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The British Late Middle Palaeolithic: an interpretative synthesis of Neanderthal occupation at the northwestern edge of the Pleistocene World

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Abstract

The British Middle Palaeolithic is divided into two discrete periods of occupation: the Early Middle Palaeolithic (MIS 9 to 7, ~330–180 ka BP) and the Late Middle Palaeolithic (MIS 3, ~59–36 ka BP), separated by a long hiatus. Owing to the relative poverty of the record and historical difficulties in dating and correlating archaeological sites, the British Late Middle Palaeolithic has, until recently, received scant attention, and has largely been regarded as the poor man of Europe, especially by British archaeologists. Indeed, there has been more discussion of the absence of humans from Britain than of what they did when they were present. We aim here to redress that situation. Following from recent considerations of the Early Middle Palaeolithic (White et al. 2006; Scott 2010), we offer an interpretative synthesis of the British Late Middle Palaeolithic, situating 'British' Neanderthals in their chronological, environmental and landscape contexts. We discuss the character of the British record, and offer an account of Neanderthal behaviour, settlement systems and technological practices at the northwestern edge of their known Upper Pleistocene range. We also examine the relationship of the enigmatic Early Upper Palaeolithic leafpoint assemblages to Neanderthals is also examined.

Introduction

For much of the Late Pleistocene, reduced sea-levels (resulting from increased global ice volume) exposed the currently submerged basins surrounding Britain, leaving it connected to Europe via dry plains – often referred to as 'Doggerland' (Coles 1998) – stretching across what is now the North Sea, and steep river valleys in the English Channel. Prior to the arrival of modern humans ~35 (^{14}C) ka BP, Britain thus formed the westernmost terrestrial extension of the Neanderthal World, which stretched at its maximum extent across Europe south of the Baltic, throughout the Levant, and as far east as Tajikistan. Evidence of Neanderthal occupation is not evenly distributed across this area, with records from southeast European and former Soviet regions being rather sparse, especially when compared to the archaeologically rich sequences from Spain, Italy, Belgium, Israel, and, most famously, southwest France. Although to an extent presumably a reflection of the uneven and fluctuating distribution of Neanderthal groups in space and time, this pattern is generally understood to be the result of unequal research histories, and untold riches and spectacular surprises undoubtedly await discovery – as shown, for example, by the recent claims of a new human species, the Denisovans, in Siberia (Reich et al. 2010).

Such promise is probably not the case for Britain, however. Despite a long and intensive history of archaeological investigation, spanning almost 200 years, the record of Neanderthal occupation of Britain remains remarkably slight in Eurasian terms. Even when one takes into account Gamble's (1999, p. 204) continental-scale observation that despite much larger-sized excavations, sites in northern Europe tend to produce smaller and fewer assemblages than those in the southern/Mediterranean zone (the result of differing intensities of long-term occupation), Britain fails to match up to its nearest neighbours. It lacks deep multi-layered cave sequences, while open air occurrences are scarce and comprise very few or even singular artefacts. The records of earlier researchers such as William Boyd Dawkins and William Pengelly, who in the 19th century excavated what became relatively major sites, seem to suggest that the lithic assemblages were of no more than a thousand or so items, probably far fewer. This has led many specialists to argue that, at most, Britain was host to low-density, intermittent Neanderthal settlement during the Late Middle Palaeolithic (Roe 1981; Wymer 1988; Currant and Jacobi 2001, 2002; Ashton 2002; White and Jacobi 2002).

Figure 1 summarizes the climate, marine isotope stages (MIS), age ranges, mammalian biostratigraphy, archaeological periods and patterns of human settlement for the entire Middle Palaeolithic of Britain. The principal subject of this paper – the Late Middle Palaeolithic (as defined by White and Jacobi 2002) – represents a period of Neanderthal occupation during MIS 3 (~59–24 ky BP) that is separated from the

Early Middle Palaeolithic on the basis of technology and typology as well as chronology (White and Jacobi 2002; White et al. 2006). The Late Middle Palaeolithic broadly correlates with the Pin Hole Mammalian Assemblage Zone (MAZ) of Currant and Jacobi (1997; 2001; 2010), and in most cases an attribution of assemblages to this archaeological period is dependent on an association with the highly characteristic faunal taxa that comprise this MAZ. No evidence of human occupation has been found associated with any other formally defined Late Pleistocene MAZ, and nor do any cogent absolutely dated archaeological sites exist between the end of MIS7 (the British Early Middle Palaeolithic) and the end of MIS4 (Ashton 2001; Lewis et al. 2010), suggesting a complete absence of human occupation until the arrival of late Neanderthals within MIS3. While absence of evidence is never evidence of absence, this pattern has yet to be convincingly challenged (e.g. Wenban Smith et al. 2010).

Insert Figure 1 around here

The evidence that does exist for the British Late Middle Palaeolithic is poorly understood and rarely integrated into broader (i.e. continental) interpretative frameworks. The reasons for this are many and varied. Part of the issue lies in biases created by the history of excavation and curation. Many sites – including major ones such as Kent's Cavern and the caves of Creswell Crags – were investigated and practically cleaned out during the 19th and early 20th centuries, using basic methods and often in less than ideal circumstances. Implementiferous (tool rich) deposits at several key sites have now all but disappeared, and their collections have been widely dispersed and/or lost. Describing early excavations at Wookey Hole, Dawkins (1862, p. 116) noted that '...the greater proportion [of finds] were either thrown away or scattered among the private collections of the neighbourhood', a phrase that could be used for almost all British Middle Palaeolithic collections. The publications and archival records that exist are almost always cursory, and aimed at historical questions no longer of pressing concern, and their testimonies are therefore often of limited value to modern Palaeolithic archaeology. Moreover, while several influential workers of the 19th and 20th centuries (for example Hinton and Kennard 1905; Moir 1926; Dewey and Smith 1925; King and Oakley 1936) tried to adopt the various Palaeolithic frameworks emerging from Europe (e.g. those of de Mortillet 1869, Commont 1912 and Breuil 1932), by fault or design their use and interpretation of these frameworks is idiosyncratic, imparting a particularly insular flavour to British scholarship.

It is therefore perhaps no surprise that the British Late Middle Palaeolithic record has played little role in answering fine-grained culture-historical or behavioural questions, and has yet to feature widely in the discussions of Neanderthal extinction, the initial Eurasian dispersal of *Homo sapiens,* and the apparently concomitant Middle-to-Upper Palaeolithic transition that have dominated the younger end of palaeoanthropological research for the past two decades (e.g. Jöris and Adler 2008; Jöris and Street 2008 and references therein). Although such debates have 'opened up' geographically over the last several years, much argument is still focused on the record of Western and Central Europe, and to an extent on the Near East, despite the fact that these complex biogeographical processes probably took place over far vaster areas (Brantingham et al. 2004; Dennell and Pettitt 2007). Despite a database of variable quality, and considerable debate over the interpretation of archaeological sequences, radiometric dates and the taxonomic significance of Initial Upper Palaeolithic lithic assemblages, there seems at least to be general agreement that Neanderthal extinction occurred in the period ~50–40 ka BP, and that the initial Eurasian dispersal of *Homo sapiens* occurred at least from the latter part of this range down to ~30 ka BP, by which time much of Europe – including Britain – was home, at least on occasion, to Upper Palaeolithic members of our own species. One of the questions we address in this paper is what the British Late Middle Palaeolithic record might add to this picture.

The sum result of these factors can best be described as an image problem, one neatly captured in the writings of John Wymer and Derek Roe, two of the most influential workers in British Palaeolithic archaeology over the past four decades. John Wymer's monumental survey of the Palaeolithic archaeology of the Thames Valley failed to identify any Mousterian assemblages at all, and as he viewed Levallois technology as an option within the later Acheulean, he classified everything as Lower Palaeolithic (Wymer 1968, p. 389). While he later modified this opinion (Wymer 1985, p. 377; 1999, p. 80), the lack of importance he attached to the Middle Palaeolithic is indicated by the title of his last book on the English Rivers Project, *The Lower Palaeolithic Occupation of Britain* (Wymer 1999). Similarly, Roe's (1981) classic synthesis of the British Lower and Middle

Palaeolithic accorded the latter only 35 of 324 pages, (15 in the form of notes), and described it as 'sparse and impoverished in the extreme … short-lived and indeed *insignificant* by continental standards' (Roe 1981, pp. 233, 252 [our emphasis]).

So what do we understand of the British Late Middle Palaeolithic? We attempt here to bring this record (broadly ~60–35 ka BP) to more focussed international attention, highlighting aspects pertinent to wider perspectives on Neanderthal behaviour. It is our contention that the very things that make the British Middle Palaeolithic different and difficult actually make it worth studying. Rather than being an insignificant and impoverished interlude, it shows Neanderthal societies operating outside their classic 'heartlands', at the northwestern edge of their world, facing challenges and conditions sometimes very different from those elsewhere. Appreciating this record for what it is can only deepen our understanding of the Neanderthals, particularly in terms of regional variation in their adaptive strategies. We can then begin the task of detailing Neanderthal adaptive abilities and responses in different situations and break away from the construction of highly generalised patterns of behaviour.

We seek here to examine the British Late Middle Palaeolithic using concepts, practices and terminology that will allow it to be fully integrated into the story of northwest European hominins and brought to bear upon wider debates concerning Neanderthal behaviour and social life. We hope to shift attention away from the *dolce vita* of southwest France, and towards the harsher realities of life on the mammoth steppe of Marine Isotope Stage 3 (MIS3), thus encouraging a more inclusive overview of Pleistocene Europe.

We first need to situate the British Middle Palaeolithic in its wider context. We therefore first consider the Upper Pleistocene palaeoclimatic context, from which we move to a palaeogeographical reconstruction of Middle Palaeolithic Britain. Following this, we present the available site database, before discussing chronological issues and settlement histories, lithic technological organisation, regional settlement systems, and extinction. We include British leafpoint assemblages (increasingly defined as the Lincombian–Ranisian–Jerzomanowician or LRJ) in our review, as, while formally defined as Early Upper Palaeolithic on technological grounds, in the opinion of most specialists they were produced by Neanderthals and are therefore most pertinent to the issue of Neanderthal extinction.

The landscapes, environments, and resources of Western Doggerland

Marine Isotope Stage 3: the 'failed' interglacial

As noted above and in Figure 1, the greater majority, and probably all, of the Neanderthal occupation of Late Pleistocene Britain appears to fall within MIS3 (~59–25 ka BP). The structure of this period is critical to understanding the rhythm of Neanderthal settlement of Britain, and indeed the rest of northern Europe, at this time. Climatically, MIS3 stands out from other 'warm' episodes in being relatively cold and extremely unstable (although, in fact, it appears that many other cycles may also show abrupt climatic oscillations of similar wavelength [Oppo et al. 1998; McManus et al. 2003], the signal being muted by the much greater depth and age of the sediments concerned). As shown in the ice core records of the Greenland Ice Core Project (GRIP) (Dansgaard et al. 1993; Bond et al. 1993), the Greenland Ice Sheet Project (GISP2) (Grootes 1993), and the North Greenland Ice Cores Project (NGRIP) (Anderson et al 2006; Svensson et al 2008), MIS3 is characterised by high-frequency, high-amplitude oscillations of the order of 500–2000 years duration. These 'Dansgaard–Oeschger' (D–O) events typically consisted of abrupt warming of c. 5–8ºC within 50 years, and perhaps as little as 10 years, followed by a slower cooling. Fifteen such events are evident in the ice core data between ~60 ka BP and ~25 ka BP (Figure 1 and Table 1). Thus, MIS3 is neither an interglacial nor a glacial, but a series of alternating warm and cold events occurring over millennial timescales (Hopkinson 2007).

Insert Table 1 around here

A series of six discrete cold events (see Table 1) – called Heinrich events – is also registered in the marine sediment record (Heinrich 1988). These events are signalled by layers unusually rich in ice-rafted debris, which represent the sediment trail of massive discharges of ice from the Laurentide ice sheet covering North America in the Wisconsin glaciation into the North Atlantic (Heinrich 1988), with corresponding episodes of calving of the Scandinavian ice sheet (Baumann et al. 1995). It has been argued that such armadas of icebergs reduced sea-surface salinity and sea-surface temperature (Bond et al. 1993) and affected the circulation of North Atlantic Deep Water, perhaps shutting it down entirely (Ganopolski and Rahmstorf 2001).

Due to their short duration, these climatic fluctuations are muted in the marine record and are extremely difficult to detect in the piecemeal terrestrial record, although recent studies of vegetation change across Europe have shown a good degree of synchrony between the ice core data and terrestrial climates (Fletcher et al. 2010). A number of both cold(er) and warm(er) events can also be detected in the British Devensian record (Table 2) (the latter term being equivalent to the Wurm/Weichselian/Wisconsin phases of the European and North American sequence). Only two currently-known sites show evidence of climatic change, however, although these changes occur in opposite directions – the sequence at the Kempton Park site shows a relatively warm climate giving way to colder conditions, while a transition from cold to warm is seen at the Ismaili Centre site in Kensington, London – indicating that at least three distinct climatic episodes are recorded. Greater variation is evident in the temperature estimates reconstructed from Devensian beetle faunas, suggesting that a number of different climatic episodes are recorded in the British geological data (see Table 3).

Insert Table 2 around here

Insert Table 3 around here

In northwestern Europe five non-forested interstadials have also been identified in the terrestrial records from the Netherlands and Germany: from oldest to youngest, the Oerel; Glinde; Moershoofd/Moershoofd Complex; Hengelo; and Denekamp Interstadials (Zagwijn 1989; Behre 1989; see Table 1). These episodes were originally detected in localised and fragmentary organic deposits (peats, humic silts), and are differentiated almost entirely on the basis of radiocarbon dates; a full sequence has never been found in stratigraphical succession at any one site. As minimal, if any, vegetation succession is evident in any of these periods (other than Oerel), and none shows any forest development, it has been suggested that they do not qualify as interstadials, but should be classed as intervals (Casper and Frund 2001). Recent studies of high resolution pollen records from terrestrial and marine sources, however, have shown that millennial scale variability is evident in the vegetation record across Europe during the last glacial, the precise vegetational response in any given region being conditioned by the character of the D–O event, latitude and historical factors (the nature of the preceding event, the location and size of refugia, migration lags etc: Fletcher et al. 2010). These findings are particularly relevant because they track climatic conditions impacting upon terrestrial ecosystems in immediately adjacent areas of Europe, although only one probable interstadial – the Upton Warren Interstadial (Coope et al. 1961), dated to ~42–44 ka BP – has thus far been identified in the British sequence. The age and distinctiveness of this period is likely to change as radiocarbon pre-treatment methods continue to develop.

