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Riparian landscapes and human habitat preferences during the Hoxnian (MIS 11) Interglacial

NICK ASHTON,[1]* SIMON G. LEWIS,[2] SIMON PARFITT[3,4] and MARK WHITE[5]
[1] Department of Prehistory and Europe, British Museum, Franks House, 38–56 Orsman Road, London N1 5QJ, UK
[2] Department of Geography, Queen Mary, University of London, Mile End Road, London E1 4NS, UK
[3] Department of Palaeontology, The Natural History Museum, Cromwell Road, London SW7 5BD, UK
[4] Institute of Archaeology, University College London, 31–34 Gordon Square, London WC1H 0PY, UK
[5] Department of Archaeology, University of Durham, South Road, Durham DH1 3LE, UK

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ABSTRACT: The archaeological, environmental and geological data from Hoxnian Interglacial (Marine Isotope Stage (MIS) 11) sites from Britain are examined to elucidate the type of habitats that humans preferred during this temperate episode. The conclusion is that humans avoided lacustrine situations, but did make use of the full range of resources that fluvial environments provide. This model is strengthened by the examination of other non-archaeological Hoxnian sites. The problem of archaeological visibility in lacustrine sediment sequences is also discussed and methods of identifying other evidence of human presence are suggested that may offset the deficiencies in the lithic record. These include presence of cut-marked bone, micro-debitage and possibly charcoal in fine-grained sediments deposited in distal settings. The reasons for human selection of fluvial situations are discussed. It is concluded that these environments provide a greater diversity of animal, plant and lithic resources, but also are major route-ways through the landscape. Patterns of human site use are identified, which seem to be triggered by local changes in hydrology and drainage, themselves possibly caused by regional changes in climate. Finally, Lower Palaeolithic sites on the interfluves are discussed. Although they lack environmental or dating evidence, it is tentatively suggested that they were used during cooler episodes, when more open conditions prevailed. Copyright © 2006 John Wiley & Sons, Ltd.

KEYWORDS: Hoxnian; MIS 11; Lower Palaeolithic; East Anglia.

Introduction

In southern Britain there are a number of sites containing predominantly fine-grained sedimentary sequences that have been attributed to MIS 11. In the conventional British chronological scheme these sites have been assigned on lithostratigraphic, palynological and faunal grounds to the Hoxnian interglacial (Mitchell *et al.*, 1973). Some of these sequences contain Lower Palaeolithic artefacts that would appear to be closely associated with the environmental data. This archive provides a good testing ground for examining the types of habitat that humans chose during the warmer phases of the Middle Pleistocene. It has long been debated whether humans were adapted to the dense woodlands of interglacial phases during the Palaeolithic. Gamble (1987, 1992) suggested that early human populations were not adapted in terms of behaviour and social organisation to survive during the estimated 8% of time represented by full interglacial, dense, deciduous forests, as well as the 36% of glacial extremes. Absence of humans during interglacial maxima was disputed by Roebroeks *et al.* (1992a,b) who listed various sites across northern Europe that record human presence associated with fully interglacial environments. The concept of interglacial, impenetrable forests has been questioned; Stuart (1995) argued that the palynological record shows open areas within the dense woodlands, and pointed out that large herbivores would have required more open areas for survival. Therefore the question becomes not whether humans were present during interglacial phases, but what sort of habitats were they favouring during these warmer periods.

The remarkable number of sites that can be attributed to the Hoxnian is, in part, the result of their preservation in depressions in the surface of glaciogenic sediments deposited during the Anglian (MIS 12) glaciation. Many of the Hoxnian sites consist of lacustrine and occasionally fluvial sediments that infill basins in the surface of the Anglian till, which are interpreted as kettle holes. In most cases they occur outside the

* Correspondence to: N. Ashton, Department of Prehistory and Europe, British Museum, Franks House, 38–56 Orsman Road, London N1 5QJ, UK.
E-mail: nashton@thebritishmuseum.ac.uk

Late Devensian (MIS 2) glacial limit and therefore have not been eroded or buried by later glaciogenic sediments. Some of these sequences are preserved in abandoned river channels (e.g. Clacton).

Pollen sequences that document vegetation change through the Hoxnian have enabled correlation with other sites in central England, where interpretation of the underlying sediments is less clear. Among the attributes of these pollen sequences that are biostratigraphically significant are the late Anglian/early Hoxnian dominance of *Hippophaë*, a marked non-arboreal phase in HoIIc, and the dominance of *Abies* in HoIIIb (Turner, 1970). Correlation may also be supported by mammalian biostratigraphy (e.g. Parfitt, 1998; Schreve, 2001), occasionally other biostratigraphic data (e.g. molluscs and beetles; Keen, 2001) and through aminostratigraphy (Bowen *et al.*, 1989; Preece and Penkman, 2005). In the case of sites in the Middle and Lower Thames valley it is also supported by terrace stratigraphy and, in particular, the relationship between the Boyn Hill/Orsett Heath terrace to Anglian till in north London (Bridgland, 1994).

