JOURNAL OF QUATERNARY SCIENCE (2006) 21(5) 471–483

Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/jqs.1033

The Clactonian elephant butchery site at Southfleet Road, Ebbsfleet, UK

F. F. WENBAN-SMITH,[1]* P. ALLEN,[2] M. R. BATES,[3] S. A. PARFITT,[4,5] R. C. PREECE,[6] J. R. STEWART,[7] C. TURNER[8] and J. E. WHITTAKER[5]

[1] Department of Archaeology, University of Southampton, Southampton SO17 1BJ, UK
[2] Department of Geography, Royal Holloway, University of London, Egham TW20 0EX, UK
[3] Department of Archaeology, University of Wales, Lampeter, Ceredigion SA48 7ED, UK
[4] Institute of Archaeology, University College London, 31–34 Gordon Square, London WC1H 0PY, UK
[5] Department of Palaeontology, The Natural History Museum, Cromwell Road, London SW7 5BD, UK
[6] Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, UK
[7] Biology Department, Gower Street, University College London, London WC1E 6BT, UK
[8] Department of Earth Sciences, Open University, Walton Hall, Milton Keynes MK7 6AA, UK

Wenban-Smith, F. F., Allen, P., Bates, M. R., Parfitt, S. A., Preece, R. C., Stewart, J. R., Turner, C. and Whittaker, J. E. 2006. The Clactonian elephant butchery site at Southfleet Road, Ebbsfleet, UK. *J. Quaternary Sci.*, **Vol. 21** pp. 471–483. ISSN 0267–8179.

Received 20 June 2005; Revised 17 March 2006; Accepted 4 April 2006

ABSTRACT: Archaeological excavations at Southfleet Road, Ebbsfleet, Kent, have revealed a complex sequence of fossiliferous Middle Pleistocene sediments containing lithic artefacts. An incomplete skeleton of straight-tusked elephant *Palaeoloxodon antiquus* was found in lacustrine sediments in close association with a cluster of mint condition cores, flakes and notched flake-tools, some with evidence of use-damage. These finds appear to reflect *in situ* tool production and butchery of the elephant carcass. A far larger concentration of similar artefacts, again in mint condition, occurred nearby in the same horizon. These finds were overlain by a fluvial gravel containing abundant handaxes, some also in mint condition. A range of fossils, including pollen, molluscs and small vertebrates, indicates temperate conditions with local woodland coeval with the elephant butchery. The sediments appear to have formed during the early part of an interglacial, almost certainly MIS 11. As well as providing rare undisturbed evidence of human behaviour, the site supports the existence of a distinctive non-handaxe Clactonian core/flake-tool industry in southeast England at this period. Copyright © 2006 John Wiley & Sons, Ltd.

Journal of Quaternary Science

KEYWORDS: Lower Palaeolithic; Clactonian; Swanscombe; Hoxnian; MIS 11; Middle Pleistocene; elephant butchery.

Introduction

This paper provides a preliminary report on a significant Lower Palaeolithic discovery, made during construction of the Channel Tunnel Rail Link (CTRL). This new rail line runs between London and Folkestone, Kent, crossing the Thames east of Dartford. Numerous archaeological investigations have taken place, initially to identify the location of significant remains, followed by excavation in advance of any unavoidable destruction. This work has dealt with remains from Palaeolithic to 20th century. In July 2003 a thick, complex sequence of Pleistocene sediments was exposed in the Ebbsfleet Valley, northwest Kent (Fig. 1). Preliminary investigation revealed the presence of flint artefacts and other palaeontological remains. Construction works were halted, and a controlled excavation took place between March and November 2004. Consideration was given to preservation *in situ*, but this proved an impossible option in view of the extent to which extraction and surrounding construction had already taken place.

Full analysis of the artefactual, faunal and environmental remains has not yet taken place, but it is already possible to summarise key aspects of the site. Here we report on the discovery of the undisturbed remains of a partial skeleton of straight-tusked elephant *Palaeoloxodon antiquus*, recovered in association with a dense cluster of mint condition lithic artefacts. This is interpreted as evidence of early human tool manufacture on the spot associated with butchery of the elephant carcass. We present information on the age of the site, the regional climate and the local environments. The general typological/technological characteristics of the lithic material are also discussed and compared with the assemblages from other key Middle Pleistocene Palaeolithic sites in southeast England. Further interpretation, particularly of site formation and human behaviour, will follow from more detailed analysis.

* Correspondence to: F. F. Wenban-Smith, Department of Archaeology, University of Southampton, Southampton SO17 1BJ, UK.
E-mail: ffws@soton.ac.uk

