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THE EARLIEST RECORD OF HUMAN ACTIVITY IN NORTHERN EUROPE[1]

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Abstract: the colonization of Eurasia by early humans is a key event after their spread out of Africa, but the nature, timing and ecological context of the earliest human occupation of northwest Europe is uncertain and has been the subject of intense debate (Dennell 2003). The southern Caucasus was occupied about 1.8 million years (Myr) ago (Gabunia 2000), whereas human remains from Atapuerca-TD6, Spain (more than 780 kyr ago) (Carbonell *et al*. 1995) and Ceprano, Italy (about 800 kyr ago) (Manzi 2004) show that early *Homo* had dispersed to the Mediterranean hinterland before the Brunhes–Matuyama magnetic polarity reversal (780 kyr ago). Until now, the earliest uncontested artefacts from northern Europe were much younger, suggesting that humans were unable to colonize northern latitudes until about 500 kyr ago (Gamble 1999; Dennell & Roebroeks 1996). Here we report flint artefacts from the Cromer Forest-bed Formation at Pakefield (52°N), Suffolk, UK, from an interglacial sequence yielding a diverse range of plant and animal fossils. Event and lithostratigraphy, palaeomagnetism, amino acid geochronology and biostratigraphy indicate that the artefacts date to the early part of the Brunhes Chron (about 700 kyr ago) and thus represent the earliest unequivocal evidence for human presence north of the Alps.

The Cromer Forest-bed Formation (CF-bF), exposed discontinuously for a distance of more than 80 km along the North Sea coast of eastern England, has long been famous for its early Middle Pleistocene fossils (Newton 1882; Reid 1882; Stuart 1996; Turner 1996; West 1980). Spectacular finds include many extinct large mammals, molluscs, beetles, remains of fruits, seeds and even trees from which the deposits get their name. Recent work on vertebrate and molluscan faunas has shown that the CF-bF is much more complex than previously realized and includes evidence for at least six distinct temperate phases between about 780 and 450 kyr ago (Preece 2001). The CF-bF sediments are primarily organic detritus muds and sands laid down within channels and on the floodplains of rivers, which drained central and eastern England before ice sheets invaded the area about 450 kyr ago (Rose *et al*. 2001). During this time, Britain was connected to what is now mainland Europe, East Anglia being located at the southwestern margin of a large coastal embayment around the subsiding North Sea basin. The flint artefacts found at Pakefield (52°25.9'N, 1°43.8'W) were recovered from river sediments, with a significant quartz and quartzite component, which formed the floodplain of the lower reaches of the erstwhile Bytham River that drained the English Midlands at this time (fig. 1) (Rose *et al*. 2001; Lee *et al*. in press).

Despite two centuries of investigation, no convincing artefacts have hitherto been found stratified within the CF-bF. However, several excavations in the recently re-exposed coastal sections of CF-bF (and associated deposits) between Pakefield and Kessingland (West 1980; Lee *et al*. in press; Blake 1890; Stuart & Lister 2001) resulted in the discovery of 32 worked flints (length more than 20 mm), including a simple flaked core, a crudely retouched flake and a quantity of waste flakes (fig. 2). These artefacts come from clear stratigraphical contexts and are associated with a wealth of evidence that allows a rare opportunity to reconstruct the environment

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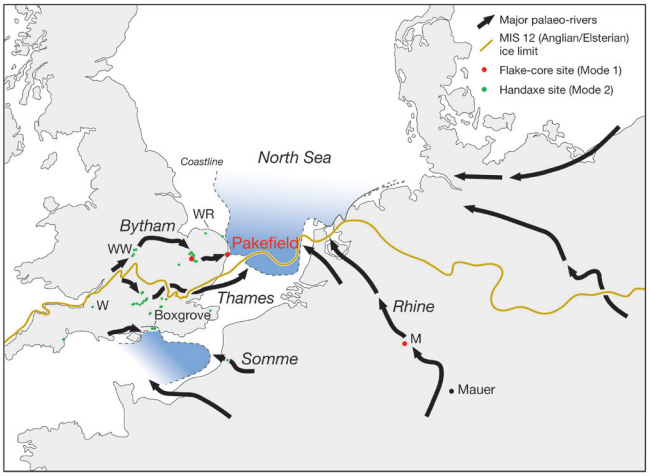