A summary of sites that have been attributed to the Hoxnian has been provided by Thomas (2001). The current paper uses Thomas's summary as the basis for this analysis although in some cases the attribution to MIS 11 or MIS 9 is unclear. As the main topic of enquiry is the type of habitats that humans are selecting during warm episodes, for the purposes of this paper all the sites listed by Thomas (whether MIS 11 or possibly MIS 9) are considered in the current analysis.

Human habitats

The Palaeolithic landscape of southern England can be seen to comprise, very crudely, a number of habitat-types. For the sake of simplicity, three types of habitat can be identified: river-edge, lake-edge and coastal or estuarine situations. In theory caves (both coastal and inland) could be considered, but there are no well-provenanced archaeological assemblages with associated palaeoenvironmental data from the period under consideration. Equally, there is clearly human activity on many of the interfluves, often found on the edge of infilled dolines (e.g. Smith, 1894, 1916; Sampson, 1978), or as surface scatters on denuded hilltops (Scott-Jackson, 2000). However, usually they cannot be related stratigraphically to other Pleistocene sediments and they seem to contain little or no environmental or biostratigraphical data that can be used to correlate them with other sites, so their age is largely unknown. This inevitably introduces biases into the analysis, but given the evidence, only river-edge, lake-edge, and coastal or estuarine situations can be investigated for the Hoxnian. These are examined below.

Human exploitation of fluvial environments during the Hoxnian is suggested by the large number of artefacts that have accumulated in sediments attributed to the Boyn Hill and Orsett Heath gravels of the Middle and Lower Thames respectively. Primary context sites with associated environmental data support this interpretation, most notably the assemblage from the Lower Loam at Swanscombe (Conway *et al.*, 1996; see also Wenban-Smith *et al.*, in this issue, pp. 471–483) and from the calcareous marl (Upper Freshwater Beds) at Clacton Golf Course (Singer *et al.*, 1973). Other river systems are less well understood, although the Solent certainly contains terrace gravels and artefacts that are argued to bracket MIS 11 (Bridgland, 2001; Hosfield, 1999).

It is likely that coastal and estuarine environments would have been exploited by humans during the Hoxnian, as they were during earlier temperate episodes (e.g. Boxgrove; Roberts and Parfitt, 1999). However, few sites attributable to the Hoxnian are preserved. At Swanscombe, the Upper Middle Gravel, which contains a brackish molluscan fauna (Kerney, 1971), is associated with a rich handaxe industry and three human skull fragments (Ovey, 1964). Otherwise, only rolled artefacts have been found at Kirmington and several locations on the Aldingbourne Raised Beach (Wymer, 1999).

As a result of the lack of evidence and problems of interpretation of interfluve, cave and estuarine/coastal localities, only lake-edge and river-edge habitats can be considered in detail. A bias is therefore introduced into the analysis at the outset which is difficult to avoid. Further investigation of interfluve sites, for example on the downlands of southeast England, may rectify this to some extent.

Analysis of the association of artefacts with lacustrine sediments

From the literature it would appear clear that humans are using lake-edge situations during the Hoxnian (e.g. Wymer, 1999). However, re-analysis of sites attributed to lake-edge locales (e.g. Barnham, Elveden and Hoxne, all Suffolk, and Hitchin, Hertfordshire) suggests that the picture is not as clear as it would at first seem. For this reason, sites that have yielded both archaeological assemblages and lacustrine sediments attributable to the Hoxnian are examined in more detail below (Fig. 1).

Barnham, Suffolk

The site consists of silts and clays that infill a depression in Lowestoft till and associated glaciofluvial gravels (Ashton *et al.*, 1998). Molluscs, vertebrates, pollen and occasionally artefacts are contained within the top 2 m of silts and clays. The evidence suggests a temperate, fluvial environment during HoII. The main archaeological industries, which consist of both handaxe and non-handaxe assemblages, were excavated from a lag gravel, and overlying silt at the edge of the depression, interpreted as a fluvial channel. Fauna has not survived in these marginal sediments. However, the stratigraphy suggests that they are contemporary with sediments containing environmental data in the centre of the channel. The fluvial sediments in both the archaeological and environmental areas are sealed by a palaeosol, which is overlain by 2–3 m of 'brickearth', probably largely colluvial in origin.