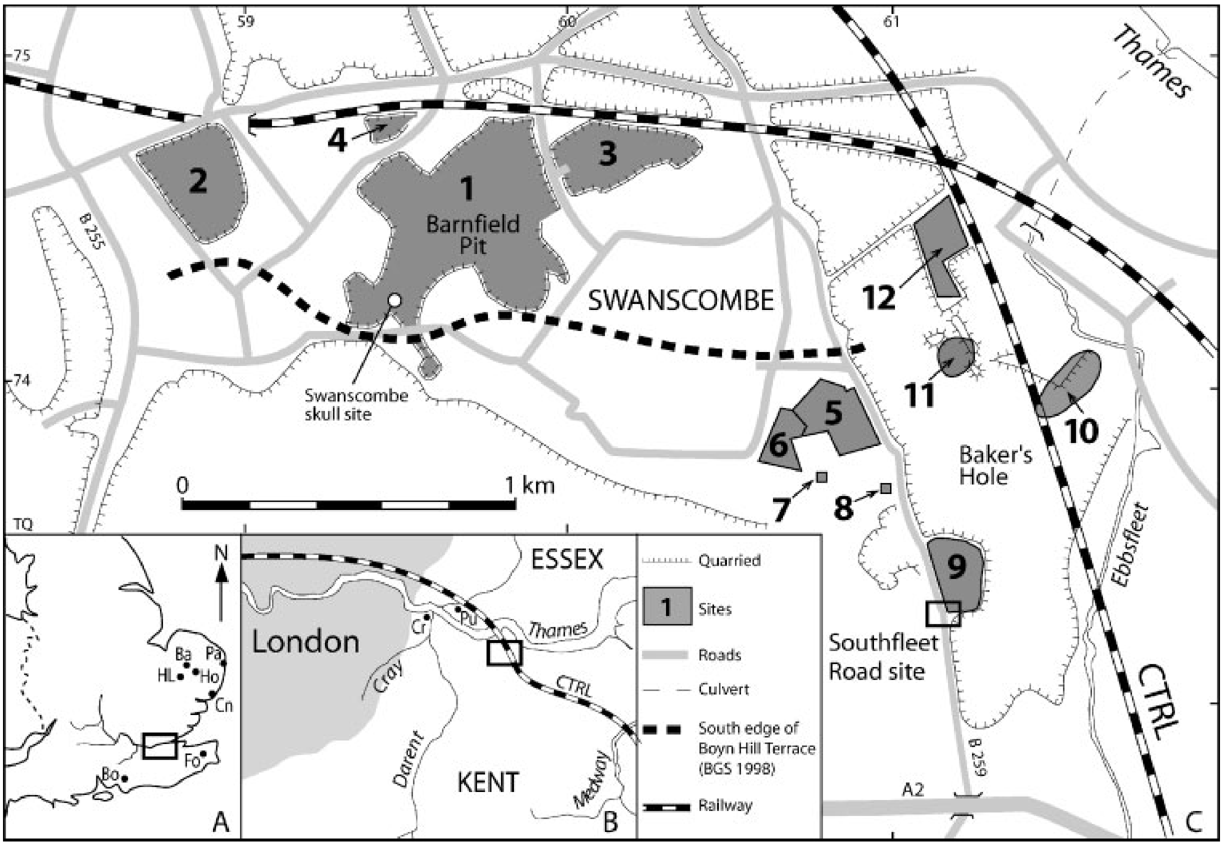

Figure 1 Southfleet Road location showing Channel Tunnel Rail Link and key sites mentioned in text: (A) within UK: Bo, Boxgrove; Ba, Barnham; Cn, Clacton; Pa, Pakefield; Ho, Hoxne; HL, High Lodge; Fo, Fordwich; (B) within Lower Thames: Cr, Crayford; Pu, Purfleet; (C) within Swanscombe area: 1, Barnfield Pit; 2, Globe Pit, Greenhithe; 3, New Craylands Lane Pit; 4, Dierden's Pit; 5, Swan Valley Community School; 6, Sweyne County Primary School; 7, Eastern Quarry, test pit 7; 8, Eastern Quarry, test pit 8; 9, New Barn Farm; 10, Southfleet Pit Levallois site; 11, Burchell's main sites; 12, Northfleet Allotments

Site location

The site is located at TQ 6115 7335, 1 km to the southeast of Swanscombe, Kent, on the B259 (Southfleet Road) at the western side of the Ebbsfleet Valley (Fig. 1). The area has been extensively quarried since the late 19th century and intact sediments are only preserved in a few locations. Southfleet Road runs northward into Swanscombe along the western edge of the main Ebbsfleet Valley quarry, previously known as Baker's Hole (Wenban-Smith, 1995a). The Ebbsfleet is a small southbank tributary of the Thames, the valley of which has cut down through the major east–west trending Boyn Hill/Orsett Heath deposits into the underlying Tertiary and Cretaceous deposits.

Research background

Southeast England is a key region for Lower and Middle Palaeolithic archaeology in Britain. Following over 150 years of collecting and excavation, it is one of the most thoroughly investigated Lower/Middle Palaeolithic landscapes in the world. Deposits in the Lower Thames valley, such as at Swanscombe (Conway *et al.*, 1996), Purfleet (Schreve *et al.*, 2002), Crayford (Roe, 1981) and the Ebbsfleet Valley (Wenban-Smith, 1995a), span the period from the Anglian glaciation to the start of the Devensian. In conjunction with remains from other major sites dating to both before and after the Anglian, such as Pakefield (Parfitt *et al.*, 2005), High Lodge (Ashton *et al.*, 1992), Boxgrove (Roberts and Parfitt, 1999), Hoxne (Singer *et al.*, 1993), Barnham (Ashton *et al.*, 1998) and Clacton (Bridgland, 1994), the archaeological remains from southeast England demonstrate phases of occupation of the British peninsula through the Lower/Middle Palaeolithic, and also provide a record of changing lithic material culture.

This record has in the past been taken as a representative model for Britain as a whole (e.g. Wymer, 1968). However, it has since become clear that, even through the Lower Palaeolithic, one cannot presume pan-British, let alone pan-continental, material cultural homogeneity. In southeast England, besides the very early flake/core industry of Pakefield (Parfitt *et al.*, 2005), we can now recognise before the Anglian the three contrasting industries of: Fordwich (crude pointed handaxes; see Roe, 1981: 104); Boxgrove (tranchet-sharpened ovate handaxes); and High Lodge (large unifacial flake-tools). After the Anglian, Roe's (1964, 1968) analyses failed to find chronological or regional trends in handaxe shape across southern Britain, a point further emphasised by Wymer (1974). Furthermore, post-Anglian assemblages lacking evidence of handaxe manufacture and exclusively consisting of flakes, cores and simple flake tools have been identified at a number of sites in southeast England. Although usually regarded as a distinctive non-handaxe cultural tradition (the Clactonian), it has also been suggested that these sites merely reflect the differential distribution across the landscape of different knapping practices by humans with a varied technological repertoire (see 'Discussion and conclusions'). We have only begun to recognise the complexity of the British Lower Palaeolithic record, and need further empirical observations of the extent and spatial scale of variation to underpin interpretation. We then need to consider (a) the typological and technological range of the lithic material culture of individual Archaic populations, and (b) how unevenly this range might have been deposited around the landscape. We would also like to address the behaviour and social life of the humans of the period.

Rare occurrences of undisturbed land-surfaces provide detailed evidence of brief episodes of activity and lithic production at specific sites. Complementing such sites is the larger-scale picture provided by accumulations of artefacts in river gravels. Despite some local disturbance, these provide a useful sample of material culture from a restricted area during a relatively short (at the Pleistocene timescale) period, during which a particular gravel body aggraded. As well as contributing to the wider picture of cultural change and diversity through time, such samples allow investigation of the spatial organisation of behaviour. Southeast England is rich in Palaeolithic evidence, which, alongside its intense history of previous investigation, makes it a key region for further work.

In the Swanscombe area, extensive gravel and chalk quarrying since the late 19th century has provided exposures rich in significant Lower and Middle Palaeolithic remains (Wymer, 1968; Fig. 1). Older remains are mostly associated with the deposits of the Boyn Hill/Orsett Heath Formation, preserved to the west of Southfleet Road, and with a base level above 20 m OD. The deposits consist of a sequence of predominantly fluviatile silt, sand and gravel units laid down by the early Thames in the Hoxnian, (Bridgland, 1994). Younger remains are mostly found in deposits to the east of Southfleet Road, in the Ebbsfleet Valley, which cuts down through the Boyn Hill/Orsett Heath deposits and contains lower-lying deposits in the altitudinal range −2 m OD to 15 m OD.

