levallois assemblage of MIS 7 age (Aldhouse-Green *et al.,* 2012)	H
32,10	L	P		Y	Square dominated by pits at Broom. Large handaxe assemblage suggests Lower Palaeolithic site, although OSL dates of MIS 8 age (Hosfield & Green, 2013)	X
34,16	L	A	L	Y	Square dominated by well-collected surface assemblage. From Chapel Pill Farm. Assemblage probably derives from the Ham Green Terrace of the Bristol Avon, probably MIS 9 or older (Campbell *et al.,* 1999)	X
36,8	L	P		Y	Square dominated by handaxes from Moreton Pits in West Knighton Gravel of River Frome. Handaxes suggest Lower Palaeolithic date	X
38,8	L	P		Y	Square dominated by Lower Palaeolithic handaxes from pits at Corfe Mullen of possible MIS 13 age (McNabb *et al.,* 2012; Davis, 2013; Hatch, 2014)	X
40,8	L	P	M		Square covers much of Bournemouth with terraces of rivers Stour and former Solent. Some Levallois recovered from probable MIS 10-8 contexts (Ashton & Hosfield, 2010; Davis, 2013; Hatch, 2014)	M
40,10	L	P	L	Y	Square dominated by Wood Green on Terrace 7 of Hampshire Avon, likely to be MIS 9 or older	X
40,12	L	P	L	Y	Square dominated by Milford Hill on 'Higher Terrace' of Hampshire Avon, likely to be MIS 9 or older	X
42,8	L	A	L	Y	Square dominated by mixed surface collection from High Down, Isle of Wight, and artefacts from Old Milton Gravel of Solent. Latter probable MIS 10 age (Briant *et al.,* 2006; Ashton & Hosfield, 2010; Hatch, 2014)	X
42,10	L	P			Poor collecting area in Southampton with dominance of handaxes	X
42,12	L	A	L	Y	La Sagesse dominates square. Site is in gravel of Terrace 1 of River Test of Devensian age (Bates *et al.,* 2008)	X
42,16	L	P	L	Y	Square dominated by Knowle Farm from head deposits. Handaxes suggest age of MIS 9 or older	X
42,32	L	A	L		Square has artefacts from pits in the Hilton area, which cut into Etwall Sand and Gravel of the Lower Dove and Trent rivers. Gravel is of probable MIS 8 age and the lack of Levallois may be significant (Maddy, 1999)	L
44,8	M	P		Y	Square dominated by Great Pan Farm with artefacts recovered from Terrace 1 of River Medina of probable Devensian age (Shackley, 1973; Wenban-Smith & Bates, 2005)	X
44,10	L	P	H		Square dominated by gravel pits on Terraces 2 and 3 of the River Test at Warsash. The significant Levallois component comes from brickearth above Terrace 3 of probable MIS 10-8 age (Davis *et al.,* 2016; Hatch *et al.,* 2017)	H
44,12		P			Poor collecting area north of Southampton with dominance of handaxes	X
44,18	M	A	M		Square dominated by Berinsfield. Artefacts probably from lower part of Summertown-Radley Terrace of the Upper Thames of probable MIS 7-6 age (MacRae, 1982)	M
44,20	L	P	L		Wolvercote is the major site of probable MIS 9 age Maddy *et al.,* 1991; Bridgland 1994). However a number of sites including Stanton Harcourt are in gravel pits in Summertown-Radley Terrace, the lower part of which might be MIS 8-6 in age. The low Levallois count might be significant	L
44,28		A	L	Y	Well-collected surface assemblage from Bramcote area, with no Levallois, but probably derived from underlying Wigston Sand and Gravel of MIS 12 age (Maddy, 1999)	X
46,8	L	P	L	Y	Square dominated by Priory Bay, Isle of Wight, of probable MIS 3 age	X