The Landscape of Western Doggerland

While MIS4 was a period of major growth of continental ice – with the margins of the Scandinavian ice sheet advancing south, southeast and southwest into Denmark, Poland and the continental shelf (Lowe and Walker 1997, p. 338) – the presence of ice-rafted sediment in the Norwegian Sea indicates that the beginning of MIS3 saw a major collapse of the ice sheet (Baumann et al. 1995). For much of MIS3, global ice volume was reduced to local caps (Shackleton 1987; Arnold et al. 2002), while recent modelling (Brown et al. 2007; Sejrup et al. 2009; Hubbard et al. 2009) reinforces the view that much of Scotland, and by implication the whole of the British Isles, was probably ice-free, with only local pockets of ice in the western highlands and no glacial advance until after ~34 ka BP and the onset of MIS2.

As a result of these fluctuations MIS4 sea levels dropped to a low of 100m below modern sea level (bmsl), with a subsequent rise to -50m bmsl with the onset of MIS3 (Shackleton 2000; Waelbroeck et al. 2002). After ~50 ka BP, sea levels fluctuated between -60m and -80m bmsl, with a general downward trend through time, in which each successive rise failed to reach the levels of the previous high stand. Combining these sea levels with the bathymetry of the North Sea and the Channel (Keen 1995), it can be presumed that throughout the entirety of MIS4 and MIS3 Britain formed a western peninsula of the European landmass, not an island.

As noted above, large parts of what is now the eastern coast of Britain, from the Scottish borders in the north to Kent in the south, were connected to the vast plains of the central and southern North Sea, an area which Coles (1998) has termed 'Doggerland'. Faunal remains and artefacts dredged up from the submerged sand and gravel banks forming shallows in the North Sea (such as Leman and Ower, Dogger and Brown, which during the Pleistocene formed the hills of Doggerland), have demonstrated that this was an area rich in herbivorous and avian resources. From a settlement point of view we can regard England and Wales as the upland peripheral remnant of an area originally three times its present size, drained by river systems – the highways of the Palaeolithic – ultimately linked to those of the continent. Recent recovery of Middle Palaeolithic archaeology and Neanderthal remains from the North Sea (Glimmerveen et al. 2004; Verhart 2004; Hublin et al. 2009) have predictably demonstrated that Neanderthals were active on Doggerland. From a geographical perspective, one should not view the vast area across which Britain was connected to the Continent as a continuous area of potential population dispersal. The river valleys of Doggerland probably afforded a number of easy opportunities for movement, but given the relatively sparse Middle Palaeolithic archaeology from adjacent areas of the European continent, such as Belgium and the Netherlands, it is likely that Neanderthal occupation of Doggerland was also sporadic and perhaps restricted to interstadials.

By contrast, the present English Channel took the form of a fluvial basin occupied by a vast east–west flowing river and its tributaries –the Channel River or Fleuve Manche – with no evidence of marine transgression during MIS3 (Lagarde et al. 2003). The modern submarine relief of this basin is incised with a complex network of channels, which represent extensions of the river valleys of southern Britain, such as the Solent and Arun, and those of northern France, such as the Seine, Somme and Béthune (Gibbard and Lautridou 2003). During the low sea level of MIS3 these rivers drained into the Channel River, which in turn drained into the Atlantic Ocean around the -100m isobar located to the south of modern Penzance, Cornwall. The Channel basin would have been dominated by the Channel River, a huge anastomosing system (possessing a network of linked streams) whose massive valleys were typically 10–20 km wide. A number of high-energy, multi-channelled or braided rivers flowed into this from northern France and southern Britain, many of which still exist – their lower reaches have been flooded by marine transgression but are recognised by submarine valley systems (Antoine et al. 2003). One such English tributary was the (now extinct) palaeo-Solent, which flowed south through the Hampshire basin, receiving tributary waters from the Arun, Test, Stour and Itchen before flowing southeastward to the east of the Isle of Wight, then turning south to flow into the Channel River some 10km south of modern Portsmouth. The Channel River system, and those of its English and French tributaries was established by the early Middle Pleistocene 'Cromerian Complex' of glacials and interglacials, and from the time of the formation of the Pas de Calais/Straits of Dover, the Channel River also drained the rivers of south-central England (the Thames system), western Belgium (the Scheldt system), and the Rhine–Meuse system. The scale of the Channel River is therefore clear, especially when one considers that from at least 250,000 BP it was carrying drainage from almost half of western Europe, which included meltwater from the Alpine and northern European ice-sheets (Bourillet et al. 2003). Given its scale, the Channel River system likely constituted a major barrier to northwards dispersal by Neanderthals, as with the succeeding Upper Palaeolithic (Pettitt 2008, Figure 2). The nature of this barrier presumably varied over seasonal and millennial timescales, in terms of discharge and the location and size of braided reaches.

Insert Figure 2 around here

To the north of the Channel basin, southern England was high ground. Today, this typically takes the form of an erosional coastline characterised by cliffs that in many areas stretch up to 80m high. Using the Hurd deep, which is today at 200m below mean sea level (that is, -200m bmsl: below the UK Ordnance Survey datum line) as a referent, cliff and plateaux heights would have reached up to 800m above modern sea level (amsl) (for the area of Dartmoor). The character of these southern uplands differed from west to east: Cornwall, like Brittany, was a rugged landscape of steep slopes and short southern-draining rivers incised into deep valleys, which contrasts with the east where gently rolling smooth slopes, dry valleys and long rivers gave way to the plains and hills of Doggerland.

Neanderthal Environments of Western Doggerland

It is frustrating that most British archaeological data derives from caves with poor palaeoecological information (Table 4), while most of the environmental proxies we have for MIS3 derive from open air sites that lack firmly associated archaeology. However, all data from both types of site show a remarkably consistent and persistent set of environmental conditions: species vary according to climate, but the structure of the British landscape remains unaltered despite the long periods of time and climatic fluctuations involved. Consequently, it is possible to provide a time-averaged, generic palaeoenvironmental reconstruction for MIS3 Britain, and justifiable to use it.

While forced by the coarseness of the data to employ a broad-brush approach, we are more than aware of the complex geographical, geological, climatic and meteorological variations that undoubtedly existed across time and space. Today, the British mainland spans a distance of approximately 1350 km from Land's End, Cornwall to Dunnet Head, Caithness, and comprises a total area of 209,331 km². Air temperatures between southern and northern Britain can vary by up to 20ºC on a single day (as both of us – southerners living in the north – are well aware); differences in precipitation leave some areas suffering droughts while others flood; and some routinely face over 50 cm of winter snow and biting temperatures while others barely suffer a frost. Such variations, along with differences in wind speed and direction, aspect, exposure, geology, pedology, biota, topography, and other micro-climatic variables are all essential to an understanding of human and animal settlement patterns. For the Pleistocene, however, such factors are, and will probably remain, unmodelled at relevant scales. During periods of reduced sea level, such as MIS3, these familiar geographical and climatic gradients from the southern and southeastern 'lowlands' to the western to northwestern 'highlands' would have been further complicated by the extension of the British landmass eastwards across the North sea (Doggerland), and westwards across the floor of the current Irish Sea. In sum, Doggerland and its western uplands would have been a morass of environmental variation imaginable to the modern archaeologist, but probably impossible to model at meaningful scales.

Insert Table 4 around here

These caveats notwithstanding, on present evidence all molluscan and insect faunas uniformly indicate an open, treeless environment, with taxa characteristic of rich grassland, with local patches of marsh, acid heath and bare sandy ground. Using data from 27 insect assemblages, Coope (2002) suggested that in the warmest months temperatures averaged just ~10°C, with the coldest months seeing lows of -20 to -27°C; if representing only the warm D–O events these estimates could be extremely conservative (Coope 2002, pp. 405–406). One marked warm period was evident at ~42–44 ka BP, when temperatures approached modern values (for Coope representing the Upton Warren Interstadial), but the structure of the environments inferred from the insects remained the same (Coope et al 1997; Coope 2002)

Pollen data, also showing a landscape dominated by rich herbaceous grassland, have been recovered from both cave and open air sites. Arboreal pollen counts are generally very low, and while species such as pine, alder, spruce, birch and willow are sometimes present, they are usually considered as being very far-travelled, or representative of dwarf species. At Lynford (Norfolk), Boismier et al. (2003) proposed that localised patches of woodland probably existed away from the floodplain environments that are normally sampled for palaeoecological remains, although this has been disputed on the basis of the molluscs and insects, neither of which show any obligate woodland species (D. Keen pers. comm. to MJW 2003).

Two famous cave sites – Hyaena Den (Wookey Hole, Somerset) and Kent's Cavern, (Torquay, Devon) – have produced sparse pollen profiles from contexts associated with human occupation (Campbell in Tratman et al. 1971; Sampson and Campbell 1971). While the low counts (129 grains at Hyaena Den and 104 grains at Kent's Cavern) and complex dispersal, transport and deposition mechanisms within cave environments demand caution (Turner 1985; Coles et al. 1989), both nonetheless are consistent with a cool steppic grassland environment. However, both sites also revealed up to 15% tree and woody shrub pollen. If accepted, these are most likely to reflect conditions directly outside the caves: experiments at Creswell Crags established that most pollen introduced into the caves was airborne, and that 90% of the airborne pollen was from taxa that grew within the gorge, often within 500m, with all the tree species present being found within 5 km (Coles et al. 1989; Coles and Gilbertson 1994). Pollen adhering to a reindeer antler fragment excavated from the southwestern chamber of Robin Hood Cave was of grassland type, with rich herbaceous vegetation and some birch (*Betula* cf. *nana*, which has been equated with the Upton Warren Interstadial: Jenkinson et al. 1986), although the antler is undated and was stratigraphically associated with a human mandible of Holocene age. Thus the antler and pollen are not reliably placed within MIS3.

Most recently, Caseldine et al. (2007) examined pollen contained within speleothem deposits in British caves, which were dated using high precision thermal ionisation mass spectrometric (TIMS) and ICP-MS uranium series dating (U-Th). Two samples from Lancaster Hole, Lancashire were dated to MIS3. The limited pollen obtained produced an unexpected result, being dominated by tree species including pine, oak, alder and hazel and suggesting the presence of thermophilous trees. Some circumspection is required when evaluating these results, and Caseldine et al. (2007) acknowledge that there are other taphonomic issues that need to be addressed. Most critically, the tree pollen may reflect the storage of grains in the groundwater system from the previous interglacial (or reworking into the groundwater), or result from long distance transport in cold periods with minimal vegetation. These possibilities, though, were all considered and emphatically rejected on the basis of excellent preservation demonstrating rapid transport and incorporation into the speleothem, the lack of speleothem growth during extremely cold periods, and the absence of modern day analogues for flowstones being fed by water with residence-times measuring thousands of years.

These results clearly challenge the view derived from molluscs and insects of a completely treeless environment, leading to the suspicion that by concentrating almost exclusively on data from microhabitats in river floodplain/braidplain situations our environmental reconstructions have missed a critical element of microclimatic variation within the British Pleistocene. This supports the view expressed by Campbell (1971), greatly elaborated by Stewart and Lister (2001), that trees survived in sheltered locations that provided isolated 'cryptic refugia', such as the southern flanks of Mendip and the Ilsham Valley, and protected gorges like Creswell Crags (Derbyshire/Nottinghamshire). In this regard, it may be no coincidence that these areas also saw perhaps the greatest incidence of Neanderthal settlement in Britain, with Neanderthals using them as relatively resource rich locales from which to conduct logistically organised activities.

Insert Table 5 around here

The MIS3 mammalian fauna has been designated the Pin Hole Mammalian Assemblage Zone (MAZ) (Currant and Jacobi 1997, 2001, 2002; see Table 5). Dominated by woolly rhinoceros, horse, mammoth, bison, reindeer and hyaena, it shows a mixture of ostensibly warm-adapted (red deer, giant deer) and cold-adapted (mammoth, woolly rhinoceros, arctic fox and reindeer) species. Although some browsers are present, none is considered an obligate forest species, and the whole has again been taken to show the dominance of rich open grasslands with abundant but low quality/high fibre graze (i.e. the Mammoth Steppe of Guthrie 1990). Overall, Currant and Jacobi suggest that the character of the MIS3 British fauna shows the existence of continental conditions right up to the Atlantic Seaboard, with fairly warm summers but harsh winters. It should be remembered that this MAZ represents a formal biostratigraphic zone, not a reconstruction of precise faunal communities, which were presumably geographically varied and continuously remodelled in response to the highly unstable climates of the period. This mixing of animals could represent a number of factors, such as seasonal variation, the impact of millennial scale climatic fluctuations (rendered invisible by limited chronological resolution of most assemblages), or a truly non-analogous community.

The site-derived proxies discussed above can be augmented by the palaeoclimatic models generated by the Stage 3 Project (Van Andel and Davies 2003). This project, which involved 34 specialists in Pleistocene archaeology, palaeontology, geology and ecology, attempted high-resolution computer simulations of the palaeoclimate of MIS3 on a European scale. As the models were generated using input-data derived from almost all dated sites across Europe, the projections yield familiar results, although a number of variables not directly evident in the terrestrial record could also be reconstructed. However, while the project succeeded in modelling a ‘typical’ warm event, it failed to generate an adequate model for any cold event of MIS3, simulations for which were generally too warm. To overcome this problem, the MIS3 Project substituted data from MIS2 (Barron et al. 2003). These cold event simulations are excluded from consideration here, because during MIS2 ice advanced over mainland Britain, reaching as far as Lincolnshire in the east and South Wales in the west, with the unglaciated areas subject to severe periglacial conditions, with greater aridity, loess formation (wind-blown silt deposits) and large areas subject to continuous permafrost (cf. Ballentine and Harris 1994; Lowe and Walker 1997, pp. 108–109). As noted above MIS3 saw no continental ice on mainland Britain. Moreover, while some MIS3 cold events are isotopically heavier and perhaps therefore more severe than parts of MIS2, the latter also differed in having far fewer and more attenuated climatic fluctuations, which suggests it was a period of more sustained cold. In sum, MIS2 is not a good analogy for MIS3 and hence only the warm event modelling is used here, with the obvious extrapolation that cold events would have been significantly harsher.

The warm event simulation was based on conditions ~45 ka BP, which was taken to represent all such events between ~60 and 42 ka BP. Given the apparent gradual deterioration throughout MIS3, these were probably the most favourable conditions Neanderthals would have experienced during this period. So, what did a 'typical' MIS3 warm event feel like? Modelled temperatures show average warm event values at least 7–10°C lower than present. Summer temperatures would rarely have exceeded 8–12°C, with winter temperatures falling to -8° and far below (Barron et al. 2003). Winters would have been long and the spring thaw late; temperatures are unlikely to have exceeded zero until April had passed (Barron et al. 2003, p. 70). These surface temperatures would have been further reduced by wind chill. Atmospheric circulation models projected strong westerly airflow over Europe, creating strong zonal winds north of the transverse European mountain ranges (Barron et al. 2003, p. 63). In Britain, wind-chill reduced the effective temperatures to at least 8°C in summer and at least -13° in winter (Aiello and Wheeler 2003, p. 59); these values are both probably underestimates of the degree of reduction (cf. Coope 2002).