The sequence of the Boyn Hill/Orsett Heath Formation in the Swanscombe area is best represented by the deposits at Barnfield Pit (Fig. 1, site 1). Here (Conway *et al.*, 1996), the lower levels of the sequence (Phase I, Lower Gravel and Lower Loam) are characterised by a non-handaxe industry, usually identified as Clactonian. The middle levels (Phase II, Lower Middle Gravel and Upper Middle Gravel) are characterised by a handaxe-dominated industry with a strong emphasis on pointed and sub-cordate forms of handaxe with a thick, often only partly worked, butt (Wymer, 1968: 338–343). The Upper Middle Gravel has also produced an early human skull making it one of only two sites in England with Lower or Middle Palaeolithic human skeletal remains, the other being Boxgrove (Roberts and Parfitt, 1999). The upper levels (Phase III, Upper Loam and Upper Gravel) are not rich in archaeological remains. None is known with secure provenance, although there are anecdotal reports of a white-patinated ovate-dominated industry from the base of the Upper Loam (Smith and Dewey, 1913).

Recent fieldwork has shown that deposits of the Boyn Hill/Orsett Heath Formation extend further south than mapped by the British Geological Survey (1998; Fig. 1), and reach a greater height and thickness than previously recognised. Excavations at the Swan Valley Community School (Fig. 1, site 5; Wenban-Smith and Bridgland, 2001) and a test pit at the unquarried eastern end of Eastern Quarry (Fig. 1, site 7; Wenban-Smith, 2002) have demonstrated the presence of abundant Palaeolithic artefacts and faunal remains in deposits equivalent to Phase II, ca. 400 m south of the mapped Boyn Hill/Orsett Heath extent. At Sweyne County Primary School (Fig. 1, site 6; Wenban-Smith and Bridgland, 2001), the top of the Phase III deposits reaches 40 m OD, indicating a thickness for the Upper Loam of at least 7 m, higher and thicker than previously recorded.

Complementing these records, Carreck (1972) reported a body of ‘ferruginous loam’ up to 5 m deep and extending 365 m northward from New Barn Farm (Fig. 1, site 9) in the quarry section along the east side of Southfleet Road. He suggested, on the basis of height above OD, that it was probably associated with the Barnfield Pit ‘Boyn Hill Terrace’ sequence, although it was not easily equated with any of the known beds.

In the younger deposits to the east of Southfleet Road, a number of significant sites have also been found, although quarrying and CTRL construction have now removed most Pleistocene sediments. Of the many localities that have produced material (Wenban-Smith, 1995a), three sites are best documented and most representative. In the northwest angle of the old Southfleet (or New Barn) Pit (Fig. 1, site 10), Smith (1911) recovered, from a fossiliferous chalk-rich solifluction deposit, flint artefacts with a substantial Levalloisian element, including both tortoise cores and blade-like flakes similar to those found in the Crayford brickearths (Roe, 1981: 86–93). Secondly, at the eastern edge of the old Baker’s Hole quarry (Fig. 1, site 11) Burchell (1957) discovered a sequence of fossiliferous fluvial and colluvial sediments including undisturbed buried land-surfaces with lithic remains. Thirdly, at the Northfleet Allotments (Fig. 1, site 12) Marston discovered a richly fossiliferous fluvial deposit, later investigated by Kerney and Sieveking (1977). Substantial archaeological investigation of these deposits has also taken place in conjunction with CTRL construction, and this will soon be reported on separately.

Site layout and methods of excavation

When investigations began, the site comprised a north–south ridge ca. 10 m wide by 80 m long, with sloping sections each side up to 5 m high (Figs 2 and 3). The *Palaeoloxodon* remains were discovered in a grey clay in the west-facing section. Four trenches (A–D) were dug across the ridge to establish lithostratigraphical correlations between the two main sections. The gravel that capped most of the site was sampled for lithic artefacts by bulk sieving. The remainder of the gravel, and other deposits that overlay the clay, were then machined away in a controlled manner, recovering and recording the location of any artefacts.

Once the clay was exposed, several test pits were dug into it by hand to evaluate the *Palaeoloxodon* remains, and to determine whether other concentrations of faunal or artefactual remains were present (Fig. 4(d)). The *Palaeoloxodon* remains were found to comprise a tight cluster of bones and teeth from a single individual, associated with a concentration of lithic artefacts. A second, larger scatter of lithic artefacts was found to the south of trench D. These areas were excavated by hand; other parts of the clay were excavated by controlled machining, with careful hand excavation and recording of any further finds.

The clay and underlying fine-grained units were sampled for pollen, small vertebrates and ostracods. A tufaceous channel-fill towards the base of the clay was particularly rich in faunal and molluscan remains, and was extensively sampled.

Stratigraphy

Six Pleistocene units were present (Table 1; Figs 2 and 3). The sequence was primarily that of an alluvial fan and clayey lacustrine deposits (units 2, 3 and 5), interbedded with coarser, slope deposits (units 1 and 4) in its up-fan zone. These in turn were overlain by ‘brickearth’ deposits of uncertain origin (unit