Elveden, Suffolk

The stratigraphy at Elveden is very similar to that at Barnham (only 7 km to the east), with fine-grained sediments infilling a basin that is formed in Lowestoft till (Ashton *et al.*, 2005). Again the environmental data only survives from the clays and silts in the centre of the basin, whereas the artefact assemblages occur in marginal locations. A rich pollen sequence in the lower part suggests an open environment attributable to HoI. Ostracods, molluscs and fish in the upper part of the clays and silts indicate a fluvial environment in a temperate climate, probably attributable to HoII. The handaxe assemblages are found in a lag gravel at the edge of the channel, and within an overlying palaeosol. These sediments are interpreted as being

Figure 1 Map showing sites discussed in the text or in Table 1. Key: 1 Kirmington; 2 Trysull; 3 Nechells; 4 Quinton; 5 Trimingham; 6 Barford; 7 Dunston Common; 8 St Cross South Elmham; 9 Hoxne; 10 Athelington; 11 Elveden; 12 Barnham; 13 High Lodge; 14 Beeches Pit; 15 Sicklesmere; 16 Foxhall Road; 17 Clacton; 18 Marks Tey; 19 Copford; 20 Quendon; 21 Tye Green; 22 Tednambury; 23 Hitchin; 24 Fishers Green; 25 Round Green; 26 Caddington; 27 Whipsnade; 28 Gaddesden Row; 29 Stanborough; 30 Hatfield; 31 Bell Lane; 32 Slade Oak Lane; 33 Swanscombe; 34 West Cliffe; 35 Boxgrove

contemporary with the fluvial sediments in the middle of the basin. 'Brickearths' above these sediments contain artefacts towards the base that are argued to be derived from the underlying lag gravel and palaeosol.

Beeches Pit, Suffolk

Glacial deposits attributable to the Anglian lie in a glacially eroded channel in the Chalk (Preece *et al.*, 2000, in this issue, pp. 485–496). Fine-grained interglacial sediments, including tufaceous clays lie in a shallow basin over the glacial deposits. *In situ* artefacts, including handaxes, lie within the dark brown silt of Bed 3b, interpreted as being laid down under a low-energy water body, perhaps in shallow pools. Similar artefacts were also recovered from the overlying tufa of Bed 4, formed by nearby springs. During both phases of human activity, the site was surrounded by dense woodland, which has been tentatively attributed on molluscan evidence to HoIIb–HoIIIb.

Hoxne, Suffolk

The sequence at Hoxne is well known for its lacustrine sediments (Strata F–C), which infill a kettle-hole formed in Lowestoft till (Evans *et al.*, 1896; West, 1956). Strata F–D span the early part of the Hoxnian (HoI–HoII) that after a hiatus is followed by Stratum C (also known as the 'Arctic Bed' because of the presence of plant remains such as dwarf birch and dwarf willow). Above this sequence lies a suite of fluvial sediments followed by colluvial and solifluction units (Strata A and B). Excavations by John Wymer in the 1970s recovered two main archaeological assemblages, the 'Lower' and 'Upper' industries (Singer *et al.*, 1993). Recent fieldwork by the authors (Ashton *et al.*, 2003) has re-examined the context of these assemblages and established that the 'Lower Industry' and its associated temperate fauna lies, not within Stratum C as originally reported, but at the base of a fluvial channel (Stratum B2) that cuts into Stratum C. The 'Upper Industry' lies within overlying colluvial and solifluction deposits (Stratum A). This reinterpretation of the stratigraphy suggests that the first human presence at the site occurs after both the Hoxnian interglacial (sensu stricto) and after a cold event represented by Stratum C (the 'Arctic Bed'). On the basis of this re-evaluation, it is probable that the 'Arctic Bed' was deposited during a cold phase within MIS 11 and that the Lower and Upper Industries date to a warmer phase towards the end of MIS 11.

Hitchin, Hertfordshire

Lacustrine sediments infill a basin (probably a kettle-hole) above Lowestoft till and glaciofluvial gravels (Reid, 1897; Boreham and Gibbard, 1995). The lacustrine sediments contain a pollen sequence that spans HoI and HoII. The overlying *Chara* marl, which is indicative of shallow pools, contains pollen that might be attributable to HoIIc (West, 1956). Above this a thick sequence of 'brickearths' have been interpreted as being deposited by a combination of colluvial, fluvial and aeolian processes (Boreham and Gibbard, 1995). Over 60 handaxes were collected in the late 19th and early 20th centuries and were clearly attributed to a gravel at the base of the 'brickearth' (Reid, 1897). However, an intriguing photograph taken in 1885 seems to indicate that at least one handaxe was found in the underlying lacustrine sediments (Bloom, 1934: 39).