46,14	L	A	L		Square with well-collected surface artefacts by Hampshire Field Club. Predominantly downland and significantly low Levallois	L
46,16	L	P	L		Large number of locations from different terraces of the Middle Thames covering MIS 12-6. Low Levallois count might be significant	L
46,18	L	G	L	Y	Square dominated by Highlands Farm in Caversham Channel of Middle Thames. Gravel MIS 12 in age (Wymer, 1968)	X
48,10	L	A	L	Y	Square dominated by Slindon Bottom on MIS 13 raised beach (Pope *et al.,* 2009)	X
48,14	L	P	L		Square dominated by sites in Farnham area, with a range of different terraces of the River Wey. Low Levallois count might be significant	L
48,18	L	P	L		Wide range of sites from different terraces of Middle Thames between around Maidenhead. Low Levallois probably significant	L
50,16	H	A	H		Square dominated by gravel pits in Yiewsley/West Draton area. Significant Levallois count from surface of Lynch Hill gravel of Middle Thames of MIS 10-8 age (Scott, 2011)	H
50,18	H	A	H		Square dominated by sites around Creffield Road, Acton. Significant Levallois count from surface of Lynch Hill gravel of Middle Thames of MIS 10-8 age (Scott, 2011)	H
50,20	H	G	L		Square dominated by doline sites at Caddington, which include Levallois material from Site C. Sites of probable late Middle Pleistocene age (Bradley & Sampson, 1978)	M
50,22	L	A	L	Y	Square dominated by Hitchin sites of MIS 11 age and Round Green in Luton of probable MIS 11-9 age	X
50,24	L	P	M		A variety of sites around Bedford from different terraces of the Great Ouse	M
50,26		G	L	Y	Square dominated by gravel pits near Little Paxton in Terraces 1 and 2 of the Great Ouse. The significant LMP component, suggests most gravel was Devensian, which may explain the low Levallois count (Paterson & Tebbutt, 1947; Wymer, 1985)	X
50,28	H	G	H		Significant Levallois count from Terrace 3 Gravels of River Nene, above Woodston Beds. Gravels of probable MIS 10-8 age (Horton *et al.*, 1992; Maddy, 1999)	H
52,14	L	A	L	Y	Square dominated by Kingswood, a surface collection of handaxes. Site probably too old to expect Levallois	X
52,16	M	P	H		Square has small number of artefacts from large number of locations and variety of deposits mainly south of the Thames in London. Only 12 Levallois artefacts from 12 different locations. Registers as high Levallois index, despite low count. Significance uncertain	M
52,18	L	G	L		Large collections from Stoke Newington area most coming from Hackney Gravel or Highbury Silts and Sands of River Lea of MIS 10-8 age. Low Levallois count seems significant (Smith, 1894; Green *et al.,* 2004)	L
52,20		G	L		Only notable site is gravel pit hear White Horse Inn, Cheshunt. Gravels noted as 'Taplow Terrace' of River Lea of possible MIS 8-6 age	L
52,26		G	H		Series of gravel pits in Terraces 1 and 2 of the Great Ouse near Huntingdon with significant Levallois count. Terraces probably range from MIS 8-2	H
52,28		G	L	Y	Square dominated by collections from Peterborough Common on low-lying terrace of the Nene. The low Levallois count may be due to the gravels being too young	X
54,14	L	A	L		Range of surface material and from pits in Oldbury-Ightham area. Assiduous collecting by Benjamin Harrison suggests low Levallois count significant	L
54,16	H	G	L		Levallois assemblage from brickearth pits at Crayford in Lower Thames of MIS 7-6 age. 'Proto Levallois' assemblage from gravel in Corbets-Tey Terrace of Lower Thames of MIS 9-8 age	M
54,18	L	P	L		Large number of locations in London/Essex border from variety of terrace deposits. Low Levallois count might be significant	L
54,24	L	P			Low number of artefacts from poor collection area	X
54,26		G	L	Y	Square dominated by Traveller's Rest pit, cut into Observatory Gravels of probable MIS 12 age (Wymer, 1985)	X
56,14	M	A	H		Significant Levallois count from gravel pits in Terrace 3 of the Medway near Aylesford. Association of handaxes and height of terrace suggest late	H