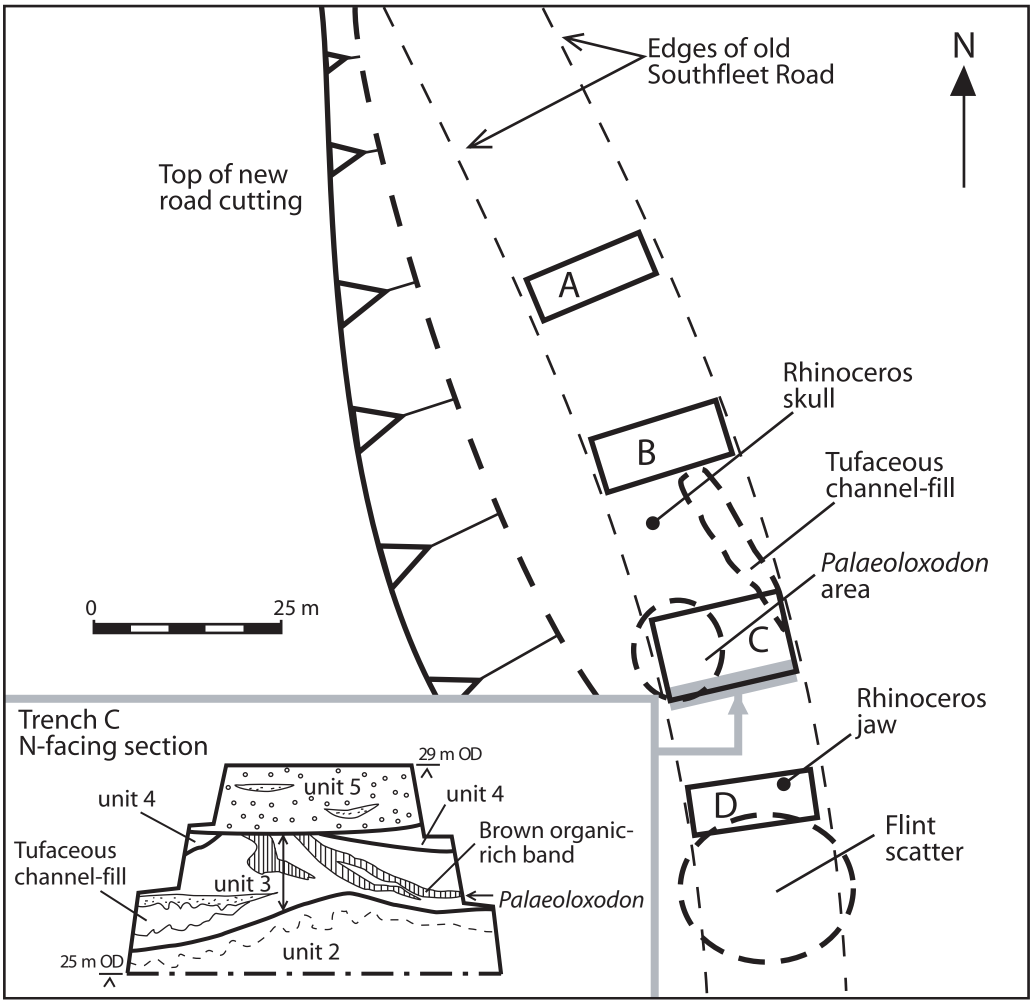

Figure 2 Site plan showing locations of trenches A–D, significant find areas and stratigraphical position of the *Palaeoloxodon* remains (inset)

6). The lower parts of the sequence (units 1, 2 and 3) were deformed into an elongate synclinal basin (Fig. 4(a) and (b)). Bedrock at the site is Cretaceous Chalk, which was not seen *in situ* in the main section, but was exposed in the base of nearby construction trenches.

Unit 1. Chalk-rich sand

The unit was poorly sorted, comprising flint and chalk pebbles and cobbles and occasional concentrations of derived Tertiary shell fragments with matrix of grey-brown structureless silty sand (Fig. 4(b)). The deposit yielded some large mammalian remains, including the well-preserved skull of a large bovid. The deposit appears to represent a phase of solifluction.

Unit 2. Sand with clay laminations

This unit comprised brownish-yellow planar-bedded sand, dipping to the north and northwest following the angle of the underlying slope. The sand was interbedded with silty clay laminations (Fig. 4(b)) and occasional thin beds of flint pebbles. The silty clay interbeds became thicker and more frequent

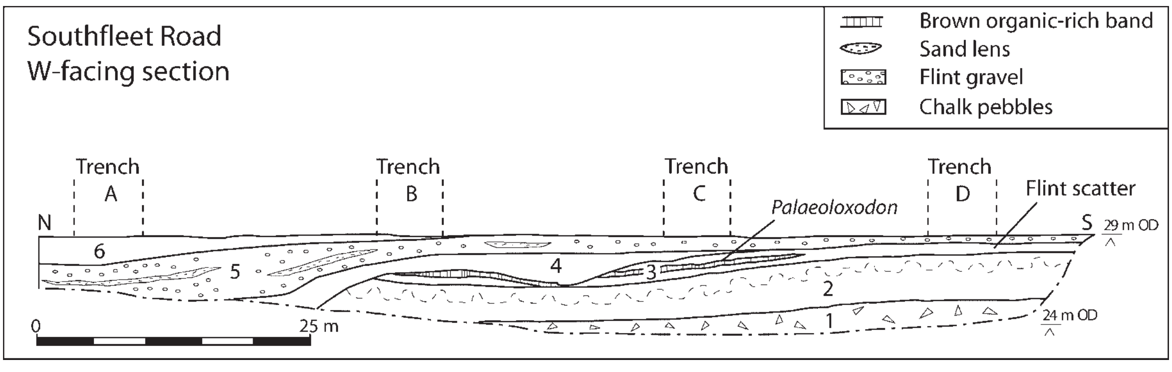

Figure 3 West-facing section showing geometry of major stratigraphical units and the locations of the *Palaeoloxodon* remains and the larger flint scatter south of trench D