Figure 1. A reconstruction of the palaeogeography of northwest Europe during the early Middle Pleistocene (Turner 1996; Rose *et al*. 2001; Lee *et al*. in press; Wymer 1999; Roberts & Parfitt 1999; Gibbard 1988). All known Anglian/Elsterian and earlier archaeological sites are shown, and their concentration in southern England is highlighted. These sites can now be shown to provide a record of intermittent early human occupation of about 300 kyr duration. Human remains are known from Mauer and Boxgrove. M, Miesenheim I; W, Westbury-sub-Mendip; WR, West Runton; WW, Waverley Wood. For clarity, the names of rivers or geographical features are italicized and site names are in Roman font.

inhabited by the humans who made the tools. The artefacts, all in very sharp condition, are made of good quality black flint. Unworked surfaces, where present, are water-worn, indicating that the raw material might have been collected from the adjacent river channel. The assemblage lacks formal tools and is thus consistent with a Mode 1 technology (that is, flakes, pebble tools and choppers made with hard hammers (Wymer 1999), but this interpretation must remain provisional in view of the small sample size.

The artefacts came from four different contexts within an interglacial infill of a channel incised into Early Pleistocene marine sediments and overlain by a sequence of marine sands, glaciofluvial sediments and Lowestoft Till (fig. 3). The oldest artefact was found in the upper levels of the estuarine silts (fig. 3) containing marine and brackish-water ostracods, foraminifera and sparse marine mammals (including dolphin and walrus). All other artefacts were found in the CF-bF, which comprises the "Rootlet bed", "Unio-bed" and "laminated silts" (Lee *et al*. in press; Blake 1890; Stuart & Lister 2001). Two artefacts were found in overbank sediments with well-developed soil features including numerous fossil root-casts and pedogenic carbonate nodules ("Rootlet bed"). Most of the artefacts (n = 28) came from a lag gravel ("*Unio*-bed") at the base of the laminated silts that fill the channel