					Middle Pleistocene age	
56,16	H	G	M		Square dominated by Swanscombe sites, but large Levallois assemblage from Bakers Hole and Ebbsfleet channel of MIS 8-7 age (Scott *et al.,* 2010)	H
56,26	L	P	L		Although square dominated by MIS 13 sites Warren Hill and High Lodge, range of additional sites with over 600 artefacts might show significant low Levallois count	L
56,28	L	P		Y	Square dominated by pre-MIS 12 sites of Lakenheath, Brandon Fields and Feltwell	X
58,16	H	G	M		Most Levallois artefacts from colluvial and loess deposits at Bapchild of unknown age (Dines, 1929; Scott, 2011)	M
58,20		P		Y	Square only has 103 artefacts with most coming from site at Witham associated with MIS 12 glacial sediments	X
58,24		G	M		Over 96% of square from Brundon, a gravel pit on the River Stour. It has a Levallois component and dates to MIS 7 (Wymer, 1985; Schreve, 2001)	M
58,26	L	A	L		Square dominated by Barnham Heath with gravel pits on at least two terraces of the Little Ouse, probably ranging from MIS 8-2. The low Levallois count might be significant	L
58,28	L	P			Area around Thetford has important handaxe sites, but little non-handaxe material	X
58,30		G	M		Square dominated by pits at Southacre. Levallois component from gravels at Bartholomew's Hills of unknown age (Sainty & Watson, 1944; Wymer, 1985)	M
60,14	M	P	H		Square dominated by gravel pits on River Stour around Canterbury. At least some of the Levallois assemblage comes from brickearth above Terrace 2 of probable late Middle Pleistocene age (Wymer, 1999)	H
60,16	L	P	L	Y	Square dominated by handaxes sites at Sturry on Terrace 2 of the Stour. The age of Sturry is unknown, but might be too old to expect Levallois	X
60,20		G	L	Y	Square dominated by Thames deposits of MIS 11 at Clacton	X
60,22		G	M	Y	Square dominated by collection from gravel pit at Thorpe-le-Soken. Age of gravel unknown, but may be too old to expect Levallois (Wymer, 1985). Small Levallois assemblage from Stutton of probable MIS 7 age (Wymer, 1985; Schreve, 2001)	X
60,24	H	A	H		Significant Levallois material from at least two terraces of the Gipping. Most assemblages mixed, other than Stoke Tunnel and Maidenhall of MIS 7 age (Wymer, 1985; Schreve, 2001)	H
60,26	L	A	L	Y	Square dominated by MIS 11 site of Hoxne (Singer *et al.,* 1993; Ashton *et al.,* 2008)	X
62,14		G	L		Area of North Downs, with significant fieldwalking by Dover Archaeological Group. Notable sites are Whitfield and Wood Hill. Low Levallois count may be significant	L
62,16	L	P			Square dominated by handaxe site at Reculver, but little non-handaxe material	X
62,22	L	A	L	Y	Gravel pit Dovercourt dominates square. Interpreted as fluvial, height at 27m suggests MIS 9 or earlier date (Wymer, 1985)	X
62,30	L	P	L	Y	Square dominated by handaxe sites at Keswick and Whittlingham, near Norwich. Age of sites not known, but might be too old to expect Levallois	X

NG Sq = National Grid Square; A1=Analysis 1; A2=Analysis2; A3=Analysis 3; H=high Levallois; M=medium Levallois; L=low Levallois; G=good collecting; A=average collecting; P=poor collecting; Y=square with dominance of sites or deposits of non Early Middle Palaeolithic (EMP) age; LMP=Late Middle Palaeolithic; X=rejected from analysis.

Table 3. Summary of squares with significantly high, medium or low Levallois presence.

NG Sq	A1	A2	A3	Landscape position	Signif Levall
30,36	H	G		Cave in small valley upland area	H
40,8	L	P	M	Middle reaches of Solent/Stour	M
42,32	L	A	L	Upper reaches of Trent	L
44,10	L	P	H	Lower reaches of Test/Solent	H
44,18	M	A	M	Upper reaches of Thames	M
44,20	L	P	L	Upper reaches of Thames	L
46,14	L	A	L	Predominantly downland	L
46,16	L	P	L	Middle reaches of Thames	L
48,14	L	P	L	Middle reaches of Wey	L
48,18	L	P	L	Middle reaches of Thames	L
50,16	H	A	H	Middle reaches of Thames	H
50,18	H	A	H	Middle reaches of Thames	H
50,20	H	G	L	Predominantly downland	M
50,24	L	P	M	Middle reaches of Great Ouse	M
50,28	H	G	H	Lower reaches of Nene	H
52,16	M	P	H	Predominantly middle reaches of Thames	M
52,18	L	G	L	Lower reaches of Lea	L
52,20		G	L	Middle reaches of Lea	L
52,26		G	H	Middle/lower reaches of Great Ouse	H
54,14	L	A	L	Predominantly downland	L
54,16	H	G	L	Lower reaches of Thames	M
54,18	L	P	L	Lower reaches of north-bank tributaries of Lower Thames	L
56,14	M	A	H	Middle reaches of Medway	H
56,16	H	G	M	Lower reaches of Thames	H
56,26	L	P	L	Mix of middle reaches of Lark and areas of interfluve	L
58,16	H	G	M	Mix of small river valleys and areas of interfluve	M
58,24		G	M	Middle reaches of Suffolk Stour	M
58,26	L	A	L	Middle reaches of Little Ouse	L
58,30		G	M	Middle reaches of Nar	M
60,14	M	P	H	Middle reaches of Kent Stour	H
60,24	H	A	H	Lower reaches of Gipping	H
62,14		G	L	Predominantly downland	L

NG Sq = National Grid Square; A1=Analysis 1; A2=Analysis2; A3=Analysis 3; H=high Levallois; M=medium Levallois; L=low Levallois; G=good collecting; A=average collecting; P=poor collecting.