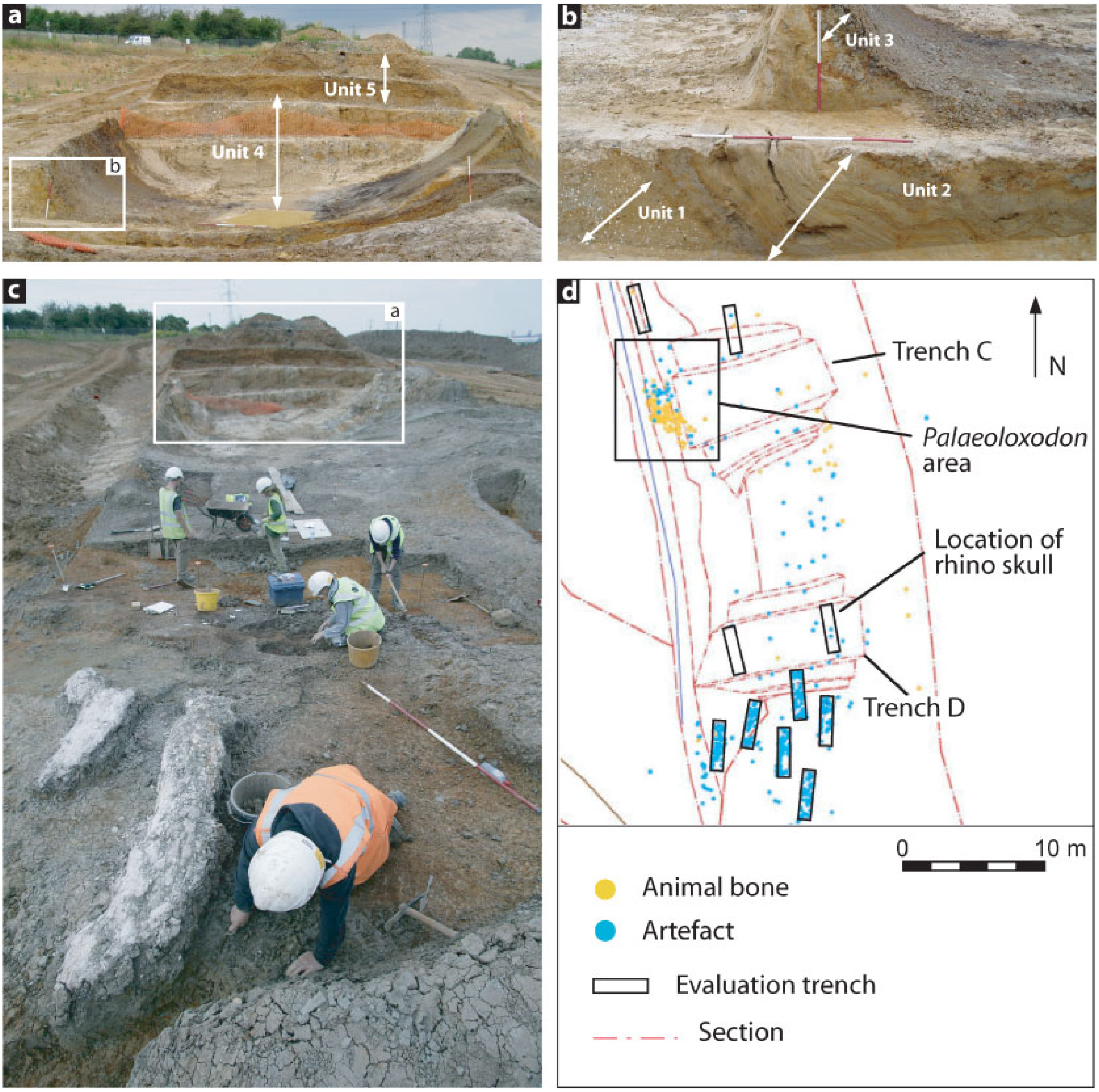

Figure 4 (a) East–west section at trench B (looking north), showing excavated synclinal surface of grey clay and overlying sequence; (b) closer view of east–west section at trench C (looking north), showing conformable deformation of grey clay and underlying units; note Chalk pebbles in unit 1, contorted clay-silt laminations in unit 2 and dark surface of grey clay; (c) the *Palaeoloxodon* remains during excavation; (d) distribution of flint artefacts and mammalian finds from the *Palaeoloxodon* area (after initial investigations) and in evaluation test pits into the concentration south of trench D

Table 1 Pleistocene sediment units (numbered up through sequence)

Unit	Name	Summary interpretation
6	Brown clay-silt ['brickearth']	?Aeolian/colluvial/alluvial
5	Bedded gravel	Fluvial deposition, gravel bars on northward-extending fan/delta, moderately high energy with occasional quieter phases
4	Mixed gravel/clay	Mass movement downslope from west
3	Grey clay (with tufaceous channel-fill)	Lacustrine or backwater environment with periodic dessication; tufaceous deposits reflect spring-fed precipitate in a small stream
2	Sand with clay laminations	Fluvial deposition, fan/delta aggradation discharging into quiet water body
1	Chalk-rich sand	Solifluction, periglacial slopewash

higher in the sequence, where they were highly deformed by loading, suggesting saturated conditions. The geometry and planar bedding suggest alluvial fan or delta aggradation. The flint pebble beds reflect episodes of higher fluvial energy, perhaps with some colluvial input. The interbeds of silty clay suggest discharge into a quiet water body with an oscillating level. This water body became progressively deeper and more extensive, culminating in a lacustrine/backwater environment (unit 3).

Unit 3. Grey clay (with tufaceous channel-fill)

The unit consists of grey and black clays with some sand-rich lenses and occasional flint pebbles. The geometry of the clays followed that of the underlying sands, showing an overall dip to the north. The clay contained intermittent brown organic-rich bands 5–10 cm thick, which were dark purple at its surface (Fig. 4(b)). These are thought to represent oxidation or weathering horizons. The *Palaeoloxodon* was found in one of these dark brown horizons towards the base of the grey clay (Figs 2 and 3), which contained numerous decayed fragments of plant material. A small channel filled with fossiliferous tufaceous sediment occurred towards the base of the clay in the centre of the main east-facing section (Fig. 2). The thick body of clay suggests accumulation in a lacustrine or backwater environment. Fine brecciation throughout the sequence indicates frequent desiccation. The tufaceous channel-fill may reflect precipitation within a spring or a small stream.

Unit 4. Mixed gravel/clay

In the central part of the site, the grey clay was overlain by yellowish-brown clayey silt/fine sand with patches of medium to coarse gravels (Fig. 4(a)). The deposit filled the synclinal basin and thickens to the west, forming a substantial clayey mass. The body is interpreted as a local mass movement deposit, originating from the west or northwest.

Unit 5. Bedded gravel

Passing unconformably across the lower sequence was a deposit of moderately well-sorted medium to coarse planar-bedded gravel with sand lenses (Fig. 4(a)). Its base level was ca. 28 m OD in the south and central parts of the site. The gravel dipped and thickened northward, reaching a thickness of ca. 2 m with its base at ca. 26 m OD (Fig. 3). The gravel formed bars during flood stages in the later development of the fan/delta. The sand lenses represent bar-top deposits, laid down under quieter conditions. Two macrofabric studies showed a predominant dip to the south (120–230°) with a minor mode to the northwest (285–335°), considered to represent imbricate deposition as the fan/delta extended northward. The clasts were >95% flint (=90% angular) derived mostly from Tertiary beds, and ca. 1% Greensand chert, probably derived from early Darent gravels (D.R. Bridgland, pers. comm.). The local lithology and angularity confirm the gravel as from a Thames tributary.

The base level is similar to that of the Lower Middle Gravel at Swan Valley School 500 m to the north (Wenban-Smith and Bridgland, 2001). Thus topographic and altitudinal evidence suggest that the water body that laid down the unit 5 gravel had a confluence with the Thames between the site and Swan Valley School, and that unit 5 possibly correlates with the Lower Middle Gravel.