In terms of precipitation, the MIS3 project found that the period was probably not extremely dry and arid, in concord with the direct proxies above. Based on projections of sea surface temperatures, sea-ice coverage and atmospheric circulation patterns, Barron et al. (2003, p. 68) concluded that onshore airflow over northwestern Europe may have delivered annual precipitation similar to that witnessed today, although summers may have been drier. In the long winters, much of this would have fallen as snow. Snow cover probably lasted between 3 and 6 months each year, reaching depths of 10–50 cm, although again drifting is presumed to have left much of the landscape with a minimal cover. However, the models also suggest that substantial winter snowfall was preceded by heavy autumn rains (Barron et al. 2003, p. 72), falling just as temperatures began to drop. Given this level of precipitation, cloud cover, precluding much in the way of direct heating by insolation, was presumably another key factor in a grey, cold and wet landscape.

The environments that Neanderthals would have encountered when they returned to Britain during MIS3 were thus vastly different from the temperate woodland and grassland mosaic their predecessors had abandoned over 100,000 years earlier. Previously, Devensian landscapes have been characterised as arctic tundra (e.g. Bell 1970), but they are actually better described as part of the so-called 'Mammoth Steppe' (Guthrie 1982, 1984, 1990). This type of environment has no modern analogue, differing from modern Eurasian steppes by virtue of the unusual mixture of species living in the same communities, but it once extended across northern latitudes from the Atlantic Seaboard into Eurasia and across Beringia into continental North America (Guthrie 1990). The name was coined to capture the two key essences: a northern, cold-tolerant fauna, and a low, rich sward; in basic terms it can be described as a rich xeric grassland with a diverse array of herbaceous plants capable of sustaining large herds of heavyweight grazers such as mammoth, woolly rhinoceros, horse and bison (Guthrie 1990, p. 270). As Guthrie states (1990, p. 227), this made it a great hunting ground, but not an ideal place for people to live.

Neanderthals and Fellow Travellers

One characteristic of MIS3 Britain is the abundance of hyaenas (A. Currant pers. comm.). Radiocarbon dates for MIS3 British hyaenas are presented in Table 6 and graphically in Figure 3. It can be seen that, with few exceptions, measurements predate 30 ka BP and stretch back beyond 40 ka BP. Three measurements on hyaenas from Creswell Crags originally appeared to show the persistence of hyaenas as late as 25 ka BP, although recent re-measurement of these samples using ultrafiltration pre-treatment has shown the original measurements to be gross under-estimates, their age now in excess of 40 ka BP. It is likely that most of the non-ultrafiltrated hyaena samples noted in Table 6 are also underestimates. This is a significant issue – bearing in mind that hyaenas appear not to have lasted beyond 30 ka BP, and extend to ages greater than 40 ka BP, in other words, the age range of the British Middle Palaeolithic. This certainly indicates that both Neanderthals and hyaenas were occupants of the MIS3 mammoth steppe, and raises the intriguing possibility that they were sympatric in Britain at the time.

Insert Table 6 around here

Insert Figure 3 around here

The spotted hyaena has a ubiquitous distribution across Africa, where clans can comprise as many as 80 individuals (Kruuk 1972, pp. 6–7). As hyaena populations appear to be governed by prey availability (Kruuk 1972, p. 104) it is reasonable to assume that their relative abundance in MIS3 Britain reflects a relatively rich mammoth steppe fauna, which seems to have been the case for the taxonomically rich Pin Hole MAZ noted above. In modern Africa, human settlements attract hyaenas and can stimulate high population numbers, whereas in areas where human settlements are few hyaena populations can fall to individual numbers (Kruuk 1972, p. 20). It seems possible, therefore, that hyaenas could have been attracted to Neanderthal territories where scavenging opportunities presented themselves, their population numbers rising accordingly. This fits with the palaeoenvironmental background discussed above; in Africa, hyaenas reach their highest densities in short grassland with few trees and with high ungulate biomass, environments very similar to those of Britain in MIS3.

It is easy to envisage how Neanderthals and hyaenas might co-exist, sharing the niche of top predators and scavenging from each other's kills, leading to a mutually-beneficial sympatry. As hyaenas consume organs and bone (Sutcliffe 1970; Skinner and van Aarde 1991), little may remain of their kills, although when parts are abandoned Kruuk found them frequently to be heads (Kruuk 1972, p. 126), a good source of fat. In Africa, hyenas routinely cache meat in shallow water, often failing to return to consume it. Such caches could provide useful opportunities for Neanderthals, at least when resources were scarce. As hyaenas are active almost entirely at night and spend the day in dens there would be little direct competition for resources. Although hyaenas have been known to attack humans, these events are generally restricted to the young or weak, and mostly take place when victims are sleeping (Kruuk 1972, p. 144). Furthermore, as other social carnivores such as lions and wild dogs can chase hyaenas away from their kills relatively easily, it seems that Neanderthals – with the benefit of cooperative action, weapons and fire – must certainly have been able to cope with these carnivores; although it is hard to imagine that this suspected mutual tolerance would have extended to sharing the same cave.

In the Serengeti, the overall range of prey species of hyaenas and lions are very similar, although the two differ in their specific preferred prey, which probably has the effect of reducing the severity of competition (Mills 1990, p. 52). Such different prey selection with a shared set of available resources could provide a mechanism for sympatry; indeed recent isotopic analysis has highlighted differences in the main prey species of Neanderthals and hyaenas in Europe (Bocherens et al., p. 2005). Under such circumstances, Neanderthals might be actively drawn to hyaena territories. Hyaenas are relatively easy to find: their calls can be heard over vast distances at night and they have a tendency to follow specific paths (Kruuk 1972, p. 22). A sensible strategy, therefore, might be to operate on the edges of clan territories, where scavenging opportunities could be exploited after hyaenas had cached meat at night, while avoiding direct confrontation. Another strategy might be to target maternity dens, a good source of accumulated carcass parts (as discussed for Creswell below). In the Ngorongoro crater, Kruuk (1972, pp. 39–40) identified seven permanent and contemporary clan territories, each typically some 6 x 4 km in extent, although Mills (1990, pp. 150) noted that territories of African spotted hyaenas were highly variable, with a mean of 308 ± 39 km^2.

Modelling of hominin ranging patterns by Gamble and Steele (1999) suggested that, in northern latitudes, hominins would have had to adopt a carnivore-scale ranging pattern. Estimates of Neanderthal home ranges based on raw material movements fell between 2025 km^2 and 5000 km^2 (Gamble and Steele 1999, p. 403; Gamble 2002), clearly an order of magnitude larger than the ranges of African hyaenas. Guthrie (1990) has suggested that even though it was a relatively rich hunting ground, the Mammoth Steppe would not have supported the density of prey found on the modern African savannah. As carnivore population density and range size is directly correlated to prey availability and distribution, it appears probable that the ranges of Pleistocene social carnivores were also much larger. The same factors presumably impacted upon both hyaena and Neanderthal range and group size.

Landscapes and Resources: The Doggerland 'Paradox'

Forming the northwest uplands of Doggerland, Britain would appear to have been a fairly well-stocked larder, home to herds of medium and large grazers and several species of top carnivore, such as the hyaenas noted above. However, given the prevailing view that Britain was a treeless grassland with short cool summers and long cold winters marked by blasting winds, frozen ground and persistent snow, other resources, particularly wood from which to fashion hunting weapons, and other things such as artificial shelters and fire, were probably extremely scarce. Given inferred Neanderthal activity levels, metabolic rates and daily caloric requirements of ~5500 kcal (Sorenson and Leonard 2001), coupled with the possibility that Neanderthal morphology did not provide a major thermal advantage in cold climates (Aiello and Wheeler 2003; Steegmann et al. 2002) and a persistent image of cultural ineptitude (Speth 2004), it becomes difficult to understand how Neanderthals could have survived at all.

White (2006) explored a number of ways in which the tensions between the current behavioural, anatomical and palaeoenvironmental reconstructions might be reconciled in the British Middle Palaeolithic. It is not our intention to rehearse all the arguments here, simply to note that he concluded that the current views require revision, particularly the environmental and cultural reconstructions, suggesting not only that trees probably existed in cryptic refugia (see above), but that Neanderthals must have had the ability, and access to the necessary resources, to create a number of survival pre-requisites – notably clothes, fire, structures and hunting weapons – that are usually archaeologically invisible. Clearly Neanderthals were operating intermittently in Britain – the low level of occupation perhaps in itself testament to the difficulties they faced here – but the challenge is to understand how they solved these survival problems when present.

Alternative resources would have been available. Bone would presumably have been plentiful, and could have been used for fuel and raw materials. However, to date the Neanderthal use of bone as a raw material has been validated at very few sites, the most famous being the pointed rib implements from Salzgitter–Lebenstedt, Germany (Gaudzinski 1999a, 1999b), although re-analysis of old faunal assemblages is beginning to reveal further examples. Sharpened mammoth ribs might well have serviced the close-encounter, ambush hunting strategies inferred from other Neanderthal hunting sites, as well as being potentially able to produce the kinds of traumas seen on Neanderthal skeletons (Berger and Trinkhaus 1995). Nevertheless, Gaudzinski casts doubt on the efficiency of the mammoth rib points for thrusting, given their curvature. Their use as structural supports might therefore be considered. Bone as fuel is also problematic, as it requires another source of fuel to generate sufficient heat for it to ignite (White 2006 and references therein); dried animal dung, grass and shrubs could provide alternative fuels, but all carry energetic costs to harvest. These questions could be answered, but new examples of hearths such as those apparently found by Victorian pioneers at Hyaena Den and Robin Hood Cave will need to be recovered with new excavations first.

Survival stresses would have been particularly acute in winter, providing an obvious solution to the problems raised above: that Neanderthals mainly used Britain as a summer hunting ground, perhaps following migratory herds, and came equipped with resources from neighbouring parts of Europe. Small, highly mobile, seasonal hunting parties would certainly fit with the technological organisation in the landscape described below (although again, seasonality data from new, well-excavated sites is required to test this). The radiocarbon evidence can also be interpreted to support the notion that Neanderthals were feasibly only present during some of the warmer interstadials, which again might help remove some of the obstacles raised by White (2006). However, a recent analysis of Neanderthal energy use during the last interglacial (MIS5e), one of the warmest periods of the last 500,000 years, showed that even then a number of cultural solutions would have been required (Sørensen 2009). The British (and indeed European) archaeological record contains no physical evidence for these solutions, but the extreme situation in Britain at least helps us push the skills needed for survival to the fore, and demands that we consider these invisible cultural elements alongside the more traditional concerns with the lithic technologies described below.

The British Late Middle Palaeolithic Record

The British Late Middle Palaeolithic record comprises a number of lithic findspots usually with singular or very few artefacts, without faunal associations and without absolute dating. Superimposed upon this scatter is a handful of larger lithic assemblages, with or without faunal assemblages and dating, only one or two of which are on a qualitative par with continental sites (Table 4). The available absolute chronology reveals that this occupation occurred, probably intermittently and for short periods, broadly between ~60 ka BP and ~35 ka BP (and probably much less – see below), and saw activity from Lincolnshire in the north to the Isle of Wight in the south, although the apparent northern limit of this occupation is almost certainly an artefact of the extent of the Last Glacial Maximum (LGM) ice advance.

South of the limits of the LGM advance, the basic distribution of findspots ostensibly shows Neanderthal presence throughout Wales, Southern England, East Anglia and the English Midlands, but even here the actual distribution is biased by a number of factors. Landscape variability has influenced both the presence of suitable preservational environments and the likelihood of their eventual discovery. The accessibility of useful caves/fissures (both now and in the deep past), fluvial-lacustrine or coastal locations, the accidental and often fleeting character of many exposures, and the serendipitous presence of people capable of recognising Palaeolithic implements have all impacted on the distribution and number of Palaeolithic sites. But as noted above, 200 years of archaeological endeavour amid rapid industrialisation and urban growth as well as enthusiastic interest has failed to produce an embarrassment of riches. Consequently, it is hardly surprising that our key cave sites are concentrated in two main areas – southwest England/south Wales, and the English Midlands – to an extent showing little more than the distribution of presently located caves, although the resources available in these areas may also have made them desirable locations for Neanderthals. Only two open air sites – Lynford and Little Paxton – have to date yielded substantial late Middle Palaeolithic assemblages, despite extensive quarrying in deposits of relevant age, with all other open air sites of this period being represented by very small assemblages or isolated bifaces of a particular form (i.e. the classic *bout coupé)*.

Insert Table 7 around here
Insert Table 8 around here

A list of bifaces attributed by others (Roe 1981; Tyldesley 1987) to the Middle Palaeolithic on the basis of typology is provided in Table 7; those believed to date firmly to MIS3 are in Table 8. Caution is needed, however, as similar forms appear to have been produced simply by chance in a number of demonstrably older assemblages (White and Jacobi 2002), and context is critical. This makes it is rather difficult to gauge the true distribution of open air sites, although, taking the entire typological sample, there appear to be several foci of activity centring around major river systems (those of the Thames, Great Ouse, Little Ouse–Wissey, and Solent) and the Chalk hinterlands of the North and South Downs (Figure 4). Taking only the dated examples, the picture is essentially the same – if somewhat more southerly – although the small sample size means that no real clusters can be recognised. Other sites have also yielded very few, or only individual Middle Palaeolithic artefacts, such as a double scraper from Ravencliffe Cave in the Derbyshire Peak District, identified by the Abbé Breuil from a layer that included reindeer, rhinoceros and bear (Storrs Fox 1930).

Insert Figure 4 around here

Although the sites are widely distributed in space, their relative paucity and small assemblage sizes are still notable, and may provide a number of insights into Neanderthal populations in Britain. Various attempts have been made to estimate the relative population density during the Pleistocene based on the density of lithic artefacts (Hosfield 1999; Ashton and Lewis 2002). The most influential of these concluded that population density decreased over time, with an abrupt population crash seen in MIS7 (Ashton and Lewis 2002). This pattern was explained as the combined result of an increasing adaptation to the continental steppic environments of central and eastern Europe, and a late breach of the Strait of Dover restricting access to Britain around this time (Ashton and Lewis 2002). This fails to explain the patterns seen in MIS3, however, when Britain was part of a wider North European Plain, and according to the faunal evidence discussed above also had a continental climate. Leaving aside the many problems of using artefact numbers to measure population size, it is unlikely that an area the size of Britain was ever host to particularly large hominin populations, and the patterns noted by Ashton and Lewis may relate more to technological organisation and the depth of time over which sediment bodies were aggraded and reworked than the number of human occupants. Indeed, based on observed data for ethnographic hunter–gatherer population density, Gamble (2002) estimated that Pleistocene populations in England and Wales (the known distribution of Neanderthal settlement) probably varied between ~13,500 and ~3000 people (greater if Scotland is assumed to have been inhabited: see Table 9). We suspect that even the lower of these figures over-estimates the Neanderthal population of Britain: it is entirely possible that only a few hundred individuals were present, and then only for very brief periods of time.