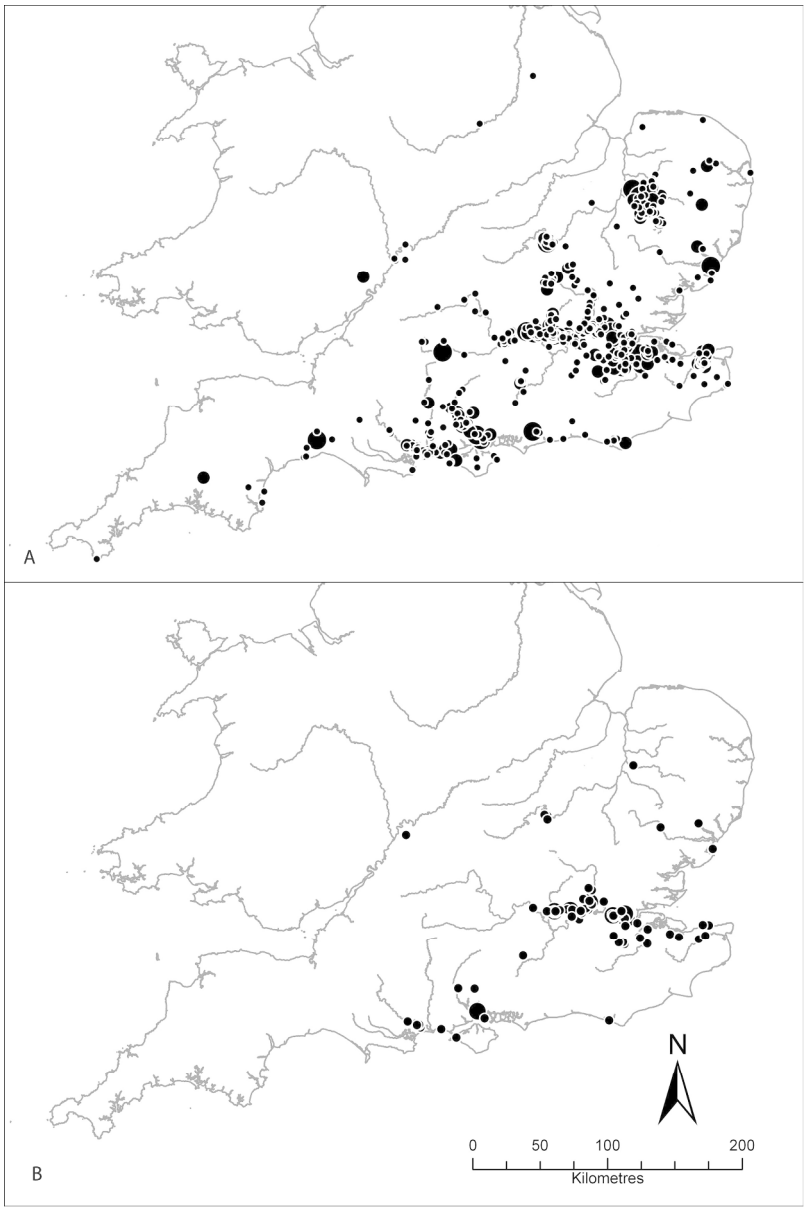


Figure 1. A. Distribution of handaxe sites and finds locations in England and Wales, B. Distribution of Levallois sites and finds locations in England and Wales. Distributions based on British Museum collections after Ashton et al., 2015.

297x446mm (300 x 300 DPI)

Figure 2. Location of main rivers and sites in England and Wales showing the limits of glaciation during the Anglian (MIS 12) and the Late Devensian (LGM, MIS 2). Glacial limits based on Chiverrell and Thomas 2010.

172x123mm (300 x 300 DPI)

Figure 3. Results of Analysis 1 showing 20 x 20 km grid squares in England and Wales with high, medium or low Levallois percentages.

230x175mm (300 x 300 DPI)

Figure 4. Results of Analysis 2 showing 20 x 20 km grid squares in England and Wales with good, average or poor collection.