Unit 6. Brown clay-silt ('brickearth')

The northern part of the gravels was overlain by yellowish to reddish-brown sandy silty clay, locally known as 'brickearth'. The deposit dipped and thickened to the north, reaching a thickness of at least 4 m. It contained regular sand-rich beds and thin trails of very fine gravel. This unit is probably equivalent to the 'ferruginous loam' reported by Carreck (1972). The brickearth appears to be an aeolian silt that has been reworked by colluvial and/or alluvial processes.

Overall geometry

The sequence had a complex geometry. The primary bedding structures dipped northwards, but units 1, 2 and 3 formed an asymmetric north–south trending synclinal basin in the main excavation area (Fig. 4(a)). This was flanked by a series of synclines and anticlines with north–south trending axes, seen in plan in adjacent areas.

This geometry is not yet fully understood, but may result from linear solution of the underlying Chalk. However, this does not explain the folding of the surrounding beds or the marked asymmetry of the basin. Alternatively it could have resulted from lateral pressure caused by downslope movement of the substantial mass of the deposits (unit 4) from the west, compressing and partially overriding the pre-existing sequence of units 1, 2 and 3.

Palaeontology

A range of fossils was recovered from units 1, 2 and 3, comprising large mammals, small vertebrates, pollen, molluscs and ostracods. Preliminary analysis has allowed climatic and environmental reconstruction, as well as contributing to dating (Table 2). No fossil remains were recovered from units 4, 5 and 6, apart from fragmentary remains (and one substantial piece) of what might be decayed wood in unit 4.

Vertebrates

Current knowledge of the vertebrate remains is limited to identifications of larger material made during hand excavation, supplemented by identifications of small vertebrates from five bulk samples that were sieved during the excavation. Further work will expand the preliminary species lists for each unit (Table 3).

Large mammal remains were scarce in unit 2, but sieved bulk samples yielded a rich small-vertebrate assemblage. Fish are the most common group, comprising almost 50% of 118 identifiable remains, including pike *Esox lucius*, eel *Anguilla anguilla* and undetermined cyprinids. The assemblage reflects a freshwater environment, probably a large and slow-moving watercourse in a temperate climate.

Table 2 Archaeological and palaeontological summary

Stratigraphic unit	Archaeological remains	Industry	Palaeontology	Climate	Environment	Correlation
6. Brown clay-silt ['brickearth']	Handaxes and debitage	Acheulian	—	?	?	?
5. Bedded gravel	Common handaxes, occasional debitage	Acheulian	—	?	?	?
4. Mixed gravel/clay	Cores/flakes (varied condition)	Clactonian (derived?)	Wood pieces (burnt?)	?Temperate	?	?
3. Grey clay (with tufaceous deposits)	Abundant cores, flakes, notched tools (all mint)	Clactonian	Woodland fauna (bank vole, wood mouse, land snails)	Fully temperate	Local forest, with open grassland near river or stream	Ho II
	Elephant butchery		Freshwater aquatic fauna (fish, ostracods, molluscs) Straight-tusked elephant Narrow-nosed rhinoceros		Alder carr	
2. Sand with clay laminations	Cores, flakes, notched tools	Clactonian	Mammoth (tusk) Ground squirrel Rabbit Freshwater fish	?Temperate ?Cool	Extensive open grassland	?Ho I ?late Anglian
1. Chalk-rich sand	Cores, flakes?	Clactonian?	Large mammals	?Cool	Open grassland?	?late Anglian

The mammal assemblage appears unusual as it consists of taxa generally thought of as cold-adapted (mammoth *Mammuthus* sp. and ground squirrel *Spermophilus* sp.) together with rabbit *Oryctolagus cuniculus*, which is a thermophile. This association has not previously been found in the British Pleistocene. Today, the natural ranges of rabbit and ground squirrels do not overlap, although areas of congruence result from human intervention (Mitchell-Jones *et al.*, 1999). *Spermophilus* today is restricted to steppe grassland in continental parts of Eurasia (Mitchell-Jones *et al.*, 1999), and the few British Pleistocene records are mostly from cold stage deposits with open vegetation (Stuart, 1982). *Mammuthus*, although a species of cold open conditions in the Late Pleistocene, also occurred in more temperate conditions during the Middle Pleistocene in northwest Europe. Overall the fauna is consistent with extensive open grassland in a temperate climate.

The grey clay (unit 3) was rich in large mammal remains, the most notable being the partial skeleton of a straight-tusked elephant *P. antiquus* and parts of the jaw and skull of one or more narrow-nosed rhinos *Stephanorhinus hemitoechus* (Fig. 2). Other species include beaver *Castor fiber*, wild boar *Sus scrofa*, red deer *Cervus elaphus* and a large bovid (*Bos* or *Bison*). This fauna suggests a fully temperate climate and a wooded biotope with dry areas and some open herbaceous vegetation close to a river or stream.

A rich small vertebrate assemblage was recovered from the tufaceous channel-fill towards the base of the grey clay (Table 3). The small mammals were probably accumulated by an avian predator, while the fish and amphibians represent animals that lived and died in the immediate vicinity of the site. Small mammals represent more than half (56%) of the identifiable specimens ($n = 939$). Amphibians are a significant component (28%), indicating areas of damp vegetation and marshy ground. Fish account for only a small proportion of the assemblage (14%), but nonetheless indicate a freshwater environment. The presence of minnow indicates a smaller and better oxygenated water body than that represented by unit 2.

The small mammal assemblage supports the molluscan evidence for dense vegetation and woodland. In particular, abundant bank vole *Clethrionomys glareolus* and wood mouse *Apodemus sylvaticus* are consistent with the presence of temperate forest. Nevertheless, there is also a significant open ground component, indicated by grassland voles (*Microtus* spp.). Mammals of waterside habitats, including water vole *Arvicola terrestris cantiana* and water shrew *Neomys* sp. are notably common, as are insectivores, which include a range of shrews and the extinct mole (*Talpa minor*). The tufa also yielded rare large mammal remains, including roe deer *Capreolus capreolus* and red deer *Cervus elaphus*. The latter is tolerant of a wide range of environmental conditions, but the former is generally associated with woodland.