Insert Table 9 around here

Chronology and settlement history

Early observations that evidence for human activity in Britain was not associated with evidence for *Hippopotamus* (despite misidentifications, for example at Rhinoceros Hole: Tratman et al. 1971) ruled out occupation during the last interglacial (MIS5e) (Currant and Jacobi 2002; Ashton 2002). There are also no convincing indications of Middle Palaeolithic activity in the early glacial period (MIS5d–b), nor any archaeological associations with fauna of the Bacon Hole, Banwell or Brean Down MAZs, which appears reasonably well correlated with MIS5a to MIS4 (Currant and Jacobi 2001, 2010; Ashton 2002; Gilmour et al. 2007). Judgement on claims of human occupation during MIS5d-b from Dartford in Kent (Wenban-Smith et al. 2010) – based on OSL dates from mass-movement slope deposits that yielded just two fresh flakes and a number of clearly derived older artefacts – must be reserved until more convincingly contextualised dates and materials are forthcoming. Overall, therefore, it seems that the Neanderthals abandoned Britain around or before the onset of MIS6, ~180 ka BP (Ashton and Lewis 2002; Ashton 2002; Currant and Jacobi

2001) and were absent for at least 120,000 years. Thus a critical issue facing British Late Middle Palaeolithic archaeology is to demonstrate accurately and precisely when the initial reoccupation of Britain by late Neanderthals occurred.

This will be achieved convincingly only by new fieldwork at existing archaeological locales, or, better still, the discovery of new sites. Dating programmes for British sites excavated long ago have to accept that ‘associations made between the materials selected for dating and evidence for Middle Palaeolithic activity are the best that can at present be achieved’ (Jacobi et al. 2006, p. 565). There are several problems with this approach. First, one has to reconstruct the original stratigraphic position of the diagnostic Middle Palaeolithic artefacts and of the bones selected for dating, which is imprecise at best, leading to unverifiable assumptions that the two are meaningfully associated. Secondly, given the almost absolute lack of cutmarked or otherwise modified bones from MIS3, virtually none of the bones and teeth selected for dating demonstrably pertain to Neanderthal activity; instead they often relate to hyaena activity, although these may be synchronous (as noted above). The chronometric inaccuracy and imprecision associated with dates of this period further confuses the picture. One therefore has to make an assumption that ^{14}C dates on hyaena denning material or other naturally accumulated faunal remains reflect the age of Neanderthal activity in broad stratigraphic association with it, which given the error margins of the ^{14}C measurements could in fact amount to a difference of 2–3 ka at 2σ.

Thus, it can hardly be said that the major British Late Middle Palaeolithic sites are well dated in any sense. As revealed in Table 4, dates exist for only two open air sites, of which one is a minimum age of dubious relevance. Of the cave sites, non- ^{14}C dates are of little use given their relatively large errors, and many existing ^{14}C measurements are on pre-ultrafiltrated samples that might change if re-dated today. Only seven sites provide reliable ^{14}C measurements pertinent to British Late Middle Palaeolithic chronology, and three to the chronology of succeeding LRJ (Lincombian–Ranisian–Jerzomanowician) leafpoint assemblages, which are discussed below (see Figure 3). OSL dates of 64 ka +/- 5 ka and 67 +/- 5 ka from Lynford place Neanderthals at the locality between ~54 ka cal BP and ~77 ka cal BP at 2σ (Boismier et al. 2003). On palaeoenvironmental grounds one might assume that the activity relates to MIS3 and not MIS4 (see above), thus constraining the age to ~60–54 ka cal BP. This calendrical age range is consistent with the ^{14}C age ranges (again at 2σ) of the Late Middle Palaeolithic assemblages at Coygan Cave, Pin Hole Cave, Robin Hood Cave, Kent's Cavern, Ash Tree Cave, Picken's Hole and Hyaena Den, spanning a period between ~60,000 and ~38,000 BP. Parsimoniously, all of the radiocarbon-dated assemblages belong to the period ~40 ka BP to 50 ka BP, and possibly relate to the bulk of Neanderthal activity in the country. LRJ leafpoints at Kent's Cavern, Bench Quarry and Badger Hole – the only sites at which they may be regarded as at all reliably dated – span the period between ~38 ka BP and ~36 ka BP. To re-iterate, a parsimonious reading of the radiocarbon age ranges, that is, one that recognises only the main range over which the chronological measurements for these sites overlap, would place all of the dated Late Middle Palaeolithic sites (bar Lynford, which has no directly relevant radiocarbon dates: Bayliss et al. 2007) between ~50 ka BP and ~40 ka BP, and the LRJ between ~38 ka BP and ~36 ka BP. There appears to have been no occupation younger than ~44 ka BP that can formally be defined as Late Middle Palaeolithic. The younger LRJ materials – on the basis of the present data some 6000 radiocarbon years younger – could represent a very different occupation event, such as a distinctly new biological population, or a weak and brief recolonisation before their final extinction in the region. We recognise that there is as yet no internationally agreed correction/calibration curve, but a comparison of the available radiocarbon measurements with the CalPal curve of Weninger and Jöris (2004) suggests that, very broadly, the calendrical age range of the existing radiocarbon chronology is ~44 ka cal BP to ~54 ka cal BP. A glance at Figure 1 shows that this broadly corresponds to the relatively stable interstadial conditions of GI14. Similarly 'corrected' dates for the three LRJ measurements indicate a broad age range of ~42 ka cal BP to ~43 ka cal BP, corresponding perhaps to GI11. We emphasise once again that these are few dates for few assemblages, and such 'corrections' to 'calendrical' dates are at present very approximate, although we hope that the hypothesis of Late Middle Palaeolithic occupation in Britain, restricted perhaps to GI14, 13 and 11, may be tested as new sites are discovered and techniques improved.

The earliest demonstrable age for the Aurignacian presence of *Homo sapiens* in Britain is ~32 ka BP (i.e. direct AMS ^{14}C dates on an antler point from Uphill Quarry

Cave 8 [OxA-13716, 31,730 ± 250 BP] and a bone point from Hyaena Den [OxA-13803, 31,550 ± 340 BP]: Jacobi et al. 2006). This equates very roughly to a 'corrected' age of ~35 ka cal BP, at least 7000 'calendar' years after the LRJ. Once again, with caution duly emphasised we forward the falsifiable hypothesis that *Homo sapiens* arrived in Britain after a considerable occupation gap following regional Neanderthal extinction, and did not play a part in the extinction process. This arrival could have occurred in the interstadial conditions of GI6 or GI7.

Needless to say, we are reluctant to make too much of such a database. Potential problems of non-ultrafiltrated ^{14}C measurements aside, it is clear that sites excavated early in the history of Palaeolithic archaeology remain open to doubt in terms of the association of dated samples with diagnostic archaeology. All one can conclude is that the Late Middle Palaeolithic occupation of Britain need not have amounted to anything more than brief pulses of activity in the period ~40–50 ka BP (~44–54 ka cal BP); the LRJ spans a very brief period, ~36–38 ka BP (~42–43 ka cal BP), and the Aurignacian ~32 ka BP (~35 ka cal BP), with periods of at least 4000 calendrical years separating the Late Middle Palaeolithic from the LRJ and at least 7000 the LRJ from the Aurignacian. We suggest that this provides a useful settlement hypothesis and scenario for the Middle to Upper Palaeolithic transition in the region to falsify.

Technology, organization, and behaviour in the British Late Middle Palaeolithic

The British Late Middle Palaeolithic may be defined as biface-dominant, with the use of typical Mousterian tool forms, notably scrapers, occurring in some of the larger assemblages. In addition, a distinct tradition of simple chopper/chopping tool technology on non-flint raw materials is found in several caves at Creswell Crags. At some sites (e.g. Creswell and Oldbury) discoidal technology was also practised. Overall, then, it corresponds to the continental Mousterian of Acheulian Tradition (MTA), a comparison that has often been made (e.g. Mellars 1974; Roe 1981). This is not surprising, given that the chronological range of the British material overlaps with that of the French MTA (Mellars 1996). Similarly, continental parallels for simple chopper/chopping tool technologies do occur, for instance at the bovid hunting localities of Mauran (Farizy and David 1992), where this technology seems to have been useful as a rapid and renewable response to the demands of heavy duty butchery of mass/multiple kills. Although the latter are as yet unknown for Britain – and may in any case be inappropriate analogies given the low frequency of Neanderthal presence in Britain and the low numbers involved – it is consistent with the exploitation of bovids and similarly large-sized animal resources.

Cave assemblages

Many cave sites in Europe have rich, deeply stratified Middle Palaeolithic sequences containing thousands of lithics representing all phases of the technological *chaîne opératoire*. It is often assumed that such caves formed relatively long-term residential foci for Neanderthal groups, from which they organised their daily hunting and foraging routines and where a range of economic and social activities took place, sometimes including burial or detachment rituals (Gamble 1999; Pettitt 2011). British assemblages, on the other hand, tend not to correspond to this picture. They tend to be numerically small, dominated by tools, and to show very limited evidence of on-site lithic manufacture. Of the sites listed in Table 4, only four (Lynford, Robin Hood Cave, Oldbury and Little Paxton, in descending numerical order) have yielded >100 artefacts. The rest comprise only a few pieces, often bifaces, scrapers, choppers and knives, sometimes accompanied by biface trimming flakes. Even the largest cave assemblage – Robin Hood Cave – contained no more than 500 or so artefacts, probably fewer. Examples from the clusters in the southwest, South Wales and the English Midlands serve to illustrate 'typical' British cave assemblage.

The assemblage from Uphill Quarry Cave 8 (Figure 5) comprises at least two small triangular bifaces, biface fragments, a convergent side scraper/Mousterian point, notched and denticulated flakes, small thinning flakes and a naturally backed knife, as well as some evidence for discoidal core technology (Harrison 1977; Jacobi and Pettitt 2000). While the presence of cores and thinning flakes led Jacobi and Pettitt (2000) to suggest that the site was the locus of on-site knapping, Harrison saw the dominant technological activity at the site as the resharpening of broken and damaged tools, probably as a result of limited access to high quality raw materials in the region. This would suggest that the site was only a temporary stopover where a transported and curated toolkit was being maintained, those tools left behind presumably discarded as not worth taking any further; the triangular biface is 6cm long and was clearly at the end of its use-life. At Coygan, the extant Middle Palaeolithic assemblage comprises three bifaces and two flakes, one of which is large enough to have served as a biface blank. A case for prolonged use of at least one of the bifaces has been made by Jacobi (quoted in Aldhouse-Green at al. 1995, p. 69) who has noted a polish consistent with a long period of rubbing in the hand or in a pouch, in association with apparent edge resharpening.

Insert Figure 5 around here

Perhaps the most famous cave site in Britain is Kent's Cavern. Its fame largely derives from its role in the establishment of human antiquity and development of Palaeolithic archaeology (White and Pettitt 2009), rather than from its Middle Palaeolithic assemblage, which is today difficult to reconstruct. William Pengelly, who conducted extensive excavations in the cave between 1865 and 1880 (Pengelly 1884), recorded over 7000 finds from his excavations, 1400 of these being lithics. Of these, only ~33 pieces that can be categorically assigned to the Late Middle Palaeolithic are now extant, to which can be added a handful of artefacts excavated subsequently by Arthur Ogilvie, and several bifaces excavated previously by John MacEnery (Figure 6).

Insert Figure 6 around here

The extant collection of 45 objects (23 of greensand chert, 22 of flint) includes five bifaces, nine scrapers, possible awls/borers, and a variety of debitage including two Levallois flakes. A number of these appear to have been isolated finds, such as those from the Clinnick's Gallery and Smerdon's Passage parts of the cave system, but accounts suggest that a concentration of Middle Palaeolithic finds occurred near to the cave's south entrance within the Great Chamber, at depths of 1–4 ft (0.3–1.2 m) (Pengelly 1884; Rogers 1955; Campbell and Sampson 1971). From what survives, there is little evidence of on-site manufacture, and the whole appears to be a collection of artefacts taken to the cave during a number of relatively brief visits: the extant debitage is almost all from discoidal or Levallois methods of managed flake production. The known and illustrated bifaces from Kent's Cavern are all small, typical Late Middle Palaeolithic cordiform examples, four of which conform to the *bout coupé* type (Tyldesley 1987). This grouping is the largest concentration of *bout coupés* in Britain, and although some show apparent reworking there is no evidence that once introduced to the cavern they were modified or further worked.

White and Jacobi (2002) suggested that the *bout coupé* form had a social resonance for those who made and carried it, and that some were deliberately cached in caves: the well-used piece from Coygan being one example, while that from the Wolf's Cave was certainly found in a relatively inaccessible part of Kent's Cavern (although for much of the Middle Pleistocene this part of the cave appears to have been a hyaena den as our recent excavations have shown: Figure 7). Caching implies not only the deliberate postponement of action – members of task groups storing objects for an anticipated return visit – but also the provisioning of sites, transforming them from spaces into places (Kuhn 1995). In conjunction with the open air discard of transported objects, this suggests that both people and places were provisioned (Kuhn 1995), perhaps another reflection of extreme mobility through the unfamiliar landscapes of Doggerland. If this is the case, then the geographical distribution of *bouts coupés* might indicate that the social networks through which these meanings flowed were extensive and complex, stretching amongst the various local groups that, we suggest, moved seasonally into Britain from the surrounding basins.

Insert Figure 7 around here

By far the densest concentration of Middle Palaeolithic occupation in Britain is found at Creswell Crags (Figure 8). This is but one gorge among a number that cut a band of Permian limestone in the wider Creswell Heritage Region of Derbyshire and Nottinghamshire. Outside Creswell Crags, at least 30 Late Middle Palaeolithic artefacts are known from Ash Tree Cave, 2 km to the north (Table 4). The recovery of hyaena remains from Ash Tree Cave, and from Langwith Cave in the Poulter Valley (4 km south of Creswell), suggests that the wider region also served as the territory of hyaena clans. Although widespread evidence for Late Middle Palaeolithic activity is rather limited, it seems reasonable to assume that the wider landscape, rather than Creswell *sensu stricto,* formed a Neanderthal local operational area (for a definition of this term, see below), which possibly extended as far as the aforementioned site of Ravencliffe Cave in the Peak District, some 40 km to the west. This may give an indication of the scale of Neanderthal mobility in the region. The gently undulating landscape of the Creswell area, with plentiful rivers draining the plateaux in easterly directions (Mills 2001, p. 57), provided a rich ecotonal resource during MIS3, and pollen from Robin Hood Cave indicates a grassland with stands of juniper and various herbaceous vegetation at the time that the cave was occupied by Neanderthals (Jenkinson et al. 1986).