233x178mm (300 x 300 DPI)

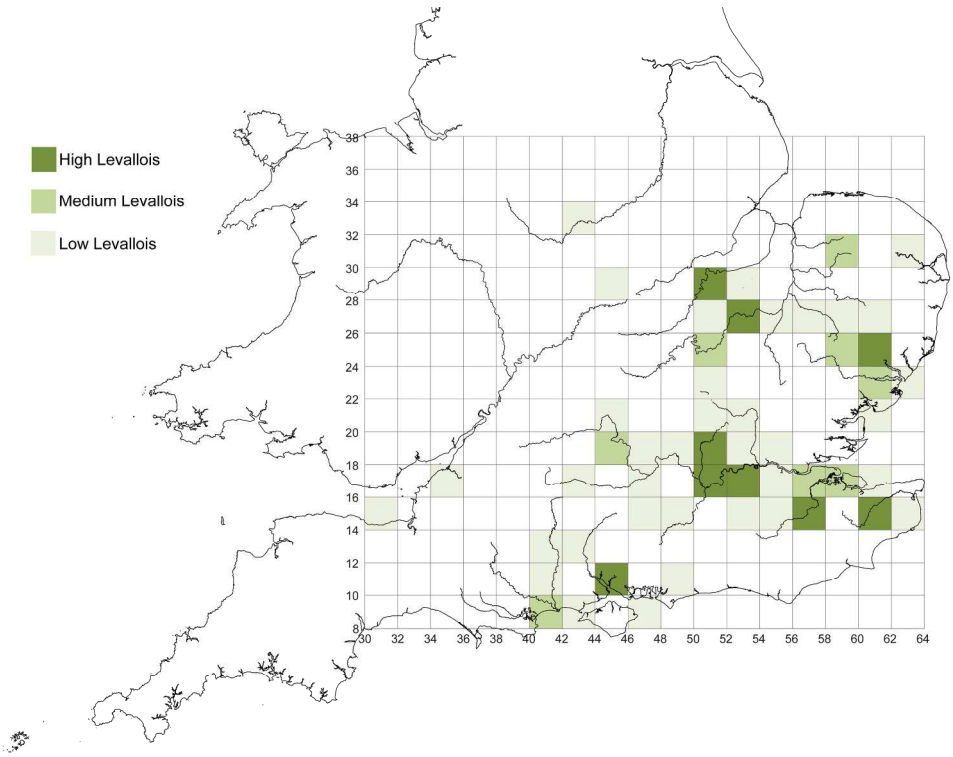


Figure 5. Results of Analysis 3 showing 20 x 20 km grid squares in England and Wales with high, medium or low Levallois percentages.

232x176mm (300 x 300 DPI)

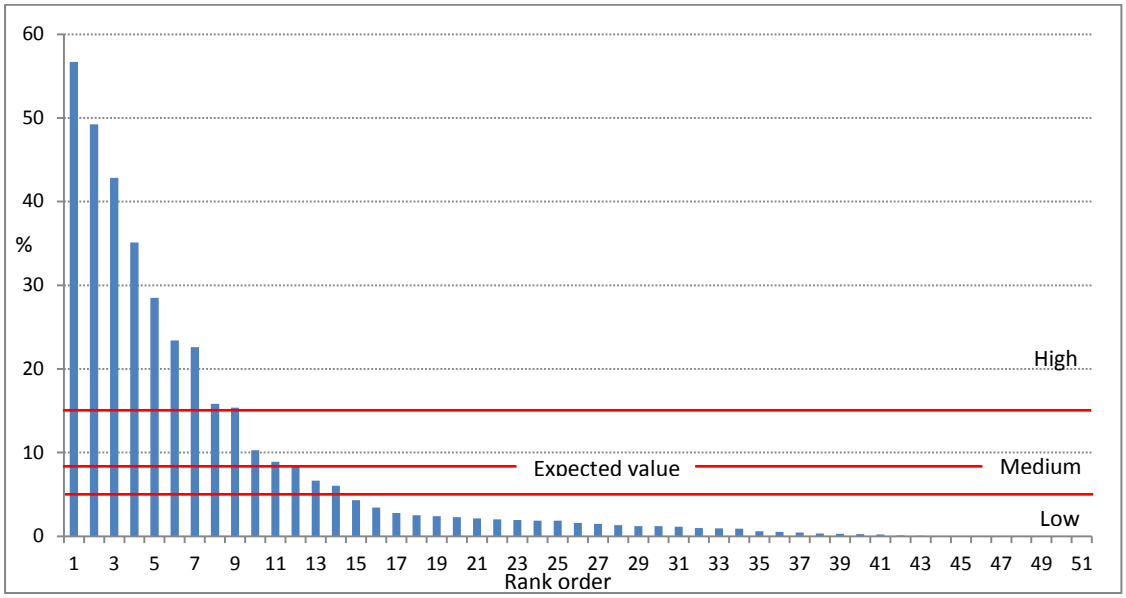
Figure 6. Summary results of Analyses 1-3 showing 20 x 20 km grid squares in England and Wales with significantly high, medium or low Levallois percentages.