Marks Tey, Essex

Lake sediments, which lie above Lowestoft till, contain a composite pollen sequence spanning HoI–HoIV (Turner, 1970). Occasional artefacts, including a handaxe, have been found in the area, but none have a firm context. However, recent fieldwork has located sediments at the edge of the basin, where several flakes have been found in association with a gravel (White, personal observation). Whether the gravel is the feather-edge of the lacustrine sequence, or part of a fluvial sediment is not yet clear.

Foxhall Road, Suffolk

This site was meticulously excavated by Layard in the early 20th century and produced a primary context handaxe assemblage (Layard, 1904, 1906). The primary context archaeology is now thought to occur in clay or on gravel at the edge of a basin cut into Anglian till and glaciofluvial gravels (White and Plunkett, 2005). This reinterpretation of Layard's work, together with recent fieldwork (White and Allen, personal observation) suggests that the clay probably represents the infilling of an over-deepened pool within a fluvial system.

Other sites

Other candidates for human use of lake-edge situations, could be Sicklesmere, Suffolk (West, 1981) and Fishers Green, Hertfordshire (Gibbard *et al.*, 1977). Both sites consist of lacustrine sediments with Hoxnian pollen signatures lying above Anglian till. Although four handaxes have been found at each site, none of them has a secure stratigraphic context.

This analysis therefore shows that although there are hints of human occupation of lake-edge situations, virtually all of the recently excavated sites indicate that human activity is associated with fluvial environments. The main exception to this pattern is Beeches Pit. However, even here, the archaeology is contained largely in deposits laid down by freshwater springs, and probably lying within a few hundred metres of the Lark valley.

Discussion

Non-archaeological lacustrine sites

The pattern established from the seven sites above is that evidence of human presence in the form of artefacts is not found unequivocally within Hoxnian lacustrine sediments. To potentially strengthen this pattern other non-archaeological Hoxnian lacustrine sites can be examined (Table 1; Fig. 1). Seventeen such sites can be identified, so the question is: in how many of these would archaeology have been recovered, if it had been present? The significant factors that might influence whether or not human evidence would be found are:

1 size of exposure (e.g. quarry or borehole);
2 date of exposure (determines whether extraction was mechanised or not);
3 interest taken by local collectors;
4 whether marginal sediments were exposed, revealing lake-edges.

Of the seventeen sites, many have been examined purely from boreholes, therefore the likelihood of artefacts being discovered is remote. Equally, other sites have been found through recent mechanised quarrying, where archaeology is less likely to be detected. Whether lake-margin sediments were ever exposed, is more difficult to gauge and the activity of collectors is not always well-documented. Nonetheless, on these grounds at 13 of the 17 sites there would be no expectation of recovering archaeology, even if it had been present.

However, there are four sites, where artefacts ought to have been recovered if they were present: Athelington, St Cross South Elmham and Sicklesmere in Suffolk and Copford in Essex. All these sites were active quarries in the late 19th or early 20th centuries and have a history of activity by local collectors. The absence of any hint of archaeology at these four sites provides additional evidence, albeit negative, to support the pattern identified at the other seven sites already discussed in the previous section. This means that at none of the eleven Hoxnian sites that have been extensively researched, or where there has been active collection, can evidence of human presence be unequivocally linked to local lacustrine habitats.

Archaeological visibility

A further question has to be addressed, in particular whether the lack of human evidence associated with lacustrine conditions is a true reflection of human habitat preference, or simply a matter of archaeological visibility. Two alternative interpretations can be developed.

It can be argued that the visibility of archaeological sites is dependent on the presence or absence of knapping debitage. On most British Lower Palaeolithic sites, knapping and at least some use and artefact discard seems to occur in close proximity to a raw material source, for example at Swanscombe (Conway *et al.*, 1996), Clacton (Singer *et al.*, 1973), Barnham (Ashton *et al.*, 1998) and Elveden (Ashton *et al.*, 2005). Human activity outside these areas is therefore archaeologically difficult to identify. This particularly applies around a lake edge, where raw material is likely to be scarce or inaccessible owing to sedimentation rather than erosion. This is a perfectly plausible argument, but one that is difficult to test because it is based on negative evidence.

It is worth noting, however, that not all Lower Palaeolithic sites are tethered quite so tightly to their flint raw material resources. At High Lodge, large blocks of good quality flint were transported across the floodplain and knapped well away from the river edge (Ashton *et al.*, 1992). Equally, at Hoxne, there is no known source of flint in the immediate vicinity for the humans who made the Lower Industry (Singer *et al.*, 1993; White, 1998).

Despite this, the difficulty of recognising human presence in lacustrine sediments might still be contributing to the pattern. There are, though, potentially three ways of determining human presence in these depositional environments, even in the absence of obvious stone tools.