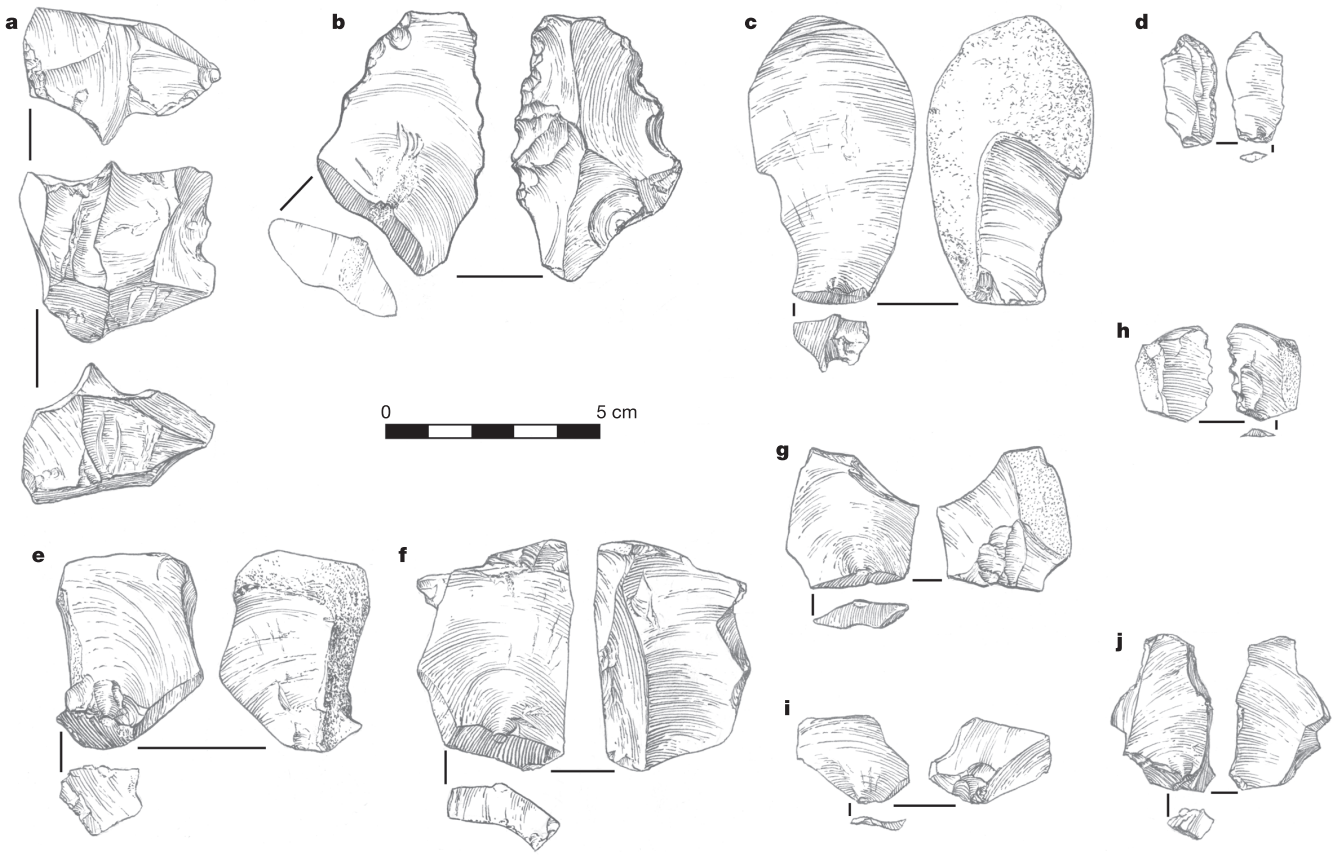

Figure 2. Lower Palaeolithic flint artefacts from the Cromer Forest-bed Formation at Pakefield. a, Core, partly alternate hard-hammer flaking, with several incipient cones of percussion on platforms. b, Retouched flake. c-j, Hard hammer-struck flakes, with previous removals on dorsal surface, often from the same direction. b, "Rootlet bed" (PaB); c, laminated silts (PaCii); a, d-j, "*Unio*-bed" (PaCi).