232x177mm (300 x 300 DPI)

Ashton *et al.* Frontiers and route-ways from Europe: the Early Middle Palaeolithic of Britain
Supplementary Information

SI Table 1. Analysis 1 with Levallois artefacts as a percentage of total handaxes and Levallois artefacts, reflecting squares with high, medium or low Levallois percentages in relation to the expected value of 8.3%.

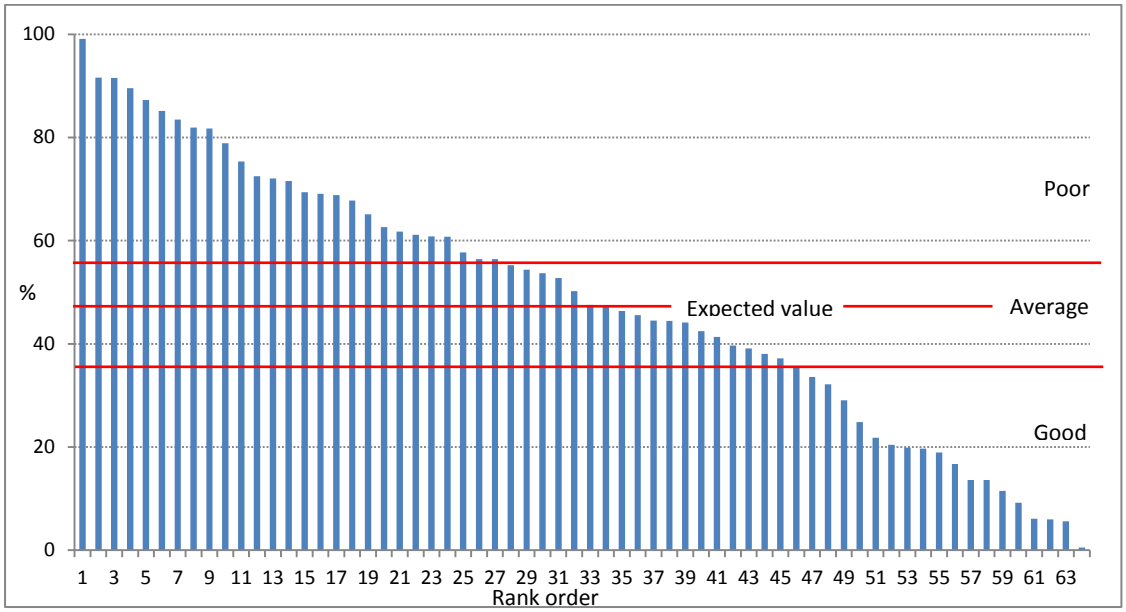
East	North	Handaxe (H)	Levallois (L)	H+L	L*100/H+L	Grade
30	36	71	93	164	56.7	High
32	10	1863	5	1868	0.3	Low
34	16	266	4	270	1.5	Low
36	8	109	1	110	0.9	Low
38	8	229	5	234	2.1	Low
40	8	1613	33	1646	2.0	Low
40	10	453	0	453	0.0	Low
40	12	722	0	722	0.0	Low
42	8	278	8	286	2.8	Low
42	10	313	1	314	0.3	Low
42	12	1518	8	1526	0.5	Low
42	16	1616	1	1617	0.1	Low
42	32	150	0	150	0.0	Low
44	8	166	19	185	10.3	Medium
44	10	1533	36	1569	2.3	Low
44	18	121	11	132	8.3	Medium
44	20	210	0	210	0.0	Low
46	8	197	0	197	0.0	Low
46	14	172	2	174	1.1	Low
46	16	1725	34	1759	1.9	Low
46	18	492	1	493	0.2	Low
48	10	769	0	769	0.0	Low
48	14	973	6	979	0.6	Low
48	18	4265	13	4278	0.3	Low
50	16	774	226	1000	22.6	High
50	18	2479	987	3466	28.5	High
50	20	253	137	390	35.1	High
50	22	297	4	301	1.3	Low
50	24	952	43	995	4.3	Low
50	28	80	60	140	42.9	High
52	14	121	0	121	0.0	Low
52	16	169	12	181	6.6	Medium
52	18	1086	28	1114	2.5	Low
54	14	741	14	755	1.9	Low
54	16	1676	315	1991	15.8	High
54	18	365	9	374	2.4	Low
54	24	99	1	100	1.0	Low
56	14	615	60	675	8.9	Medium
56	16	1225	1188	2413	49.2	High
56	26	2938	13	2951	0.4	Low
56	28	832	1	833	0.1	Low
58	16	121	37	158	23.4	High
58	26	672	11	683	1.6	Low
58	28	644	8	652	1.2	Low
60	14	483	31	514	6.0	Medium
60	16	1152	11	1163	0.9	Low
60	24	259	47	306	15.4	High
60	26	142	0	142	0.0	Low
62	16	168	6	174	3.4	Low
62	22	264	5	269	1.9	Low
62	30	408	5	413	1.2	Low



SI Figure 1. Analysis 1 showing rank order of Levallois artefacts as a percentage of total handaxes and Levallois artefacts. Expected percentage is shown with high, medium and low thresholds.