Insert Figure 8 around here

All of the major caves in the Creswell gorge have yielded Late Middle Palaeolithic assemblages. In order of size: at least 13 Late Middle Palaeolithic artefacts are known from Mother Grundy's Parlour, 58 from Pin Hole, 93 from Church Hole and 479 (possibly a little over 500 originally) from Robin Hood Cave (Dawkins 1876, pp. 250–251; 1877, p. 591; Jenkinson 1984; Jacobi 2004; 2007a). Furthermore, the recovery of a number of unworked quartzite pebbles from the Yew Tree Shelter at the eastern end of the Creswell Gorge suggests that the shelter was used to cache material in anticipation of future needs (R. Jacobi pers. comm.). It is likely that all of these counts are underestimates: Middle Palaeolithic quartzite flakes were recovered from the spoil heap of the 1875 excavation of Robin Hood Cave (Campbell 1969–1970), and by one of us (Pettitt) from the spoil heap of the 1876 Church Hole excavation (Figures 9, 10 & 11), which demonstrates that less-impressive elements of debitage (at least) were often overlooked. As the majority of pieces have now been lost it is unlikely that the picture will improve. It is unlikely, however, that significant numbers of artefacts were discarded or lost, and even assuming under-estimation, these are, by Continental standards, small assemblages that, as with the rest of British sites, suggest low population numbers and brief periods of occupation.

Insert Figure 9 around here
Insert Figure 10 around here
Insert Figure 11 around here

In all of the Creswell caves, quartzite is the dominant raw material (~96–99%), deriving from Triassic deposits commonly referred to as the 'bunter' pebble beds and available in the stream that ran through the gorge itself. Small numbers of artefacts on clay ironstone and flint suggest wider raw material procurement, the latter perhaps 40–60km distant. Jacobi (2004) has noted a clear link between clay ironstone and biface manufacture at Creswell, which suggests deliberate selection. The dominant technology, however, is either simple chopper/chopping tool reduction or the discoidal method, both well suited to the small cobbles, although given the presence of bifaces or biface thinning flakes in Robin Hood Cave, Pin Hole and Mother Grundy's Parlour the collections fall broadly within the definition of the MTA, as with all British Late Middle Palaeolithic material.

Armstrong excavated at least 13 quartzite artefacts from Mother Grundy's Parlour, including four sidescrapers, six flakes, and a biface of clay ironstone that is now either lost or represented only by a fragment in Manchester Museum (R. Jacobi, pers. comm). Armstrong noted the similarity of these artefacts 'to those figured from the Robin Hood and Church Hole caves' (1925, p. 152). Although it is unclear whether Late Middle Palaeolithic artefacts were excavated from the cave by the Dawkins/Mello team and are now lost, it is fair to assume that the cave was probably the least used in the gorge by Neanderthals. Ninety-three Middle Palaeolithic artefacts have been published from Church Hole, of which the majority are flakes and choppers. Seventy-three of these were described as 'round pebbles' – apparently unmodified – and 33 pieces were extant, until a further 13 recently emerged out of storage at the University of Cork (P. Woodman, pers. comm. to Pettitt). Among these, chopping tools are most abundant, several of which were also used as hammerstones (Pettitt pers. obs.). In addition to these, three discoidal cores, five side scrapers (one of flint), two naturally backed knives, and various flakes reveal that, as with the other caves in the gorge, a small number of tool forms complemented the otherwise simple chopper/chopping tool assemblage.

At least 58 Late Middle Palaeolithic artefacts are known from Pin Hole, a figure probably close to the number originally recovered from the cave (Jacobi 2004; Jacobi et al. 1998). Armstrong (1931–1932, p. 179) felt that there were at least three separate Late Middle Palaeolithic assemblages in Pin Hole, each separated by thick layers of cryoclastic slabs, although as Jacobi et al. (1998) noted, there is no reason to separate these stratigraphically, even if they may have derived from a number of brief occupations. The assemblage size and character suggests that *in situ* knapping was limited, and while flakes dominate the quartzite and flint assemblages, the cave is noteworthy for having a large proportion of tools, sidescrapers being the most common tool type on both materials (around 45% of the tool count). Two bifaces are present, although a large quartzite thinning flake (larger than any extant biface) and a thinning flake of clay–ironstone (for which there is no matching biface) suggest that others were moved in and out of the cave. Quartzite cores, whose colour does not match any known flake, suggest a similar pattern of import and export. Late Middle Palaeolithic artefacts from Pin Hole were re-plotted using Armstrong's excavation notes, which showed a main cluster in the rear of the cave (Jenkinson 1984, p. 74). Stratigraphically, the artefacts form a relatively discrete 'horizon' clearly distinct from the overlying Early Upper Palaeolithic artefacts, and a large series of U-series and AMS ^{14}C dates on faunal remains associated with the lithics – including mammoth, woolly rhinoceros, horse, reindeer and a bovid – indicate an age for Neanderthal use of the cave between 0 ka BP and 50,ka BP (Jacobi et al. 1998; 2006 and Figure 3).

On the basis of known archaeology, it is Robin Hood Cave that clearly received the most Neanderthal attention. This is not surprising, given that it has the largest and airiest mouth of all of the Creswell caves. Choppers and flakes dominate the extant quartzite artefacts from Robin Hood Cave, although at least four cordiform bifaces of flint, ironstone and quartzite, several scrapers, and two Levallois flakes are also known. Spatially, their distribution was concentrated in the rear of the cave's western chamber. An ESR measurement of 55000 ± 4000 BP for a tooth of woolly rhinoceros provides a *terminus post quem* for the Middle Palaeolithic occupation of the cave of ~63–47 cal ka BP, which is consistent with radiocarbon measurements that place it in the range ~43–47 ka BP.

Dawkins (1877) reported a total of 479 artefacts from the Cave Earth and Red Sand in the Western Chamber (possibly out of a total a little higher than 500), 445 being quartzite chips (flakes); as no stratigraphical details are recorded on the artefacts these can no longer be substantiated. In the 1980s, Coulson (1990) assessed the surviving material (most of which is housed in the British Museum, having been donated by

Franks who obtained it directly from Mello in 1883; the remaining objects are distributed around nine museums: Coulson 1990, p. 292), and was able to re-assign 83 pieces to the Middle Palaeolithic (Table 10), including a flint biface and Tayac point recovered by Campbell (1969) from the Victorian spoil. The material recovered by Robert Laing from the rear of the cave, which reportedly included 'rude' choppers and scrapers, is now completely lost (Jenkinson 1984). This is extremely regrettable, as his short published account describes an area on or within the Red Sand that may represent Mousterian activity around a hearth, with scrapers, charred material and processed bone (Laing 1889, p. 582).

Insert Table 10 around here

Coulson (1990, p. 299) observed that seven chopping tools showed signs of having been used as hammerstones and as cores, and in each case the sinuous 'chopping edge' showed use-related damage, suggesting that these objects had ultimately served as tools. The presence of hammerstones, choppers at the end of a varied use-life, flakes and cores – some abandoned due to faults and knapping errors (Coulson 1990) – suggests that a relatively large amount of knapping actually took place in and around this cave. However, there is nothing to suggest that this site served as a longer-term residence, and it is equally possible that, simply because of its large size, Robin Hood Cave saw more frequent visits by hunting parties, some of which came equipped with exotic flint objects. Indeed, the assemblage from Pin Hole Cave shows an even greater proportion of flint artefacts, including an elongated Mousterian point, five scrapers and thinning /resharpening flakes from scrapers or bifaces, again showing the introduction of curated items brought into the region from elsewhere. In both sites, though, there is an element of *in situ* knapping of local quartzites to produce heavy-duty tools to service immediate needs, possibly including breaking bone, as at the Pyrenean hunting site at Mauran (Farizy and David 1992; White in press). The absence of any clear human modification on the extant faunal assemblage, however, precludes further speculation.

Jacobi (2004) compared the Middle Palaeolithic lithics from Pin Hole and Robin Hood Cave. Of the 58 artefacts from Pin Hole, over half are formal tools, mostly scrapers. By contrast, although the extant material from Robin Hood Cave is a sample of the original 479 claimed pieces, the greater majority (~80%) comprise cores and debitage. Jacobi has interpreted these differences in functional terms related to the structure of the caves, although the exceptionally high ratio of tools to unretouched forms suggests that the Victorian excavators were selectively retaining tools and discarding debitage, so one must be careful of such interpretations. This being said, Pin Hole is generally very narrow and confined, Robin Hood Cave far more spacious and amenable to housing larger groups. Charcoal is also present in the latter but not the former. Noting that tool manufacture occurred in Robin Hood Cave but not in Pin Hole (to which tools were taken), Jacobi considers that Robin Hood Cave was used as a local operational base (a general purpose camp site), whereas Pin Hole was used for the specific task of hide working, a suggestion previously made by Jenkinson (1984, p. 75).

Jacobi does, however, caution that the use of caves by hyaenas may well have been another factor that determined which of the Creswell caves were suitable for habitation. Hyaena remains are known from Robin Hood Cave, Pin Hole, Mother Grundy's Parlour and Church Hole, as well as smaller caves and fissures such as C8 (the 'Ossiferous Fissure') and C9 ('The Arch' collapsed cave). Although one should be suspicious of the accuracy of pre-ultrafiltrated ^{14}C measurements, as discussed above, the broad range of measurements for hyaena at Creswell shows that it was a regular visitor to the area in MIS3. Directly-dated shed reindeer antlers at Creswell Crags and at the nearby Whaley 2 rockshelter reveal that the region functioned as a calving ground between ~45 ka BP and 35 ka BP, and may therefore have proven attractive to Neanderthals and hyaenas during the calving season, even if cutmarked reindeer material is lacking from this time period (Pin Hole: OxA-3790 shed male reindeer antler 33600 ± 670 BP; OxA-3791 shed female reindeer antler 30940 ± 490 BP, Hedges et al. 1994. Whaley 2: OxA-4433 reindeer antler 42700 ± 2300 BP; OxA-4434 reindeer antler 39600 ± 1500 BP, Hedges et al. 1996). It is interesting that radiocarbon determinations for hyaena denning at the gorge generally overlap those for reindeer in the area, presumably because this carnivore was exploiting the presence of calving and young reindeer. The presence of hyaena gnawed reindeer antler at Creswell supports this observation, while a hyaena neonate in the MIS3 deposits of Pin Hole shows that, at least on occasion, the Creswell caves were used as maternity dens. Neanderthals may have been attracted to the reindeer herds for other reasons – their furs. Reindeer furs have very high insulation values, and may therefore have been as valuable as their meat in energetic and thermal terms (Stenton 1991; White 2006).

In summary, in those British Caves where a Neanderthal presence can be demonstrated, only the most ephemeral of visits are noticeable, perhaps nothing more than a number of overnight forays by well-equipped hunters, who whiled away the hours by repairing items in their tool kit (some of which they abandoned or otherwise left at the site), and who used local raw materials to produce expedient choppers and other tools to supplement their few curated items. The apparent abundance of hyaenas in MIS3 Britain, and the dominance of their bones and bones of their prey in faunal assemblages, suggests that while potentially desirable residences, most British caves often had very unwelcoming sitting tenants.

Open air assemblages

The situation found in British caves is mirrored in the open air sites, only two of which have produced large assemblages, and only one of these – Lynford Quarry, Mundford, Norfolk – has been excavated using modern techniques. The main Lynford assemblage comprises some 565 fresh-mint artefacts ≥20 mm maximum dimension, consisting of 45 bifaces and 489 flakes alongside a small flake-tool element including scrapers, notches and bifacial pieces (Figure 12). The assemblage was recovered from slow-moving or still waterlain organic deposits (Facies Association B-ii), infilling an abandoned channel of the River Wissey (Figure 13), although it seems likely that much of the lithic assemblage was introduced into the channel through the collapse of the adjacent channel edges where primary activities took place (White, in press; Lewis, in press). A rich palaeoenvironmental sample including pollen, plant macrofossils, insects, and molluscs was also recovered (Boismier et al. 2003), alongside an important Pin Hole MAZ faunal assemblage that included horse, reindeer, bison, and mammoth.

Insert Figure 12 around here

Insert Figure 13 around here

The Lynford lithic assemblage reveals much about Neanderthal activities and organisation of technology in the landscape. The flakes are dominated by soft hammer pieces from biface trimming, with the prevalence of bifaces and low frequency of cores (n=3) indicating that almost the whole sample, including hard-hammer and indeterminate examples, derives from biface manufacture. Furthermore, the pattern and number of dorsal scars, butt type and cortex percentage suggest that most come from the later stages of biface trimming, with minimal primary working or shaping taking place on site (White in press). In this sense the Lynford assemblage is a numerically larger open air expression of the assemblages found in caves.

Like Robin Hood Cave, Lynford also contains limited evidence for much shorter chains of manufacture–use–discard on site using local fluvial raw materials, including a minimally-worked biface on a cobble with conjoinable primary removals. Other on-site manufacture is indicated by three flake-based roughouts and two flake 'preforms', most of which were abandoned when flaws became evident in the flint (White, in press). However, given the paucity of cores from Lynford, none big enough to produce the preforms, it is assumed that these were introduced to the site from elsewhere, possibly in a dressed state, and thus may again point to logistical lithic movements, similar to the apparent cache of quartzite cobbles from Yew Tree Shelter.

The Lynford bifaces form a tight group in terms of shape and technology, tending to be intensively worked, broad and highly refined, with a number of flat butted cordiforms and one 'true' *bout coupé* (White in press). They also show a number of informative techno-functional features. Twenty-three complete and broken bifaces show varying levels of macroscopic tip damage, generally snaps rather than crushing. In several cases, snaps in opposite directions occur, suggesting that they were produced through a twisting or 'to and fro' prising motion. This recurrent pattern of breakage suggests that one of the major tasks to which the bifaces were being put involved using the tip as a lever, possibly to disarticulate the joints of large animals. In two cases the break surface shows evidence of fine regular 'retouch' and some possibly break-related spalling, but others show deliberate modification to thicken and strengthen the broken edge.

Other evidence for repair, recycling and edge modification is widespread (White in press). In two cases fragments of once larger bifaces have been re-fashioned into new tools by judicious retouch along the break and re-orientation of the tools' long axis. Another example of extreme reworking is shown and described in Figure 14. Ten bifaces show tranchet removals (12 tranchet flakes were also found). Given the other indicators of breakage and reworking, these possibly represent the resharpening of broken or blunted tips. Five bifaces also show evidence of notching to the edges and 20 show 'scraper-like' lateral retouch (White in press; cf. Depaepe 2001; Soressi and Hays 2003). The bifaces with retouch are significantly larger than those without, conforming to Dibble's (e.g. 1995) assertion that the larger and better pieces were preferentially selected for extended usage. A number of bifaces also show what appears to be deliberate 'backing', in at least one case on the opposite margin to an area of scraper retouch.