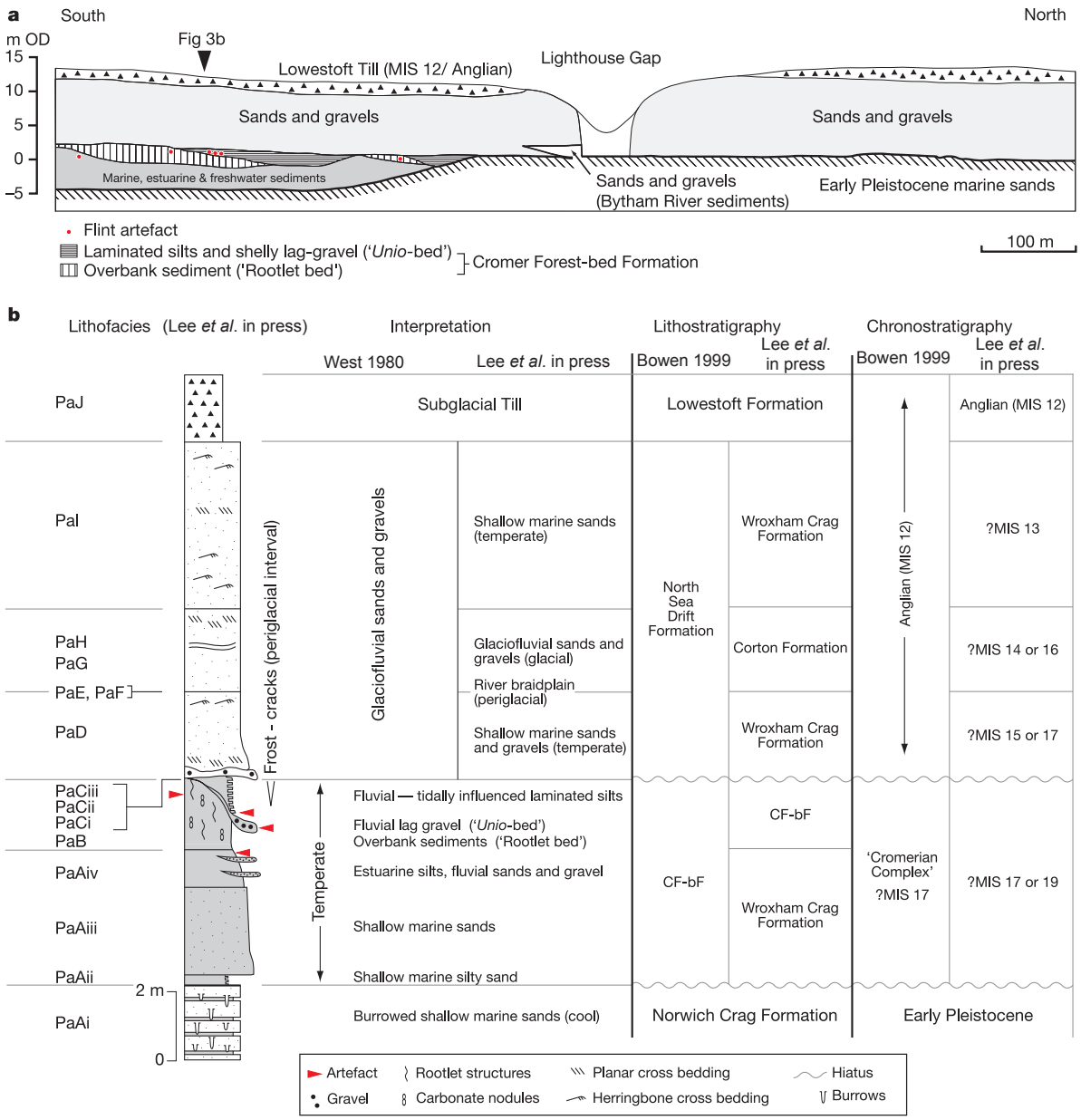

Figure 3. Stratigraphical context of the Pakefield artefacts. a, Coastal sections between Pakefield and Kessingland. b, Geological profile and interpretation.

cut into the overbank sediments, but a single flake (fig. 2c) was found in the laminated silts at the edge of the channel. Sediments overlying the channel infill were originally interpreted as glaciofluvial deposits attributed to the North Sea Drift Formation (Marine Isotope Stage (MIS) 12; fig. 3b), thus implying a long hiatus between the CF-bF and the glacial sequence. A new interpretation (Lee *et al*. in press) suggests that a more complete sequence is represented (fig. 3b) by the complex succession of marine sands, Bytham River sands and gravels, and glaciofluvial sands and gravels from the Happisburgh Glaciation, which are separated from the CF-bF by a periglacial interval indicated by the presence of frost-cracks. Another marine deposit overlies these sands and gravels and the whole sequence is capped by the Lowestoft Till Member, deposited by the Anglian Glaciation (West 1980), when ice sheets reached their maximum extent in Britain.

Fossils from sediments that contain the artefacts indicate that the local climate was significantly different from that of the present day in terms of temperature and seasonality of precipitation. Plant (*Trapa natans*, *Salvinia natans* and *Corema album*) and beetle (*Cybister lateralimarginalis*, *Oxytelus opacus* and *Valgus hemipterus*) remains include several thermophilous species no longer living in Britain, and the presence of *Hippopotamus* and frost-sensitive insects and plants implies warmer summers and mild winters. Mutual Climatic Range (MCR) (Atkinson *et al*. 1987) analysis of the beetle assemblage enables quantitative estimates to be made of the thermal climate at that time. These suggest that the mean temperature of the warmest month (July) was between 18 and 23°C and the mean temperature of the coldest months (January/February) was between -6 and +4°C. Pedogenic carbonate nodules in the "Rootlet bed" indicate an annual moisture deficit, whereas their isotopic composition reflects

intense soil moisture evaporation during their formation (Candy *et al*. in press). The combination of warmer summer and winter temperatures together with a strongly seasonal precipitation regime is indicative of a warm, seasonally dry Mediterranean climate.