1 *Cut-marked bone*. Several of the above-mentioned sites contain antler, bone and teeth (e.g. Hitchin, St Cross South Elmham and Copford). Little cut-marked bone has yet been identified except at Hitchin, where several pieces have now been recognised from the *Chara* marl, immediately beneath the flint artefact horizons. Cut-marked bone has also been recognised from Grays and Great Yeldham (both Essex; Parfitt submitted). Although artefacts may have been present at these sites, they were not collected. In the case of Grays, this was undoubtedly because collecting at the site was during the 1820s–1830s, prior to the widespread recognition of Palaeolithic stone artefacts. These sites indicate the potential of recognising human presence from cut-marked faunal remains.
2 *Lithic micro-debitage*. Small chips from knapping or resharpening ought to be present in most sediments where humans have been present. These tend to be far more ubiquitous in

Table 1 List of non-archaeological Hoxnian, lacustrine sites, showing factors that might have determined the recovery of human artefacts

Site	Exposure	Lake edge exposed	Size of lake	Collectors	Pollen zones	References
Athelington, Suffolk	quarry from 1860s	?	200 m	yes	IIc–IV	Coxon, 1979, 1985; Prestwich, 1860
Barford, Norfolk	borehole	no	?	no	IIc–IIIb	Philips, 1976
Bell Lane, Herts	pit	?	?	?	I	Gibbard, 1977
Copford, Essex	pit, 19th century		800 m	yes	IIIb	Dalton, 1880
Dunston, Norfolk	borehole	no	?	no	IIIb–IV	Philips, 1976
Fishers Green, Herts	road construction—borehole 1974	no	?	no	I/IIIb	Gibbard *et al.*, 1977
Hatfield, Herts	section in gravel pit from late 1960s	no	?	?	I–IIIb	Sparks *et al.*, 1969
Stanborough, Herts	borehole	no	?	no	I–III ?	Sparks *et al.*, 1969
Nechells, W. Midlands	borehole/excavation	no	300 m+	no	I–III	Kelly, 1964
Quinton, W. Midlands	borehole	no	?	no	I–IV	Horton, 1989; Thomas, 2002
St Cross S. Elmham, Suffolk	brick pit	?	?	yes	I–IIc	West, 1961; Coxon, 1979
Sicklesmere, Suffolk	brick pit from 1880s	?	?	?	I–III	West, 1981
Slade Oak Lane, Bucks	borehole	no	40 m	no	III–IV	Gibbard *et al.*, 1986
Tednambury, Herts	borehole	no	?	no	I–IIc?	Betts and Boreham, 2004
Trimingham, Norfolk	cliff section	?	300 m	no?	I ?	Hart and Peglar, 1990
Trysull, W. Midlands	quarry, section recorded 1969–70	?	?	?	I–II	Morgan and West, 1988
Tye Green, Essex	tunnel construction 1989/boreholes	no	200 m	no	I–IV	Boreham *et al.*, 1999

the archaeological record than larger artefacts, and would have been be more liable to transport beyond the lake margins and into the lacustrine sediments. For example, at Barnham flint chips are frequently found associated with the environmental data in the centre of the basin, although larger artefacts occur only rarely. Recovery of microdebitage by fine-mesh sieving of reasonably large samples from sites with only limited exposure may therefore provide some indication of human presence or absence.

3 *Charcoal*. Little work has been undertaken on charcoal records from British Lower Palaeolithic sites, but with the identification of hearths at Beeches Pit (Gowlett and Hallos, 2000; Preece *et al.*, in this issue, pp. 485–496) there is good reason to expect the human use of fire during this period. Evidence in the form of charcoal ought therefore to be visible in lake sediments. Micro-charcoal has been identified from sediment adhering to the cut-marked bone from Hitchin. However, distinguishing anthropogenic charcoal from that produced by natural fires would be necessary before a full assessment of the archaeological significance of any charcoal present can be made. Methods used in the investigation of later pre-historic fire histories may be applicable to this problem (Blackford, 2000; Innes and Simmons, 2000).

Fluvial habitats

In the absence of any evidence to the contrary, it can be suggested, on the basis of the British evidence, that humans preferentially targeted fluvial environments. The question that arises is why were these habitats favoured? There are three interrelated factors that can be identified: vegetation, resource availability and location in the landscape.