SI Table 2. Analysis 2 with handaxes as a percentage of total artefacts as a measure of good, average or poor collecting in relation to the expected value of 46%.

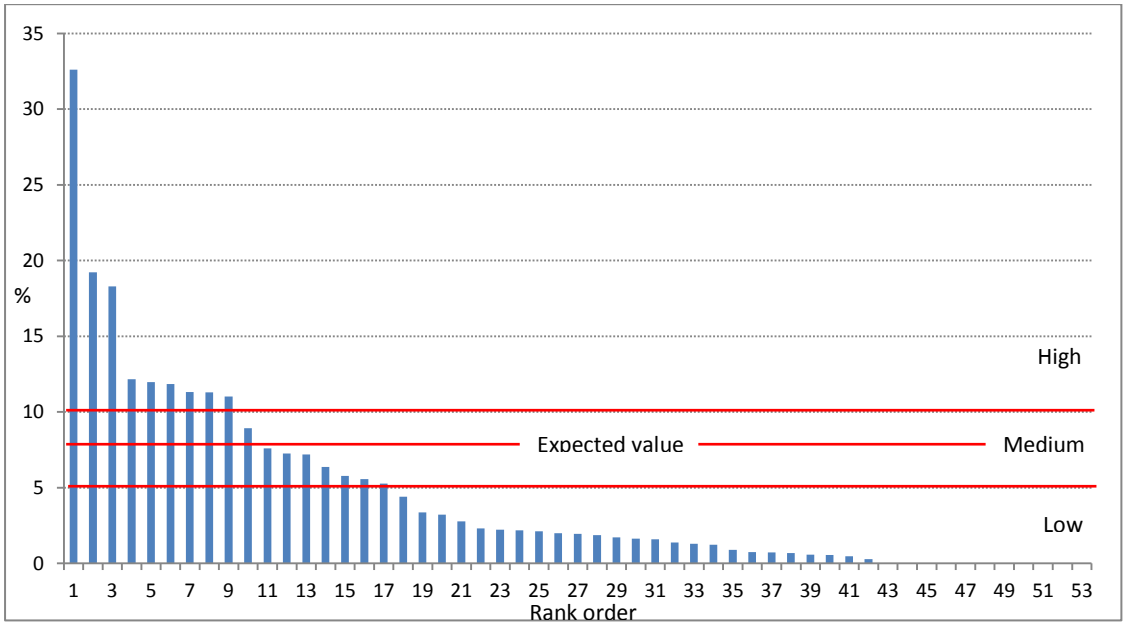
East	North	Handaxe (H)	Levallois (L)	Core+flake (CF)	H+L+CF	Hx100/H+L+CF	Grade
30	14	28	1	177	206	13.59	Good
32	10	1863	5	12	1880	99.10	Poor
34	16	266	4	445	715	37.20	Average
36	8	109	1	9	119	91.60	Poor
38	8	229	5	86	320	71.56	Poor
40	8	1613	33	593	2239	72.04	Poor
40	10	453	0	172	625	72.48	Poor
40	12	722	0	431	1153	62.62	Poor
42	8	278	28	395	701	39.66	Average
42	10	313	1	28	342	91.52	Poor
42	12	1518	8	1692	3218	47.17	Average
42	16	1616	1	360	1977	81.74	Poor
42	32	150	0	213	363	41.32	Average
44	8	166	19	60	245	67.76	Poor
44	10	1533	36	268	1837	83.45	Poor
44	12	96	3	11	110	87.27	Poor
44	18	121	11	142	274	44.16	Average
44	20	210	0	130	340	61.76	Poor
44	28	99	0	154	253	39.13	Average
46	8	197	0	152	349	56.45	Poor
46	14	172	2	278	452	38.05	Average
46	16	1725	34	737	2496	69.11	Poor
46	18	492	1	3790	4283	11.49	Good
48	10	269	0	335	604	44.54	Average
48	14	973	6	254	1233	78.91	Poor
48	18	4265	13	927	5205	81.94	Poor
50	16	774	226	467	1467	52.76	Average
50	18	2479	987	1880	5346	46.37	Average
50	20	253	137	4126	4516	5.60	Good
50	22	297	4	539	840	35.36	Average
50	24	952	43	729	1724	55.22	Poor
50	26	17	5	262	284	5.99	Good
50	28	80	60	252	392	20.41	Good
52	14	121	0	164	285	42.46	Average
52	16	169	12	97	278	60.79	Poor
52	18	1086	28	2263	3377	32.16	Good
52	20	50	2	120	172	29.07	Good
52	26	35	27	195	257	13.62	Good
52	28	14	3	135	152	9.21	Good
54	14	741	14	804	1559	47.53	Average
54	16	1676	315	6846	8837	18.97	Good
54	18	365	9	258	632	57.75	Poor
54	24	99	1	62	162	61.11	Poor
54	26	78	2	152	232	33.62	Good
56	14	615	60	471	1146	53.66	Average
56	16	1225	1188	3805	6218	19.70	Good
56	26	2931	13	1875	4819	60.82	Poor
56	28	832	1	96	929	89.56	Poor
58	16	121	37	450	608	19.90	Good
58	20	57	0	44	101	56.44	Poor
58	24	18	20	256	294	6.12	Good
58	26	670	11	551	1232	54.38	Average
58	28	504	6	82	592	85.14	Poor
58	30	41	13	191	245	16.73	Good
60	14	483	31	228	742	65.09	Poor
60	16	1152	11	511	1674	68.82	Poor
60	20	12	0	2383	2395	0.50	Good
60	22	37	10	102	149	24.83	Good
60	24	259	47	210	516	50.19	Average
60	26	120	0	150	270	44.44	Average
62	14	48	1	171	220	21.82	Good
62	16	168	6	49	223	75.34	Poor
62	22	264	5	310	579	45.60	Average
62	30	408	5	175	588	69.39	Poor