Both the insects and plants indicate the presence of marshy ground with extensive reedy vegetation and alder trees adjacent to a meandering river with shallow riffles and deeper pools. Oak woodland grew on drier ground with open grassland nearby. This mixture of habitats supported a variety of large browsing and grazing mammals dominated by *Mammuthus trogontherii*, *Stephanorhinus hundsheimensis*, *Megaloceros savini*, *M. dawkinsi* and *Bison* cf. *schoetensacki*, and their predators and scavengers (*Homotherium* sp., *Panthera leo*, *Canis lupus* (small) and *Crocuta crocuta*). The floodplain would have provided a resource-rich environment for early humans, with a range of plant and animal resources. An additional attraction, in an area where good quality flint would have been scarce, was the flint-rich river gravels, which provided the raw material for tool manufacture.

Pollen analysis indicates that the channel infill accumulated during an interglacial with regional vegetation dominated by broad-leaf woodland that included *Carpinus* (hornbeam) in its later part (West 1980). These sediments were originally correlated with those at the Cromerian stratotype at West Runton, Norfolk, 60 km to the north-west, on the basis of palynology (West 1980) and malacology (for example the presence of the extinct freshwater mollusc *Valvata goldfussiana* (Preece 2001). This suggestion is broadly supported by the extent of racemization and the pattern of amino acid decomposition in the intracrystalline fraction of *Bithynia* opercula. However, although these sites are close in age, several lines of evidence indicate that they are not exactly contemporary. West Runton lacks the important component of southern thermophile plants and beetles seen at Pakefield. Moreover, several large mammals, such as *Hippopotamus*, *Megaloceros dawkinsi* and *Palaeoloxodon antiquus* (the latter recorded only from unstratified material) known from Pakefield/Kessingland have never been found at West Runton, despite the much more extensive collections from that site (Stuart & Lister 2001). Furthermore, the occurrence at Pakefield of two vole species of the genus *Mimomys*, *M. savini* and *M*. aff. *pusillus* (fig. 4), of which only the former is known from West Runton, is also consistent with a difference in age. *M. pusillus* is known from the Early Pleistocene to its latest occurrence in the early Middle Pleistocene Ilynian Complex (European Russia) (Pevzner *et al*. 2001). As the latter is overlain by the Don Till (Donian), correlated with MIS 16, this suggests a minimum age for the Pakefield "*Unio*-bed".

This evidence indicates that sediments containing the artefacts belong to an interglacial in the early part of the "Cromerian Complex" (Turner 1996). This interpretation is supported by independent evidence derived from the lithostratigraphy. A maximum age is indicated by palaeomagnetic data from the laminated silts, which show normal polarity (Lee *et al*. in press), consistent with the early part of the Brunhes Chron. A minimum age is indicated by the overlying Lowestoft Till