Molluscs

Residue from a 30 litre sample from the tufaceous channel-fill was scanned for preliminary assessment of mollusc remains. The molluscan fauna is evenly divided between aquatic and terrestrial species, with 13 taxa from each group, but in terms of abundance, it is the aquatics that dominate. Especially common are *Valvata piscinalis*, *Bithynia tentaculata* and bivalves belonging to the genus *Pisidium* (*amnicum*, *casertanum*, *subtruncatum*, *nitidum* and *moitessierianum*). This suite of species is typical of small hard-water streams, a conclusion supported by the occurrence of the river limpet

Table 3 Vertebrate assemblages

	Unit 1	Unit 2	Unit 3	
			Tufa	Grey clay
PISCES				
Anguilla anguilla (European eel)		X		
Pungitius pungitius / *Gasterosteus aculeatus* (nine-spined or three-spined stickleback)		X		
Esox lucius (pike)		X		
Gymnocephalus cernua / *Perca fluviatilis* (ruffe or perch)		X		
cf. *Phoxinus* (minnow)			X	
Indeterminate Cyprinidae (carp family)		X	X	
Indeterminate teleost (bony fish)		X	X	
AMPHIBIA				
Bufo sp. (undetermined toad)			X	
Rana sp. (undetermined frog)			X	
REPTILIA				
Anguis fragilis (slow worm)			X	
AVES				
Anatidae sp. (undetermined duck)			X	
MAMMALIA				
Insectivora				
Talpa minor (small mole)[a]			X	
Sorex minutus (pygmy shrew)			X	
Neomys sp. (water shrew)			X	
Primates				
Homo sp. [flint artefacts] (undetermined hominin)	X	X		X
Lagomorpha				
Oryctolagus cuniculus (rabbit)		X		X
Rodentia				
Spermophilus sp. (ground squirrel)		X		
Castor fiber (beaver)				X
Clethrionomys glareolus (bank vole)			X	
Arvicola terrestris cantiana (water vole)			X	
Microtus (Terricola) cf. *subterraneus* (common pine vole)			X	
Microtus agrestis (field vole)			X	
Microtus sp. (vole)		X	X	
Apodemus sylvaticus (wood mouse)			X	
Carnivora				
Panthera leo (lion)		X		
Proboscidea				
Palaeoloxodon antiquus (straight-tusked elephant)[a]				X
Mammuthus sp. (mammoth)[a]		X		
Perissodactyla				
Stephanorhinus hemitoechus (narrow-nosed rhinoceros)[a]				X
Artiodactyla				
Sus scrofa (wild boar)				X
Cervus elaphus (red deer)			X	X
Capreolus capreolus (roe deer)			X	
Bos or *Bison* (bovid)	X	X		X

[a] Extinct

Ancylus fluviatilis. Many specimens are encrusted in lime, a common feature in such environments. Surrounding marshland is indicated by the occurrence of *Vertigo antivertigo*, *Zonitoides nitidus* and members of the Succineidae. *Arianta arbustorum* was common and far more frequent than *Cepaea* sp. The climate was fully temperate as reflected by the occurrence of species such as *Ena montana*, the modern range of which is thought to be limited by a lack of summer warmth. Members of the Clausiliidae were particularly well represented and appear to include *Clausilia pumila*, a central European forest species no longer living in Britain. *Discus ruderatus*, another species now extinct in Britain, was also present and far more common than its congener *D. rotundatus*. The assemblage bears some similarity to the fauna from the Lower Loam at Barnfield Pit, Swanscombe, in which *Discus ruderatus* also outnumbers *D. rotundatus* and in which *Ena montana* is likewise frequent (Kerney, 1971). However, the assemblage from the Lower Loam would seem to reflect the floodplain environment of a much larger river, bordered by more extensive areas of dry open ground.

Ostracods

The tufaceous channel-fill was overlain by an intermittent thin layer of white silt, which yielded seven species of freshwater ostracod (*Fabaeformiscandona balatonica, Ilyocypris bradyi, Pseudocandona rostrata, P. longipes, Herpetocypris reptans, Cyclocypris sp.,* and *Potamocypris zschokkei*). Almost all of these live either in shallow waterbodies fed by springs (e.g. *Pseudocandona rostrata, P. longipes*), slow waters flowing from springs (e.g. *Ilyocypris bradyi*) or in the seepages/springs themselves (*Potamocypris zschokkei*). The most common ostracod, *Fabaeformiscandona balatonica*, today prefers shallow and swampy pools that dry up in summer, often in shaded woodland situations. The absence from the upper part of the deposit of *Herpetocypris reptans*, which prefers well-vegetated unpolluted waters, together with the scarcity at this horizon of *Potamocypris zschokkei*, suggest increasing stagnation.

Pollen

Six pollen samples were analysed. Three samples from the clay-silt laminae of unit 2 were devoid of any trace of fossil pollen or other organic residue. This was consistent with the partial orange-staining of many of the laminations, suggesting that they had been subjected to fairly rigorous oxidation processes, probably during fluctuations in the local water table.

One sample from a clay pebble from the tufaceous channel-fill deposits of unit 3 was analysed. This was also devoid of pollen. It seems likely that these clay pebbles, found in residues from the bulk sample sieving, were reworked from nearby surface exposures of London Clay, which is here devoid of pollen.

Two samples (40132 and 40133, collected ca. 2 m apart laterally) from the brown organic-rich horizon in unit 3 associated with the *Palaeoloxodon* skeleton did contain pollen and spores, albeit at low frequency (Table 4). A few fragments of cypselas (i.e. achenes) of the hemp agrimony *Eupatorium cannabinum* were also present. The assemblages have been affected by considerable differential destruction. The taxa best represented are those that are most resistant to corrosion and easily identified (Havinga, 1985), namely fern spores, *Pinus*, *Tilia*, *Alnus* and *Corylus*. Less-resistant taxa that would be expected to be present, even abundant, in temperate forest assemblages such as *Quercus*, *Ulmus*, *Fraxinus* and some herb pollen types, are barely represented or absent.

The Southfleet pollen spectra cannot, therefore, be directly compared with the data from sites such as Hoxne (West, 1956) or Marks Tey (Turner, 1970) where the pollen was well preserved. Nonetheless, they indicate that unit 3 was deposited under fully temperate conditions, probably in or immediately adjacent to a swampy alder carr. This is suggested not only by the presence of relatively abundant *Alnus* pollen, but also by frequent *Alnus* sieve plates derived from the breakdown of wood fragments. The presence of *Quercus*, *Ulmus*, *Tilia* and *Corylus* pollen, as well as *Pinus*, suggests that higher and drier ground in the vicinity of the site supported mixed, largely deciduous forest characteristic of the early-temperate substage of interglacial periods. However, typical rarer shrub taxa of the forest, such as *Ilex*, *Hedera* or Type X are not represented, being either too poorly preserved or too sparsely produced to be found in these weathered assemblages.