Insert Figure 14 around here

Twenty flake tools were also recovered from the palaeochannel deposits. These show a high frequency of working to both faces, with 12 of the scrapers plus a hachoir showing some bifacial working. In eight cases this has been directed towards thinning or removing the butt, with further working occasionally found elsewhere on the ventral surface to regularise edges. In shape and general morphology the distinction between bifaces and scrapers is rather fuzzy, with an arbitrary separation of a technological continuum based on intensity of bifacial working and edge modification. Some of the bifaces, although extensively worked on one face, retain enough evidence of an original ventral flake surface to qualify as partial bifaces under Bordes's (1961) typology. Recent studies of Middle Palaeolithic biface assemblages in Northern France have similarly begun to emphasise a number of blending categories: true bifaces, partial bifaces and bifacial scrapers (papers in Cliquet 2001), with the artefacts from each class serving as either tools in themselves or as supports for other tools (that is, the scraper edges and notches to bifaces described above).

Lynford thus appears to have been a place in the landscape to which bifaces in various states of reduction were brought from manufacturing sites farther afield. Several were broken, repaired and finessed on site, where they were finally lost or discarded. Some of the partial bifaces/bifacial scrapers may represent similar tools at the beginning of an intended longer use-life, and only a small number were made on-site from local materials to fulfil an unanticipated need or to replace items irretrievably broken or lost. The Lynford bifaces also conform to recent suggestions that Middle Palaeolithic bifaces possessed prehensive and active edges, the role and location of which may have changed during the life of the tool (Boëda 2001; Soressi and Hays 2003). Middle Palaeolithic bifaces were highly flexible implements with varifunctional edges, which formed tools, and supports for other 'tools' such as scrapers and notches, and which were subject to extensive resharpening throughout an extended and mobile use-life (e.g. Boëda et al. 1990; Turq 2000; Soressi and Hays 2003). The partly decorticated preforms and roughouts taken to the channel edge in various stages of advancement would have provided a range of options when it came time to use them. This pattern of artefact curation, rejuvenation and discard is entirely consistent with what we see occurring in the caves.

The conclusions drawn from the Lynford assemblage can be extended to the corpus of British Middle Palaeolithic bifaces. Many of these occur as isolated discards, some (such as Fisherton) apparently in direct association with the remains of large herbivores (Stevens 1870). None are found in situations that imply large social gatherings at domestic foci, and nor are they associated with the debris from their manufacture. Nearly all, then, appear to be objects that have been widely transported and modified until finally abandoned in the context of use – highly mobile and morphologically fluid objects. The limited occurrences in precise cave contexts may represent small caches of personal gear stashed by Neanderthal hunters for later use.

This technological behaviour must be viewed in relation to the mammalian assemblage from the site. Schreve (2006) reported 1245 pieces of mammoth bone (91% of the total assemblage), representing a minimum of 11 individuals. The mammoth remains were dominated by fragments of tusk, crania and ribs and were noted as having been heavily trampled. An analysis of weathering patterns on the surfaces of the bones led Schreve (2006) to conclude that the mammalian assemblage represented a palimpsest that had entered the channel by various means over a period of tens of years. Neanderthals had played some role in its accumulation, however. Green bone fractures and broken teeth indicative of marrow extraction were found on the remains of horse, reindeer and rhinoceros. The mammoth remains lacked cutmarks (perhaps not surprisingly given their size and condition, cf. Schreve 2006; Haynes 2002; Gaudzinski 1999) or other direct features associated with human butchery. However, the mortality profile (mostly young to middle-aged males), the high number of pathologies in the prime target area around the ribs (possibly non-fatal humanly inflicted wounds), and the virtual absence of meaty long bones suggested that Neanderthals had been involved, probably removing the latter from the site for processing elsewhere (Schreve 2006, p. 555, in press; Lister in press). Evidence for carnivore gnawing was negligible, but where present hyaena was identified as the prime suspect.

In the broader behavioural and environmental context, the technological organisation suggests a degree of planning, a versatile butchery kit being transported around the open landscape to counter the difficulties of predicting the distribution of mobile (animal) resources, and the possible spatial differentiation between (known) flint sources and the locations in which tools would be needed (Torrence 1989; Nelson 1991; Ashton 1998). Even if they were simply scavenging dead animals or actively seeking-out sick ones on the mammoth steppe, this tool kit would have helped Neanderthals respond quickly to visual cues like carrion birds and gain early access; thoughtful and prepared Neanderthals reading the signs. The absence of hind limb bones and the flexion breaks on biface tips may show that despite the absence of cutmarks Neanderthals were dismembering fairly complete mammoth carcasses at Lynford. We also know from isotopic evidence that Neanderthals consumed considerable quantities of mammoth in adjacent areas of Belgium (Bocherens et al. 1999; 2001). An important question is whether the quantity of animals in the small area excavated at Lynford might require a more proactive Neanderthal, perhaps 'shepherding' animals, many of whom were previously wounded, into the marshy palaeochannel, or whether one random encounter every year for 12 years explains it all.

This pattern of transport and curation is not evident at Riverside Pits, Little Paxton, Cambridgeshire, where artefacts were recovered in the basal gravels of the low terrace (Terrace 1–2) of the Great Ouse, alongside a Pin Hole MAZ (Tebbutt et al. 1927; Paterson and Tebbutt 1947; Tebbutt pers. comm. to Jacobi 1982). Some 210 artefacts were recovered, including 200 flakes and flake tools, eight bifaces and two cores, which Paterson divided into two groups based on condition and patina. Paterson's Group B comprised 201 artefacts in fresh to slightly rolled condition, with some edge damage and slight battering, clear evidence of some fluvial disturbance. Two flint sources were noted, a grey 'Lincolnshire' flint and local black flint with a worn cortex; both were probably obtained from local river gravels (Paterson and Tebbutt 1947). The assemblage included seven small bifaces, one being a classic *bout coupé* showing evidence of possible use-wear at the butt produced by heavy-duty battering, and a number of scrapers including a déjeté scraper, a 'Quina'-type side-scraper and a convergent scraper with bifacial retouch, both similar to forms found at Lynford. Although this is a palimpsest assemblage, the absence of cores suggests that biface manufacture was the key technological activity at Little Paxton. The range of flakes present appears to reflect complete biface reduction sequences: 30% were from roughing out with fully cortical dorsal surfaces, 45% from shaping or thinning flakes, and 5% from finishing or retouching (Paterson and Tebbutt 1947, p. 43). Paterson also identified a number of Levallois flakes from both groups, although later workers have dismissed these as biface thinning flakes (Wymer 1985). Overall it would appear that, in contrast to Lynford, Little Paxton represents a more complete manufacturing sequence, perhaps one of the places where a rich source of raw material was used to gear up for activities elsewhere in the landscape.

The issue of Levallois technology

There are remarkably few unambiguous Levallois products in the British Late Middle Palaeolithic, a fact that clearly distinguishes it from the Early Middle Palaeolithic (White and Jacobi 2002; White et al. 2006). The few examples that do exist are all flakes, and we know of no Levallois core from a firm MIS3 context. A small number of Levallois flakes are known from Kent's Cavern (>5) and Robin Hood Cave (2). A number of flakes hitherto identified as Levallois (Patterson and Tebbutt 1947) have subsequently been reclassified as biface thinning flakes (e.g. Little Paxton –Wymer 1985). Evidence from Oldbury and other sites suggests that discoidal core technology was a dominant feature of the British MTA, and it is therefore possible that some of the more ambiguous flakes identified by some as Levallois are actually products of this technology. At all sites where unambiguous Levallois products have been found it is noticeable that they are in no more than single figures. The extreme rarity of

Levallois material among sites and findspots overall, their low number on sites where they do exist, and the total absence of cores cannot be an artefact of recovery, and one might confidently conclude that Levallois technology was rarely practised in MIS3 Britain.

Interestingly, at the two sites where unambiguous Levallois products occur, leafpoints have also been found. It seems plausible that these Levallois products were generated during the use of laminar technologies aimed at the production of blade blanks for the manufacture of leafpoints. Given the nature of the relevant sites, however, we recognise that this remains speculative. If correct, however, it would again suggest that Levallois technology was not a feature of the British Late Middle Palaeolithic, but of the Early Upper Palaeolithic.

In recent years, a number of studies have suggested that Levallois technology was preferentially selected for long-distance curation in the landscape (Geneste 1985; 1989). White and Pettitt (1995) suggested that this flexible technology would be suited to wide-ranging movements in relatively unfamiliar territory, making its absence in a sparsely and ephemerally occupied Britain puzzling. However, Geneste (1985, p. 511) also observed that MTA assemblages tend to have a high frequency of exotic raw materials, suggesting that this too is a mobile technology. In France the larger MTA assemblages occur most frequently in open air sites, and in regions of good quality raw material; in areas of poor-quality raw materials, assemblages tend to be small, often isolated pieces (Turq 2000). The British sites do not appear to conform to these patterns, southern Britain at least being an area of rich primary and secondary chalk flint sources, yet dominated by isolated finds and small assemblages. In summary, we suggest that the reason for the virtual absence of Levallois technology in the British Late Middle Palaeolithic is due to the fact that, when here, Neanderthals were reliant upon a highly-curated biface-centred toolkit, superimposed upon which, when necessity demanded, was the simple use of heavy-duty toolkits made of local resources. A relative unfamiliarity with the landscape due to ephemeral and irregular visits may explain the differences between Britain and Europe in terms of assemblage size and transport practices.

Settlement systems

The procurement and mobility of raw materials in the Neanderthal landscape is now well established, at least for France (Geneste 1988; 1989). The three main procurement distance clusters concerned are local (<5 km), regional (<30 km), and distant (80–100 km). The shortest of these probably reflects the local foraging range immediately surrounding a site – materials found within an hour's walk – while the regional distances presumably reflect longer term foraging patterns over days or weeks. The more distant raw materials are presumed to represent annual ranging behaviour – according to Gamble (2002) an individual's 'landscape of habit'– the maximum 80–100 km transport distances suggesting home ranges with a radius of 40–50 km (encompassing an area of ~5000 km^2). These data are of heuristic importance for understanding the British material, to which we return below.

Raw material use: local and exotic

A striking contrast between southwest England and southwest France is that in the latter raw materials from a variety of sources – usually 6 or more – are ubiquitous in most Mousterian assemblages, even if these sources were within 5–10 km (Mellars 1996). In Britain, in contrast, most assemblages are produced on only one or two raw material types, most of which were available from sources at the local scale – again possibly reflecting something of an unfamiliarity with the landscape.

British flint is widely distributed in the north and south, although better in quality in the south; igneous rocks are most common in the west, and other fine-quality stones such as cherts are found in the southwest and east. All of these rocks occur as primary outcrops, as components of fluvial terrace gravels, and as glacial erratics. Most British Late Middle Palaeolithic artefacts are made on flint that was available at the local scale, typically <5km from their findspot, and never more than ~30–40km (one day's walk). This includes single artefact findspots and larger sites in all of the major river valleys. Non-flint materials were widely employed in regions where these were more abundant than flint, notably quartzite and ironstone in the Creswell region (both available in the immediate vicinity of the caves), and cherts in the southwest. Deposits of Cretaceous greensand chert occur in eastern Devon and Somerset (Roberts 1988), where flint deposits are rare. Late Middle Palaeolithic lithics are most commonly found on this locally available material (Roberts 1988, p. 220). Carboniferous chert, for example, was used for artefacts at Picken's Hole (ApSimon 1986). Greensand chert was used at Kent's Cavern, and at Limekiln Quarry (Wells, Somerset; Vranch 1981). At Coygan, bifaces were made of igneous rock obtainable locally (Aldhouse-Green et al. 1995, p. 67). A small number of Middle Palaeolithic flakes from Creswell are on a grey flint, similar to Lincolnshire Wolds flint. The very small amount of material involved could possibly have been obtained locally as glacial erratics; but if it is of Wolds type and collected at source this still need not represent a transport distance greater than ~30km.

In contrast, there is little evidence of long-distance raw material movements. The dominance of apparently short transport distances does not, however, imply that this technology was in any way expedient or unplanned, but relates to the local landscapes through which Neanderthals operated. The technological signatures at most sites – both cave and open air – and the existence of diminutive bifaces consistent with their having been heavily resharpened (e.g. Robin Hood Cave and Uphill), and polish possibly indicative of curation in a pouch (Coygan), indicate that some elements of the tool kit may have circulated for relatively long periods of time. In flint-poor regions of the north, flint from the south appears to have been preferentially transported as valued personal gear such as bifaces and scrapers, but there is no evidence that quartzites or ironstone were moved southwards, perhaps suggesting that this material was not valued outside its local availability, possibly due to difficulties of working (quartzite) or relatively soft and non-durable edge (ironstone). This would support the notion that local operational areas were relatively small, and knowledge of good quality raw materials was at a premium within these. These observations are not inconsistent with the notion that Britain was occupied by Neanderthals only seasonally.

PUT FIG 15 AROUND HERE

Bout coupé *bifaces*

The apparent temporal and spatial distribution of *bout coupé* bifaces raises other intriguing issues regarding Neanderthal settlement in Doggerland. A number of MIS3 Middle Palaeolithic facies across Europe have yielded geographically specific biface forms, clear evidence of the emergence of cultural geographies at this time: for example the Vasconian Mousterian of the Pyrenees and Northern Cantabria (Bordes 1953; Cabrera-Valdés 1988), the Micoquian of Central Europe (Bosinski 1967); the Micoquo–Prondnikian of Southern Poland (Allsworth-Jones 1986), and the MTA of France. As noted above, the British assemblages appear to have cultural links with the broadly contemporary continental MTA, but there are some significant differences in biface shape. In Britain the *bout coupé* forms a unique regional variant (Roe 1981; Tyldesley 1987; White and Jacobi 2002: Figure 15), while types such as the exaggerated triangulates of northern France and the various 'Micoquian' forms are absent except as very occasional and probably fortuitous specimens. While chronology may explain such typological absences, certain forms being used in Europe during periods when Britain was not visited, this cannot account for the absence of *bouts coupés* in Europe.

Insert Figure 15 around here

This is unlikely to be an artefact of classification (cf. Coulson 1990), as comprehensive surveys (Tyldesley 1987; Soressi 2002) have shown that, while a few examples of *bouts coupés* do exist in the Paris Basin, their frequency is extremely low compared to the British situation. Given the tensions between the environmental data and Neanderthal survivorship, we suggested above that Neanderthals were only summer visitors to Western Doggerland, perhaps then only during the warmer oscillations. This, though, raises new issues because the clear contrasts in biface morphology appear to preclude the notion of movement from contiguous Neanderthal territories in France, Belgium and the Netherlands. It is entirely possible that the main focus of Neanderthal presence in northwest Europe was restricted in the main to the now submerged landscapes of Doggerland, and Britain formed merely the temporary western periphery. It is still uncertain whether a sufficient ecological gradient existed between 'upland' Britain and the adjacent lowland plains to make winter survival there any easier (see Barron et al. 2003), but it would certainly fit a number of known distance parameters, including the 300 km seasonal movements inferred from raw material transfers in central Europe, and the total area traversed by modern cold-adapted hunter–gatherers over the course of several decades (Gamble 1993; Binford 1983). Both further match onto the distribution of Middle Palaeolithic sites in mainland Britain. To resolve these issues we need far more sites like Lynford, and new anthropogenic cave assemblages from which we can begin to judge the seasonality of Neanderthal activity in Britain. Future offshore finds of Middle Palaeolithic materials (similar to those mentioned in Glimmerveen et al. 2004; Verhart 2004; and Hublin et al. 2009) may also help resolve the interaction between different Neanderthal groups within these basins.