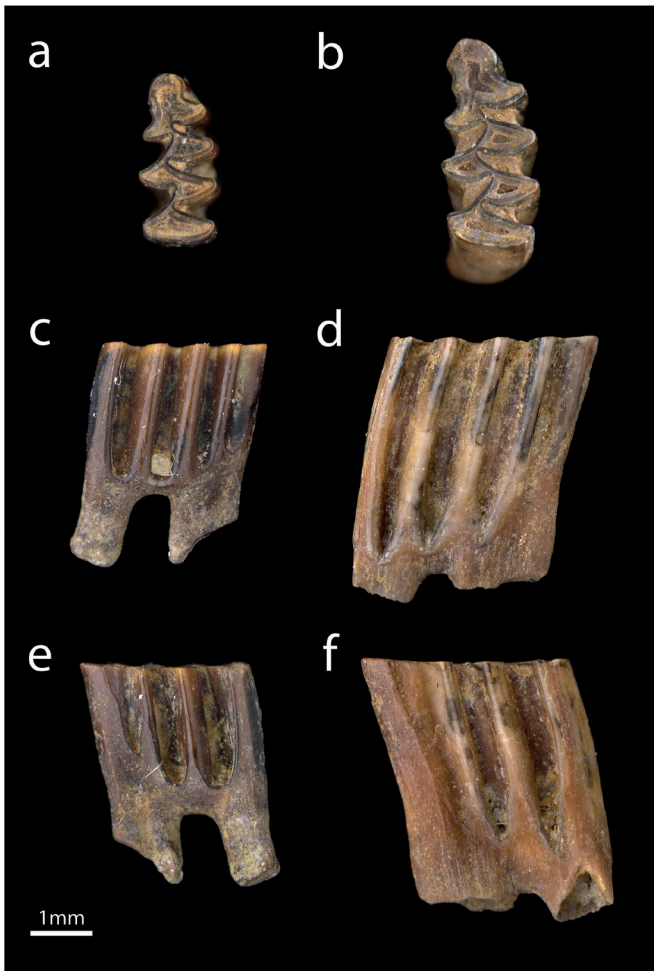

Figure 4. First lower molar of *Mimomys* aff. *pusillus* from Pakefield (a, c, e) (BMNH. M 63567, ex R. Mutch collection 1108.1, "*Unio*-bed") compared with that of *M. savini* (b, d, f) (BMNH M. 63568, ex R. Mutch collection 1242.2, "*Unio*-bed"). a, b) occlusal view; c, d) lingual view; e, f) labial view. Scale bar = 1 mm.

Member, conventionally thought to have been emplaced during MIS 12. The sediments between the CF-bF and the till have been traditionally interpreted as being of glaciofluvial origin, deposited during the Anglian Stage (West 1980; Wymer 1999). A longer chronology has recently been proposed on the basis of sedimentological evidence suggesting that the CF-bF may be separated from the MIS 12 till by two separate high sea-stands and two cold episodes (Lee *et al*. in press) (fig. 3b). By using the premise that temperate-climate marine deposits and cold-climate aggradations in the lower parts of large, temperate latitude rivers can be matched, respectively, to the peaks and troughs of orbitally tuned MIS cycles (Bassinot 1994), the archaeology can be dated to MIS 17 (about 680 kyr ago) at the very youngest. If evidence for ice-sheet extension across eastern England during MIS 16 is valid (Lee *et al*. 2004), then an additional temperate/cold cycle is required and the archaeology at Pakefield could be as old as the later part of MIS 19 (about 750 kyr ago).

The oldest human fossils in northwest Europe are from Mauer (Dennell & Roebroeks 1996), Germany and Boxgrove (Roberts & Parfitt 1999), UK, where they are part of vertebrate

assemblages that include the water vole *Arvicola terrestris cantiana*. All other northwestern European sites containing early Middle Pleistocene archaeology in association with rich small-mammal assemblages (for example, Miesenheim I in Germany, and Westbury- sub-Mendip and Waverley Wood in the UK) (Dennell & Roebroeks 1996; Wymer 1999; Bishop 1975), have similarly yielded *Arvicola* (with unrooted molars) rather than *Mimomys* (its ancestor with rooted molars). These early Middle Pleistocene archaeological sites with *Arvicola* have all been correlated with MIS 13, the basis for the belief in a short chronology for human occupation in this region (Dennell & Roebroeks 1996). The discovery at Pakefield of unequivocal artefacts in beds yielding *Mimomys* demonstrates a much longer human occupation of northwest Europe, pre-dating other evidence by as much as 200 kyr. There has been much discussion about what additional social, technological or physiological adaptations humans would have required to colonize northwest Europe compared with their occupation farther south (Gamble 1999; Roebroeks 2001). The Mediterranean climate reconstructed for the archaeological levels at Pakefield suggests that these pioneers were able to spread northwards in familiar climatic conditions, using their existing adaptations.

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