Vegetation

The palynological record suggests that there were important vegetational differences in the areas around lacustrine and fluvial sites. Comparison of the percentage of non-arboreal pollen (NAP) from zone II records from British interglacial sites shows that lacustrine sites were surrounded by denser woodland (Fig. 2). In contrast, the analysis shows that fluvial sites were generally more open, and also had a greater range of fully open to more forested habitats. It is informative that the lacustrine site of Hitchin falls within the NAP range of the fluvial sites. This may indicate that the basin lay within a valley system, perhaps as an oxbow lake, or a lake that was fed and drained by a substantial stream or river.

The reason river valleys were more open environments than lake sites is probably the destructive effects of the large herbivores. Extensive areas of open vegetation would have been partly initiated and certainly maintained by the grazing, browsing, trampling and tree-felling activities of elephant and rhinoceros (Turner, 1975; Philips, 1976; Bradshaw *et al.*, 2003). They would have been using the river valleys for watering, feeding and passage through the landscape, and importantly keeping these valleys open for human use. In contrast, the pollen records suggest that the areas beyond the river valleys were dominated by dense woodland, which would have been difficult for humans to penetrate.

The difference between Pleistocene and Holocene situations is informative. Although it has been suggested that during the early Holocene medium-size herbivores (red deer, elk, wild pigs and aurochs) would have helped to reduce the forest canopy (Vera, 2000), a more recent study from Ireland suggests that these dense forests would have been maintained despite the herbivores (Mitchell, 2004; Moore, 2005). The absence of elephant and rhinoceros in these environments during the Holocene is the critical factor, allowing the persistence of dense woodland.

Resources

Partly because the river valleys were more open environments, they would have provided a greater range of resources. The herb-dominated vegetation growing in the floodplains would have maintained a higher biomass of grazing herbivores than the woodland areas on the interfluves. These