In terms of Neanderthal behaviour, these seasonal movements would probably have required a high degree of long-term logistical planning and provisioning, with resources not apparently available in Doggerland (e.g. wooden shafts and spears); enhanced levels of co-operation; possible task divisions; finely tuned knowledge of the landscape and prey behaviour – a list of traits that includes much often deemed missing from the Neanderthal repertoire (White 2006; cf. Roebroeks 2001; Speth 2004).

Local operational areas (LOAs)

We use this term to describe local clusters of Middle Palaeolithic materials, which, we believe, may be linked into an operational whole; and to avoid more behaviourally loaded terms such as 'territories' or 'group ranges'. Local operational areas (LOAs) may be recognised in the previously mentioned 'clusters' of Middle Palaeolithic bifaces, particularly the relative hotspots in the Bournemouth area, in the Great Ouse around Fenstanton, in the Middle Thames around Hillingdon, the South Downs of Sussex, and, of course, the Creswell Heritage Area. It is also worth noting the two *bout coupé* bifaces recovered some five miles northeast of Lynford, in a buried channel beneath the floodplain of the Norfolk Blackwater (a tributary of the Wissey), one on the southeast bank near Little Cressingham (TF 888004) and one on the northeast bank in the parish of Saham Toney (TF888005). The gravel from which these were recovered was tentatively correlated with the low-lying terrace-like gravel deposits of the Wissey at Wretton (Lawson 1978), where a complex sequence of Devensian braided river deposits has been recorded overlying Ipswichian fluvial sediments (Sparks and West 1970; West et al. 1974). The proximity of these two sites to Lynford, their proposed MIS3 age, and the similarity in the bifaces might suggest that they too formed part of the *local operational area* of a single Neanderthal group. The river at Little Cressingham enters a constriction between two spurs, forming low hills to both the north and the south, perhaps vantage points for hunters who subsequently lost their transported bifaces in the context of animal encounters in the landscape (Lawson 1978).

We here offer an extended case study of the Axe valley, and would also speculate that other key site clusters, such as those in the Creswell Crags Heritage Area and around Tor Bay, formed similar foci in other LOAs.

The Axe valley, Somerset

The two richest areas of Late Middle Palaeolithic archaeology in southwest England are the open landscapes of the Solent river and its environs and the Somerset caves area (Hosfield et al. 2007). Within the latter region, it has been observed on the basis of archaeological materials from enclosed sites (Jacobi pers. comm. to Pettitt) that a significant Neanderthal occupation can be attributed to the valley of the River Axe, despite the fact that with only one exception no palaeoliths have been found in the gravels of its tributaries (Wymer 1996). This apparent lack of Late Middle Palaeolithic archaeology in the gravels of the Axe itself, however, is very likely due to the lack of relevant exposures or commercial exploitation of MIS3 deposits outside the area between Chard and Hawkchurch (Wymer 1996, p. 18). The River Axe rises at Wookey, flowing northwestwards until today it meets the Severn in the vicinity of Uphill, a little to the south of Weston-super-Mare. At source (the caves of Wookey Hole), the Hyaena Den contained what was apparently a rich Late Middle Palaeolithic assemblage in association with fauna of the Pin Hole MAZ, including combustion zones and, with the possible exception of Robin Hood Cave, the largest amount of charred bone recovered from any English or Welsh Lower or Middle Palaeolithic site. Neanderthal occupation is also in evidence at the immediately adjacent Rhinoceros Hole (Proctor et al. 1996). At the other end of the river, some 20km downstream, Uphill Quarry Cave 8 lay at the point at which the Axe poured onto the great plain that is now the Severn River, and contained small amounts of Late Middle Palaeolithic material in addition to a fragment of an LRJ leafpoint and an Aurignacian lozangic point (Jacobi and Pettitt 2000). Between the two, the small cave of Picken's Hole (Tratman 1964), situated in a small box valley suitable perhaps for trapping herbivores, contained a small number of Late Middle Palaeolithic artefacts. Outside the Axe valley, a number of Middle Palaeolithic bifaces reveal Neanderthal activity in the wider region, notably triangular/sub-triangular forms from St Audries, West

Quantoxhead (30 km to the west of the Axe valley), *bout coupé* forms from North Petherton, Somerset (20 km southwest) and Chepstow, Gwent (40 km to the north) (Jacobi 2000 and pers. comm.).

Insert Figure 16 around here

Insert Figure 17 around here

The Hyaena Den (Figure 18) is the most comprehensively documented of the Axe valley sites, although as it was excavated by Boyd Dawkins between 1859 and 1863 (and subsequently by several other specialists) its archaeology and palaeontology is still relatively poorly understood. Later excavations, of better quality, were conducted by Tratman between 1966 and 1970 (Tratman et al.1971) and by Roger Jacobi and Christopher Hawkes in 1991/1992 (Jacobi and Hawkes 1993), although little of the original contents remained. The site was discovered in 1852 during the removal of Pleistocene deposits that had entirely covered its entrance, for the purpose of constructing a mill leat. It takes the form of a low-arched cave, 10 m wide and 13 m deep, with a rear opening now blocked by spoil from the adjacent Rhinoceros Hole. Its deposits approached two metres in thickness and contained an abundant Upper Pleistocene fauna ('the 243 bones, the 64 jaws, and 240 teeth obtained from it are to be looked upon as merely a small fraction of the whole' Dawkins 1863, p. 264). Many of the faunal remains bear traces of gnawing ('the marks of those [hyaena] teeth upon every one of the 800 to 1000 bones' Dawkins 1863, p. 267), and clearly derive in the main from the eponymous hyaena denning; Middle Palaeolithic artefacts were stratified between layers of hyaena coprolites, suggesting a broad co-existence between Neanderthals and hyaenas in the region. Such interstratification, as Aldhouse-Green (2002, p. 1) has noted, could suggest that Neanderthals were 'happy to reoccupy carnivore dens littered with faeces and food refuse'.

Insert Figure 18 around here

Dawkins found around 35 Middle Palaeolithic artefacts of flint and chert, including 11 bifaces (Figure 19), a biface trimming flake, and an LRJ bladepoint. Most of the finds seems to have been concentrated in the cave's mouth (the current entrance – what Dawkins referred to as the antrum): 'all the ashes and implements were found in positions, near the mouth of the cave, where man himself may have placed them' (Dawkins 1863, p. 273), and the discovery of lithic microdebitage in this area by Jacobi and Hawkes (1993) further supports the notion than Neanderthals carried out some knapping in the cave mouth. The fauna from the cave's occupations – probably largely deriving from the hyaena denning – is of a Pin Hole MAZ type and includes hyaena, lion, wolf, bear, horse, bison, woolly rhinoceros, giant deer, red deer, reindeer and mammoth, and in part seems to have been recovered from a breccia or within stalagmite (Dawkins 1862, p. 117). The deposits of burnt bones possibly indicative of a hearth and apparently associated with artefact scatters seem to have clustered in three zones, all within the daylight zone of the cave.

Insert Figure 19 around here

Rhinoceros Hole, only 10 m from Hyaena Den, today takes the form of a collapsed cavern, although like Hyaena Den and Badger Hole it originally formed part of the Wookey Hole cave system. Like Hyaena Den, it was the object of several early excavations, and more usefully, excavation by Tratman between 1970 and 1976 (Proctor et al. 1996). As with Hyaena Den, it contained faunal remains attributable to the Pin Hole MAZ, dominated by hyaena, bear and woolly rhinoceros. The cave seems not to have attracted much attention from Neanderthals: only four artefacts of clearly Middle Palaeolithic attribution have been recovered, including a biface and three biface trimming flakes. A U-series date on speleothem from the site provides a *terminus post quem* of ~50 ka cal BP for the assemblage (Proctor et al. 1996).

Badger Hole, in close proximity to Rhinoceros Hole and Hyaena Den, was, like them, excavated by Balch (1938–1953), and subsequently by Charles McBurney in 1958 and John Campbell in 1968, the latter two excavations remaining unpublished. It contained a number of Early Upper Palaeolithic artefacts probably attributable to the LRJ, including four partly-bifacially worked bladepoints. Thus, although our understanding of the Late Middle Palaeolithic of the Wookey sites is poor, it seems that Hyaena Den saw most of the activity.

One can say little about the other sites in the Axe valley: finds from Uphill Quarry Cave 8 (discussed above) were largely destroyed when a bomb hit Bristol Museum during the Second World War; at Picken's Hole, excavation has not been extensive, and publication has been cursory. Uphill Quarry Cave 8, which may have been originally linked to Cave 7, contained at least two Middle Palaeolithic bifaces, both small triangular forms, one on chert and the other on flint; a flint scraper made on a possible biface (Harrison 1977), a Mousterian point and blade on chert, a flint naturally backed knife, various chert flakes, and fragments of an LRJ leafpoint. The Pin Hole MAZ fauna with which the artefacts were associated is almost identical taxonomically to that from the A2 loamy cave earth at Kent's Cavern. Several chert artefacts from Picken's Hole are compatible with a Late Middle Palaeolithic occupation, notably two hammerstones, a flake, and several biface thinning flakes, again found in association with a Pin Hole MAZ fauna (ApSimon 1986).

The Late Middle Palaeolithic archaeology of the Axe valley sites shares some common characteristics, enough in our opinion to link them together as a local operational area. All of the assemblages are very small; utilise a mixture of flint and (mainly) locally-available chert for *chaînes opératoires* largely focussed on the production of small, irregular ovate/cordiform bifaces which are of similar dimensions and which were heavily retouched; and are associated with characteristic Pin Hole MAZ faunas in the context of abundant hyaena denning. Evidence of *in situ* knapping is certain at Hyaena Den, and possible at Picken's Hole; otherwise the degree of economy seen in the use of the bifaces is noticeable; resharpening is attested at Hyaena Den and Uphill, where most bifaces are worked down to a considerable degree, and broken examples are also known from both sites. Roe (1981, p. 245) saw this as evidence that Neanderthals 'used the same implement for as long as possible'.

Jacobi (2000, p. 46) has noted that the box-like form of the valley at Wookey would have been tactically suited to trapping game, and that the plateau above the valley affords wide panoramic views over the Axe valley. The plateau above the Hyaena Den and Rhinoceros Hole rises 70 m above the cave and offers an exceptional view of the central part of the Axe valley. The same may be said for Picken's Hole: the valley forms a dead end also presumably of tactical importance, and the site is most easily accessed from the valley bottom, although the plateau above is easily reached and affords a long-distance view over at least 25 km (Pettitt pers. obs.). Although the Uphill caves have long been quarried away, the approximate position of Cave 8 and the remaining local topography suggest that it may have been more accessible from the plateau above, from which the view is excellent: at least 30 km eastwards along the Axe valley, and a similar distance out to the Severn/Bristol Channel as far as Quantoxhead to the southwest.

Topographic features link the sites. The major river in the region was the Severn, although this would have been considerably reduced in size in the Pleistocene, running through a vast plain ultimately into the English Channel. The Late Middle Palaeolithic occupational traces discussed here, however, relate to a tributary of this major river, a situation that is found also in southwest France (Mellars 1996, p. 248). Perhaps the Severn acted as a funnel, directing the herds out of the main floodplain of the Severn into the more steeply-defined Axe valley, where the movement of game could be monitored from afar and wherein the small box valleys at its sides could be used to disadvantage and trap game. The viewsheds available from the plateaux above the occupied sites may explain the nature of occupation in the Axe valley LOA; it is apparent that visibility (assuming a largely treeless landscape) was 20–30 km from these locations (Figure 17). Perhaps it is no coincidence that distances of this order fall into Geneste's 'regional' scale of raw material movement categories for the Middle Palaeolithic. In the apparent absence of any ability to divide up time and space into arbitrary and exact units and organise hunting behaviour according to these, visual clues to the distribution of resources in the landscape would have been critical. Long-distance viewsheds would have been advantageous in such a 'here-and-now' hunting adaptation; hunting episodes would have begun by scanning the landscape from plateaux and responding to visual clues; hunting opportunities at 20–30km distances could lead to artefact discard preferentially at these distances. After such resource procurement, in order to return to pivotal sites such as Hyaena Den, one need only find, in this case, the River Axe and walk upstream to source.

It is possible that the Axe valley LOA formed part of a wider system of LOAs, perhaps linked by relocations. The potential LOAs of Tor Bay (Kent's Cavern and Brixham Caves and their environs) and of southern Wales (Coygan and Paviland) could be interpreted in similar ways. It is of interest that these are respectively ~120 km and ~100–140 km distant from the Axe valley LOA, which corresponds to Geneste's third , 'distant' category of raw material movement. Could it be that the Tor Bay, Axe valley and southern Welsh LOAs represent periodically different activities of the same Neanderthal group? Obviously one cannot hope to test this hypothesis but, we suggest, perspectives of this nature might profitably be used as heuristics for future work.

Leafpoints, Neanderthal extinction, and the Middle to Upper Palaeolithic transition

Whether the KC4 partial human maxilla from Kent's Cavern represents a late Neanderthal or early *Homo sapiens* is unclear due to the lack of diagnostic characteristics (Stringer 2006). Similarly ambiguous are the enigmatic 'leafpoint' assemblages that seem to date broadly to the period ~38 ka BP to ~36 ka BP – at present it is unknown whether these were made by anatomically modern humans or the Neanderthals. Technologically they define the earliest Upper Palaeolithic (formally EUP) in the region, but whatever their bio-taxonomic significance, they bear strong similarities to broadly contemporary forms from Belgium, Germany and Poland, assemblages from which have been taxonomically grouped together as the Lincombian–Ranisian–Jerzmanowician (LRJ) (Flas 2008).