SI Figure 2. Analysis 2 showing rank order of handaxes as a percentage of all artefacts. Expected percentage is shown with good, average and poor thresholds.

SI Table 3. Analysis 3 with Levallois artefacts as a percentage of total non-handaxe artefacts. as a measure of squares with high, medium or low Levallois values in relation to the expected value of 7.7%.

East	North	Levallois (L)	Core+flake (CF)	L+CF	Lx100/L+CF	Grade
30	14	1	177	178	0.56	Low
34	16	4	445	449	0.89	Low
40	8	33	593	626	5.27	Medium
40	10	0	172	172	0.00	Low
40	12	0	431	431	0.00	Low
42	8	8	395	403	1.99	Low
42	12	8	1692	1700	0.47	Low
42	16	1	360	361	0.28	Low
42	32	0	213	213	0.00	Low
44	10	36	268	304	11.84	High
44	18	11	142	153	7.19	Medium
44	20	0	130	130	0.00	Low
44	28	0	154	154	0.00	Low
46	8	0	152	152	0.00	Low
46	14	2	278	280	0.71	Low
46	16	34	737	771	4.41	Low
46	18	1	3790	3791	0.03	Low
48	10	0	335	335	0.00	Low
48	14	6	254	260	2.31	Low
48	18	13	927	940	1.38	Low
50	16	226	467	693	32.61	High
50	18	240	1880	2120	11.32	High
50	20	137	4126	4263	3.21	Low
50	22	4	539	543	0.74	Low
50	24	43	729	772	5.57	Medium
50	26	5	262	267	1.87	Low
50	28	60	252	312	19.23	High
52	14	0	164	164	0.00	Low
52	16	12	97	109	11.01	High
52	18	28	2263	2291	1.22	Low
52	20	2	120	122	1.64	Low
52	26	27	195	222	12.16	High
52	28	3	135	138	2.17	Low
54	14	14	804	818	1.71	Low
54	16	155	6846	7001	2.21	Low
54	18	9	258	267	3.37	Low
54	26	2	152	154	1.30	Low
56	14	60	471	531	11.30	High
56	16	233	3805	4038	5.77	Medium
56	26	13	1875	1888	0.69	Low
58	16	37	450	487	7.60	Medium
58	24	20	256	276	7.25	Medium
58	26	11	551	562	1.96	Low
58	30	13	191	204	6.37	Medium
60	14	31	228	259	11.97	High
60	16	11	511	522	2.11	Low
60	20	0	2383	2383	0.00	Low
60	22	10	102	112	8.93	Medium
60	24	47	210	257	18.29	High
60	26	0	150	150	0.00	Low
62	14	1	171	172	0.58	Low
62	22	5	310	315	1.59	Low
62	30	5	175	180	2.78	Low



SI Figure 3. Analysis 3 showing rank order of Levallois artefacts as a percentage of total non-handaxe artefacts. Expected percentage is shown with high, medium and low thresholds.