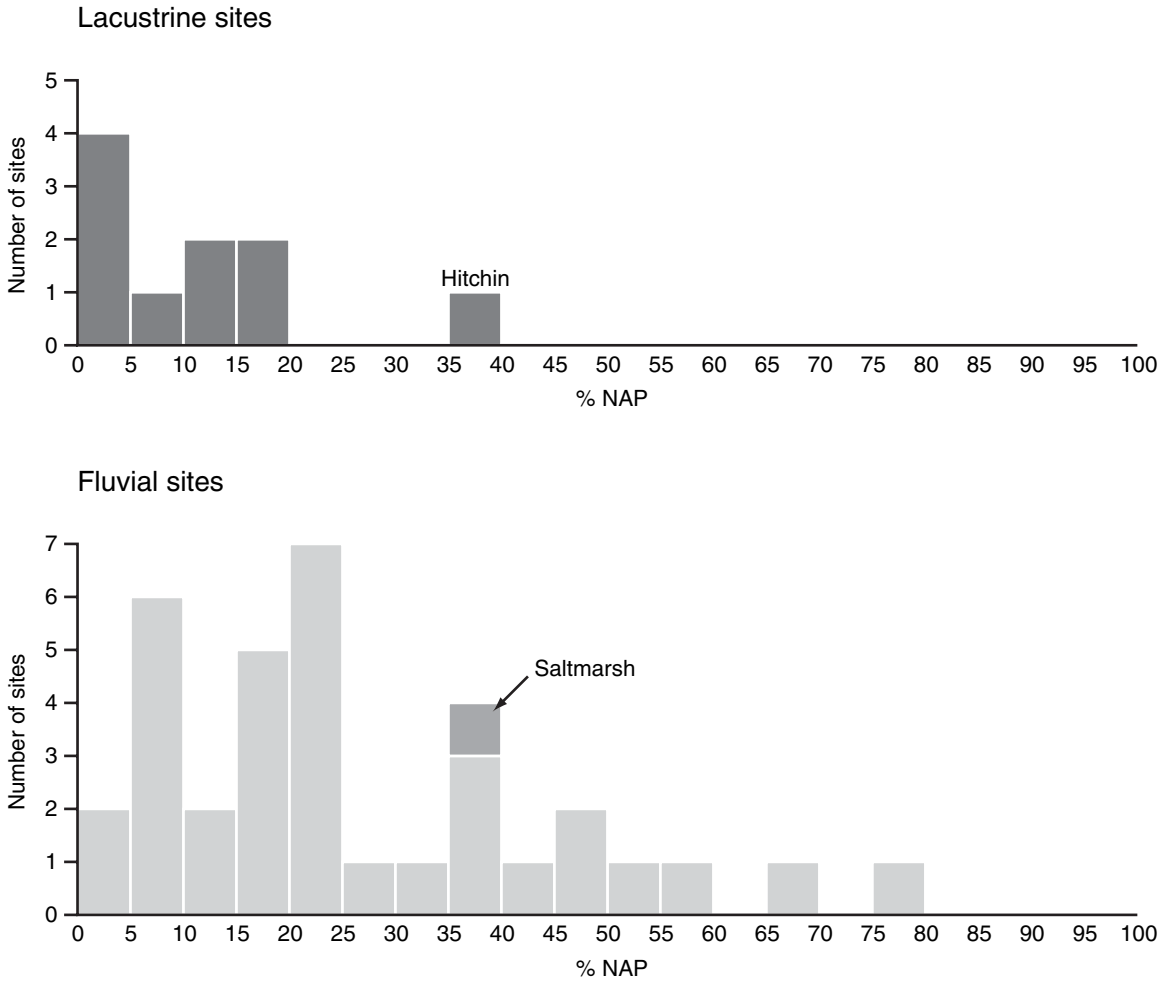

Figure 2 Comparison of non-arboreal pollen (NAP) percentages in early temperate substage pollen assemblages from fluviatile and lacustrine sites in southern England (Parfitt, unpublished data). Note, NAP values are given as a percentage of total land pollen and values for the Hoxnian do not include the anomalous Hoxnian IIc high NAP phase. Using NAP values as an indication of tree cover is supported by Aaby (1994) and Dambach (1998)

animals would have been easily visible and have had predictable behavioural patterns, which would have allowed planned hunting by early humans, rather than chance encounter hunting in woodlands. Although the mechanism for forest clearance was different in the Mesolithic, the effects on animal populations, mobility and hunting efficiency were the same (Mellars, 1976).

The floodplains would also have a mosaic of habitats, being composed of open water, marsh, grassland and woodland, and providing a wide range of animal and plant resources in close proximity. By contrast, the range of habitats and resources around lakes would have been much more limited and further diminished during the periodic phases of low water recorded on many of the Hoxnian lake sites. At Hoxne for example, the beetle fauna from Stratum D reflects a situation of stagnant still-water surrounded by reed swamp. The paucity of dung beetles also shows the rarity of large herbivorous in the area (Coope, 1993).

Of equal importance was the stone raw material resource that rivers could supply. The erosive nature of fluvial systems provided a mechanism for gaining access to flint and other stone. This could have been through direct erosion of Chalk or till, or through access to the frequently occurring fluvio-glacial gravels that underlie many of the sites. This was the case at both Barnham and Elveden, where coarse flint gravels were exposed at the edges of the channels. In lacustrine situations, access to these resources would have been hindered by fine-grained sediments and vegetation.

Location in the landscape

Not only would the river valleys have been accessible and have had richer and more varied resources, but they would also have been navigable. Just as they provided route-ways for the herbivores, they would also have acted as natural corridors through the landscape for humans, and would have been important links between different resources and possibly even social groups. Just as importantly, they were easily locatable and would have been prominent features in the natural topography of the landscape. By comparison, the Hoxnian lakes were small bodies of water, often less than 200 m across, and much smaller during drier phases. Although many of them have evidence of slow-flowing water and being fed and drained periodically by small streams, they were not sufficiently large to attract humans. Although these water bodies may occasionally have been encountered by humans, they probably contained too few resources, were difficult to access, were difficult to relocate and would have formed only minor points on the human mental map.

Human reaction to changes in local and regional hydrology

At each of the sites of Barnham, Elveden, Hoxne and Hitchin there is the succession of lacustrine followed by fluvial

sediments, with humans arriving at the initiation of fluvial conditions. These changes in sedimentation are clearly not synchronous as shown by the differences in dating of, for example, Barnham and Elveden with Hoxne (see above). However, what they do show are localised changes in drainage and hydrology, which trigger changes in human use of the landscape.

These changes in hydrology might be part of a more regional pattern that could be linked to changes in climate. The initiation of fluvial conditions at Barnham and Elveden are interpreted as occurring during HoII. The reason for this change was probably the infilling of the comparatively small lake basins (less than 100 m across). Perhaps contributing to this process, though, was an increase in precipitation. Gibbard *et al.* (1977) suggested a pattern of increased precipitation that could be recognised across several sites in Hertfordshire (Hitchin, Stanborough and Fishers Green). Through correlation of the pollen sequences, a rise in lake level was identified towards the end of HoII. This rise was linked to an increase in precipitation, which was suggested by an increase in *Alnus* starting in HoIIb (Turner, 1970). At Nechells (West Midlands) an increase in rainfall was also recognised during HoIIb. However, at this site the increase coincided with a drop in lake level (Kelly, 1964), which was suggested to be due to an initial rise in water leading to the destruction of an impounding barrier. This could conceivably have been the same situation at Barnham and Elveden.