Leafpoints are known from ~31 findspots in England and Wales, usually occurring as isolated finds, but in number at several sites, notably Kent's Cavern (10 examples), Robin Hood Cave, Creswell Crags (at least 10), Pin Hole, Creswell Crags (at least 2), in fissures at Beedings, Near Pullborough in Sussex (36, probably more originally; Figure 20) and Badger Hole at Wookey, Somerset (4; Figure 21). The geographical span of isolated finds covers much of the country, with examples in:

- The southwest (e.g. Bench Tunnel Cavern and Windmill Hill cave, Brixham, Devonshire; Hyaena Den, Wookey and Soldier's Hole, Cheddar, Somerset),
- The southeast (e.g. Bapchild, Kent)
- The Thames Valley (e.g. Creffield Road, Acton, London; Earl of Dysart's Pit, Ham, London)

- East Anglia (e.g. Barham, Warren Hill, and Baldings Hill, Suffolk; Drayton, Norfolk)
- North Wales (e.g. Ffynnon Beuno cave, Tremeirchion, Flintshire)
- South Wales (e.g. Goldcliff, Newport; Paviland, Gower)
- The Midlands (e.g. Glaston Grange Farm, Uppingham, Leicestershire, and as far north as Wallow Camp, Salmonby, Lincolnshire)

The apparent northern limit of their distribution in Lincolnshire is once again probably a biased survivorship issue produced by subsequent glacial scouring of the landscape during MIS2. Interestingly, the distribution of LRJ material in Britain corresponds closely to the distribution of preceding Late Middle Palaeolithic, suggesting that LRJ groups were exploiting similar geographic affordances to their Mousterian predecessors and, in our opinion, further strengthening the notion that the LRJ was made by Neanderthals and not by *Homo sapiens.*

Insert Figure 20 around here
Insert Figure 21 around here

Among leafpoints in general, Jacobi (1990) has identified two technological categories:

1) *leafpoints* (sensu stricto) – bifacially worked pieces showing relatively intensive manufacture (see, for example, Jacobi 2000)
2) *bladepoints* – minimally worked pieces where retouch – always restricted to the ventral surface and usually to the ends – was employed simply to reduce the natural curvature of the object and bring about a convergence of the proximal and distal ends and thus a leaf shape. Bladepoints are demonstrably made on blades, where known deriving from opposed platform blade cores. This term covers also covers partially-bifacial leafpoints, Jerzmanowician points, *Pointes du Spy,* and unifacial leafpoints. They have been recognised from 26–27 English and Welsh sites and thus dominate the sample of British LRJ material.

Jacobi's (1990) survey of leafpoint assemblages considered examples from both cave and open contexts. They display clear typological parallels with the broadly contemporary assemblages to the east, such as Ranis and Mauern in Germany, and especially with the Jerzmanovician of Poland. When British leafpoints are found in association with other tool forms (particularly at Beedings, Sussex) these are clearly Upper Palaeolithic (if culturally undiagnostic) in nature, notably endscrapers on blades and burins. By contrast, there is no evidence to associate them with Mousterian typological forms (Jacobi 1999). Campbell (1977) suggested that leafpoints formed part of a wider technology of which the few known British Aurignacian assemblages were part, but as Jacobi (1990) has noted, there are no known associations between the minimal Aurignacian presence in Britain and leafpoints. Only three sites (Kent's Cavern, Paviland and Ffynnon Beuno) have yielded both assemblage types, but this can probably be explained by the strategic position and importance of these caves rather than any meaningful connection between the assemblages (Jacobi 1980, p. 17). At Kent's Cavern, the spatial distribution of the two artefact types was mutually exclusive. Furthermore, south of the LGM ice-limit, the distribution of leafpoints is strongly biased to central and eastern England, in sharp contrast with the distribution of the seven known Aurignacian sites, and the leafpoints display a far wider geographical spread (Jacobi and Pettitt 2001). Thus if the two were related in a technological whole employed by the same groups of *Homo sapiens*, one would have to conclude that these groups used weapons tipped with leafpoints across much of England, and then changed their toolkits radically for operating in Wales. Clearly the most parsimonious interpretation is that these two assemblage types represented distinct human populations, although the issue of whether these were biologically distinct, that is, *Homo neanderthalensis* and *Homo sapiens*, does remain to be resolved.

The largest British leafpoint assemblage is Beedings, near Pulborough in Sussex (Jacobi 2007b). Here, material was derived from 'gulls' (erosional fissures) that provided sedimentary traps in which artefacts also accumulated. Originally excavated in the early twentieth century, and comprising some 2,300 pieces, the collection has been considerably reduced and now only around 180 pieces can be identified with certainty. In addition, the lack of fauna and thus dating, and the mixing within the gulls of archaeological materials of significantly different ages severely limits the utility of the Beedings collection for understanding the behaviour of LRJ makers and, potentially, Neanderthal extinction. As Jacobi (2007b, p. 271) notes, 'there is an inevitable element of subjectivity when it comes to identifying the Early Upper Palaeolithic component of what is very clearly a multi-period collection among which there are few clues, such as condition, as to the relative ages of individual artefacts'. Despite this, his comprehensive analysis of the surviving artefacts allows us to understand the technological and typological context of British leafpoints. The source of the flint used for the Beedings assemblage is not known, but in all probability is located locally in the Sussex Downs. The 36 examples of leafpoint from Beedings are bladepoints *sensu stricto.* Microstructural fabric analysis of the artefacts showed that variable raw materials were used for non-leafpoint artefacts at the site, suggesting an *ad hoc* use of locally-available stone, whereas far less variability was observed for the leafpoints, suggesting greater selectivity of material from a source of finer quality flint. The specific source of the flint is unknown, beyond the fact that it is generic flint from the south Downs, although the presence of angular quartz grains within four of the leafpoints implies that the chalk from which the flint derived was located close to a palaeo-shoreline (C. Clayton, quoted in Jacobi 2007b).

Debitage accounts for 55 of the Beedings pieces (30.5%), but a number of examples are possibly of post-Palaeolithic age. Of the retouched tool assemblage, two items appear to be Late Middle Palaeolithic in age – a piece which can be identified either as a unifacial biface on a flake thinned at the butt, or a partially-bifacial double sidescraper, and the proximal end of a sidescraper. A number of Late Middle Palaeolithic bifaces have been found from nearby locations in the Sussex Weald and in Kent, so an identification of a small Mousterian element at Beedings is not surprising. Of material that can confidently be identified to the Early Upper Palaeolithic (and thus probably to an association with the leafpoints) there exist 11 burins, two of which appear to have been made on fragmentary leafpoints. No type dominates, with dihedral, break, truncation and Corbiac burins present. Of seven endscrapers, six are probably Early Upper Palaeolithic, two of which were made on fragmentary leafpoints in a similar way to the burins. Four or five Kostenki knives from the site have been taken by some as an indication that it is of younger (i.e. Mid Upper Palaeolithic) age, although as Jacobi points out these forms are found in Middle Palaeolithic and leafpoint assemblages on the Continent. Seven composite tools, three of which are burin/Kostenki knife combinations, one a burin/endscraper, and two Kostenki knives, one with a truncation and the other lateral retouch, form the last group of tool forms. One denticulate and one piercer may also belong to the leafpoint assemblage, and ten utilised pieces are indicative of a variety of tasks. Otherwise, the Beedings assemblage is overwhelmingly dominated by leafpoints, all of which are of the bladepoint form. They typically have a triangular cross-section, and several have been fluted, perhaps to assist hafting. All examples are broken, and the symmetry displayed on fragmentary points suggests that they were finished pieces. Thus, in the main, the Beedings site represents a place where weapons/knives were being discarded, although at least two examples of leafpoint manufacture survive, suggesting that retooling was practised at least on occasion at the site; the two activities may, of course, have been linked.

The existing chronology for LRJ assemblages is not good, although enough stratigraphic and chronometric data exist for cave sites such as Kent's Cavern, Pin Hole and Robin Hood Cave to demonstrate that they post-date the Late Middle Palaeolithic as they do on the Continent. In view of this, and a lack of demonstrable association with the succeeding Aurignacian, most scholars view the LRJ as representing Neanderthal populations – in the case of the UK and adjacent parts of the North European Plain probably the last Neanderthals to live in the region.

Non-^{14}C dates for MIS3, such as a TL date of 31,100 ± 5700 BP on a burnt flint from Beedings (Jacobi 2007b), are so imprecise that they play no role in the chronological definition of Middle and Early Upper Palaeolithic technocomplexes. The few existing ^{14}C dates on fauna found in stratigraphic association with leafpoints suggest ages in excess of 32 ka BP (Jacobi 1999, *contra* Aldhouse-Green and Pettitt 1998), and most likely in the ~36 ka BP to ~38 ka BP range (See Figure 3). As Jacobi (1999) has noted, however, there are problems with almost all radiocarbon dates on fauna apparently associated with leafpoints. We critically need new examples of leafpoints, excavated and recorded with modern methods, and ultrafiltrated radiocarbon dates on associated fauna. The only potential association between human remains and leafpoints is at Kent's Cavern, where the KC4 human maxilla was originally dated directly by AMS radiocarbon to ~31 ka BP. The maxilla, however, was found in a separate area of the cave from the cluster of leafpoints, and although these come from the same general depth, this means little in a stratigraphically complex cave excavated without modern methods of recovery and recording, and a clear association between the two is obviously lacking. The few lithics apparently – but not demonstrably – associated with the maxilla are technologically Upper Palaeolithic but culturally undiagnostic. All one can do is assume, on the grounds of stratigraphic and technological parsimony, that there is a very broad connection. Recent dating of fauna stratigraphically related to the maxilla, which had been pretreated using the new ultrafiltration technique at the Oxford Radiocarbon Accelerator Unit, has demonstrated that the age of the maxilla is likely to be in the range of 37–35 ka BP, assuming that the association is true (Higham et al. 2006). If this age range is correct, the taxonomic identification of the fragmentary maxilla – previously assumed to be *Homo sapiens* but now open to question – has become of critical interest. Whatever the biological identity of leafpoint makers was (and one cannot rule out that it was a technology sufficiently generalised to have been used by both the last Neanderthals and first modern humans on the Northern European Plain), the connection with the east is typologically apparent. This suggests that the fluviatile barriers of the Channel River that were to pertain throughout the Upper Palaeolithic (Pettitt 2008) were already in operation.

The lack of LRJ assemblages excavated with modern methods, or lack of clear association with fauna, renders the broader contextualisation of this technocomplex impossible. Breakage fractures on wild horse bones at Glaston may indicate that leafpoint users were exploiting this species (Thomas and Jacobi 2001), otherwise there are no further data, other than a broad chronological overlap between the LRJ and faunas of the Pin Hole MAZ noted above. Their pertinence to Neanderthal extinction is also severely limited; assuming the LRJ does represent the latest Neanderthals in Britain, all one can say is that they became extinct in the region some time before 35 ka BP, and possibly after 37 ka BP.

Assuming that the eight known Aurignacian sites in Britain represent the earliest arrivals of *Homo sapiens* (see Jacobi and Pettitt 2000; Jacobi et al. 2006; Pettitt 2008) there seems to be no chronometric overlap between these and the LRJ. A direct AMS radiocarbon date on a lozangic bone/antler point from Uphill Quarry Cave 8

(Somerset) indicates an age of 31,730 ± 250 BP (OxA-13716, Jacobi et al.2006). This is typologically similar to points from continental Aurignacian II assemblages with similar ages, and the age is further supported by a direct date on a typologically undiagnostic bone/antler point from the Hyaena Den of 31,550 ± 340 BP (OxA-13803, Jacobi et al. 2006). While these are the only two dates currently existing for the British Aurignacian they are at least consistent and suggest an age of between ~32 ka BP and 31 ka BP for the appearance of modern humans in the country. Thus, even assuming the LRJ dates to be as young as 36 ka BP, and the Aurignacian to be as old as 32 ka BP, there seems on current evidence to have been a gap between the two of at least 4000 ^{14}C years, (and perhaps much more in calendrical terms, as discussed above). Although the database is far too poor to allow statements of any confidence, we hypothesise, therefore, that a contact and interaction situation does not apply to Britain.

Conclusions

We have attempted to bring the British Late Middle Palaeolithic back to international attention and make it relevant to our overall understanding of European Neanderthals. The picture that emerges is both familiar and different. It would appear that Neanderthal 'settlement' was restricted to very brief pulses occurring mainly between ~50 and 37 ka BP, coinciding with the early milder phases of MIS3, and then possibly only during the warmest peaks and mildest seasons. The chronological distribution of Neanderthals in Britain appears on present evidence to coincide with that of hyaenas, suggesting that whatever attracted one large social carnivore to this western upland region also attracted another; we have here also raised the possibility that these two species were engaged in a potentially mutually beneficial relationship focussed on the co-exploitation of resources.

Britain has thus far yielded no evidence of long-term, semi-permanent occupation by large Neanderthal groups. Rather, most sites show repeated but probably very brief occupation by Neanderthal task groups, whose main technological activity appears to have been maintaining and repairing a heavily curated tool-kit (suggesting high mobility, planning and scheduling), alongside the knapping of local raw materials to service local needs. The organisation of technology thus points to the flexible use of locally- and regionally-available raw materials geared largely to ‘expedient’ chopper/chopping tool technologies, combined with a small transportable tool kit consisting of bifaces, scrapers and selected blanks. This may point to the need to plan for the unpredictable distribution of large herbivores within the landscape, or an unfamiliarity with raw material sources creating a constant need for curated tools. These settlement traces are consistent with the peripheral use of the region by extremely mobile, small groups on a temporary basis – possibly during the summer, with overwintering on the plains and hills of Doggerland. Continued discoveries of artefacts from the North Sea will hopefully help to improve this picture. One also wonders whether larger, ‘domestic’ foci remain to be found – possibly open air aggradations rather than large residential caves – although such a find would be remarkable, especially given the current evidence.

There is limited direct evidence of Neanderthal subsistence activities in Britain, although we assume that they moved westwards to seasonally exploit large herds. Isotopic work on British Pleistocene faunas and new sites capable of generating seasonality data are critically needed to test this assumption. What evidence we do have (Lynford and sites of the Axe valley) suggests that while here they were successfully exploiting a range of large game including mammoth, utilising tactical points in the landscape such as box valleys and swampy areas where prey could be disadvantaged.

If one accepts that Neanderthals were also the authors of the LRJ leafpoint assemblages, it would at present appear that the last Neanderthals visited western Doggerland ~36 ka BP, several thousand years before the arrival of *Homo sapiens*. This suggests two things: 1) that Neanderthals at this time were independently changing their technologies to a more Upper Palaeolithic form (cf. d’Errico et al. 1998), and 2) that Britain, based on current evidence, has little role to play in the Middle–Upper Palaeolithic transition. The task ahead, then, is to determine why Neanderthals finally abandoned Britain at this time. Perhaps it was simply an indirect effect of diminishing populations.

It is clear that the British Middle Palaeolithic was 'discovered too early for its own good' (Roe 1981, pp. 80, 175). While playing a key role in the establishment both of human antiquity and of Palaeolithic archaeology as a discipline in its own right, the results of the early excavations have left a scattered, biased and partial record of what once existed. The British Middle Palaeolithic does have a story to tell – of Neanderthals on the northwest edge of their range – but it is our contention that very little can now be gained from poring over old collections, or pursuing minor chronological issues. In order to make Britain relevant to large questions of Neanderthal behaviour, sociality and extinction, new sites and an increased focus on fieldwork are sorely needed.

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