Therefore it can be suggested that there is a regional pattern of increased rainfall during HoIIb, which might have helped trigger the change to fluvial conditions at Barnham and Elveden, where these comparatively small lake basins were already infilled with lacustrine sediments. In contrast, at the larger lake at Hoxne (at times 400×300 m), the build-up of sediment within the basin was not sufficient to lead to fluvial conditions at this time. The fluvial system was active across the site considerably later after a major cold phase (Stratum C—the Arctic Bed). The even larger and deeper lake basin at Marks Tey has no evidence of fluvial conditions except perhaps in the form of a gravel at the end of a long interglacial–glacial cycle.

Human presence on the interfluves

Although there are no known Hoxnian sites on the interfluves, humans undoubtedly used these areas during the Lower Palaeolithic as indicated by the lithic assemblages. Sites occur on the Downs of Kent and Sussex and on the Chilterns, either as artefact scatters on eroded hilltops and plateaux or as artefacts within the sedimentary infills of dolines (Smith, 1894, 1916; Sampson, 1978; White *et al.*, 1999; Scott-Jackson, 2000). The excavated assemblages seem to be typical of most other Lower Palaeolithic assemblages, with a dominance of core and flake debitage, with occasional handaxes and flake tools (Bradley and Sampson, 1978; White, 1997; White *et al.*, 1999; Scott-Jackson, 2000).

Owing to the paucity of environmental data from these sites, the climate and vegetation with which they are associated is not well understood. The preservation of sparse pollen at Caddington is an exception (Campbell and Hubbard, 1978). It has been suggested on the basis of the pollen that the archaeological assemblage might be attributable to the end of an interglacial with a relatively cool, open environment (White, 1997). Further evidence for this might be suggested by the stratigraphic records from several other sites on the Chilterns. Round Green, Gaddesden Row and Whipsnade have all been interpreted as solution hollows or dolines that were formed and largely infilled during temperate conditions. There is some evidence to suggest that the lithic assemblages are associated with the final phases of their infilling and are therefore argued to date towards the end of these temperate episodes (White, 1997).

In support of this interpretation, is the evidence of the flint raw material that was being exploited on these interfluve sites. The raw material seems to have been local, for example at Caddington having come from a maximum distance of 250 m (Bradley and Sampson, 1978). At West Cliffe (Kent) the doline was surrounded by a flint pavement, the result of subaerial erosion (White and Lewis personal observation). In the absence of fluvial erosion, it is likely that cool or cold conditions would have been required to make this flint accessible for human exploitation. At all these sites, this could either have been through subaerial weathering of the underlying clay-with-flints, or through solifluction down the hill-slopes and edges of the dolines.

It can be suggested therefore that during fully temperate conditions humans targeted the range of habitats that were available in the river valleys, but during more open, cooler environments the interfluves were also utilised. Not only would there have been easier access and navigation across these more open landscapes, but also a new range of resources would have become available, such as larger herds of game for hunting and new ponds and small lakes for watering, together with new supplies of lithic raw material.

Conclusions

The integrated archaeological, geological and environmental record for MIS 11 in Britain is probably the best in Europe for examining human habitats. However, a model of human habitat preference identified in southern Britain is not necessarily applicable in a wider European context and such a comparison is beyond the scope of this paper. The British evidence suggests that humans did not favour lake-edge situations, but were exploiting the river valleys. The open nature of river valleys was better suited to humans. Equally, there was a greater variety of resources, in terms of plants, animals and lithic raw materials. Finally, they acted as open corridors through the otherwise dense forest, having good accessibility and being easily navigable, and as prominent features in the landscape were simple to relocate.

At a number of the sites there is a pattern of human colonisation following a change from lacustrine to fluvial environments. Between individual sites these changes are rarely synchronous, but rather human occupation is triggered by changes in local landscape. More regional patterns might be identifiable, where increased precipitation during pollen zone HoIIb, identifiable from a broad range of sites, might coincide with the infilling of some lake basins (Barnham and Elveden) and a change to fluvial conditions, following which human occupation is more likely to occur.

Although Lower Palaeolithic archaeology occurs as surface scatters and associated with doline infills on the interfluves, little of it is associated with environmental data. Some evidence suggests that artefacts are associated with the final infill of the dolines, probably at the end of a temperate episode in cooler, more open conditions. Support for this comes from the exploitation of local flint, which would only have been accessible through subaerial erosion of hilltops or solifluction. Not only would these environments have been more attractive during more open, cooler conditions, but would also have

provided access to new animal, plant and raw material resources.

This paper therefore examines human landscape use and adaptation in a range of environments and habitats during the Lower Palaeolithic. The models presented can be tested through other forms of evidence of human occupation (cut-marked faunal remains, stone micro-debitage and possibly charcoal) and in the case of the sites on interfluves by continuing the search for fine-grained sediments that contain environmental data.

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