Four further samples from the grey clay (ca. 10 m northwest of the first two samples), contained no pollen but one sample yielded part of a megaspore of the water fern *Azolla filiculoides*, which also has some dating implications, discussed below.

Dating, climate and palaeoenvironment

The palaeontological remains at Southfleet Road record a period of transition from extensive herbaceous vegetation during deposition of unit 2 to woodland with local open habitats during deposition of unit 3. This succession reflects climatic amelioration, probably extending from the end of a cold stage into the early part of an interglacial (Table 2). The site is located near the mouth of a small tributary entering the Thames from the south, in a location that oscillated between flowing water, standing water and exposed ground (cf. Table 1).

Both biostratigraphical and chronometric lines of evidence indicate that this interglacial is the Hoxnian (MIS 11). All of the biostratigraphically important fossils come from unit 3. Key mammalian species for dating are the narrow-nosed rhinoceros *S. hemitoechus*, the water vole *A. terrestris cantiana*, the pine vole *M. subterraneus* and the mole *T. minor*. *S. hemitoechus* is unknown from pre-Anglian deposits, its earliest record coming from the Lower Gravel at Barnfield Pit (Sutcliffe, 1964; Stuart, 1982). In contrast, the latter two small mammals occur in pre-Anglian and Hoxnian deposits, but, crucially, not in any younger deposits than Bed 4 at Hoxne (Upper fauna).

The molluscan and plant assemblages support this correlation and also suggest that the sediments accumulated during the early temperate substage (Ho II). The land snail fauna shows some similarities with the fauna from the Lower Loam at Barnfield Pit, although representing a different depositional environment. The presence of *Azolla filiculoides*, despite its paucity, is also of importance, since it seems to have become extinct in Britain after MIS 9 (Green *et al*., 2006). The absence of *Abies* and *Carpinus*, though the latter but not the former might be relatively susceptible to corrosion, makes an early-temperate rather than a late-temperate substage attribution more probable. In southeast England *Alnus* expands during the Hoxnian to its highest percentages in Ho IIb, but remains abundant in Ho IIc and through the late-temperate substage (Ho III). The abundance of *Alnus* at Southfleet Road therefore suggests that unit 3 was deposited during the early-temperate substage of the Hoxnian.

The biostratigraphical evidence is supported by preliminary indications from amino acid dating of *Bithynia* opercula from the tufaceous channel-fill, which also suggest attribution to MIS 11 (K. E. H. Penkman, pers. comm.).

Archaeology

Flint artefacts were found in every unit, except possibly the lowermost chalk-rich sand, which produced a possible core (Table 2). Artefacts were sparse within unit 2, but abundant within the other units, particularly the grey clay. Preliminary information is given here on three key aspects of the site.

The *Palaeoloxodon* butchery site

The site is represented by a tight cluster (within an area ca. 6 × 4 m, oriented broadly northwest–southeast) of flint artefacts and bones and teeth from a single adult *Palaeoloxodon* (Fig. 4(c) and (d)). These remains occur within a brown organic-rich band towards the base of the grey clay (Figs 2 and 3). The *Palaeoloxodon* bones consist of parts of the upper torso, forelimbs and cranium. Two tusks and two upper molars were present, but the jaw and lower molars were not recovered. The lower torso and hind limbs were missing, removed by ground extraction before the site was discovered. The bones were mostly in quite poor condition. The larger bones and tusks were in the worst condition, having been subject to compression and minor lateral movement within the clay, indicated by slickenslide striations showing movement of up to 10 cm. The tusks were in poor condition, being crushed into splinters, although broadly retaining their original shape (Fig. 4(c)). Some

Table 4 Pollen spectra from two samples from brown organic-rich band adjacent to *Palaeoloxodon* remains

	Sample 40132		Sample 40133	
	No. of grains counted	Percentage of total land pollen	No. of grains counted	Percentage of total land pollen
Trees & shrubs				
Betula	1	1		
Pinus	8.5	10	4.5	20
Ulmus	1	1		
Quercus	1	1	1	4
Tilia	3	3.5	1	4
Alnus	64	73	12	45
Corylus	8	9	5	20
Herbs				
Poaceae	1	1	3	11
Total land pollen	87.5		26.5	
Spores				
Pteropsida (Filicales)	130	149	16	60
Osmunda			1	4
Polypodium	1	1		
Crumpled & broken grains	40	(14)	9	(15)
Corroded grains	19	(3)		
Exotic	86		40	
Eupatorium cannabinum Cypsela fragments	2			
Sieve plates derived from *Alnus* wood	70	3		

of the larger bones were also damaged by mechanical excavation before discovery. Smaller bones, including a cluster of metapodials, representing at least one foot, were generally in good condition.

Immediately beside and amongst the bone scatter, and within the same brown organic-rich horizon, were ca. 100 unpatinated mint condition lithic artefacts. These were concentrated in a strip to the immediate northwest of the bone concentrations, and between the tusks. This juxtaposition, in a part of the deposit otherwise containing few vertebrate remains and artefacts, strongly suggests a genuine causative association. The carcass could perhaps have floated into its present position, but no process other than human knapping on the spot could account for the associated concentration of mint condition artefacts, two of which refit and several of which weigh over 500 g. Furthermore, the denser concentration of artefacts between the tusks and beside the elephant torso suggests that knapping activity took place adjacent to the carcass. The artefacts are mostly medium/large flakes, some with macroscopic use damage and some with single or multiple notches. There are also at least six cores. The site appears to reflect on-the-spot production of large sharp-edged flakes and simple flake-tools for butchery of meat or other soft tissue from the elephant carcass.

The assemblage does not include any handaxes, nor any debitage from handaxe manufacture. Thus the typological and technological characteristics of the assemblage are indistinguishable from the Clactonian horizons at Clacton (Wymer, 1985), Barnfield Pit (Smith and Dewey, 1913; Conway *et al.*, 1996) and Barnham Area I (Wymer, 1985; Ashton *et al.*, 1998).

Flint artefact scatter south of D

A larger concentration (ca. 1500–2000) of lithic artefacts was found in the grey clay (unit 3) to the south of trench D (Fig. 4(d)).The concentration extended east–west across the full width of the surviving sediments, so its original extent is unknown. Stratigraphically, the concentration occurs at a similar horizon to the *Palaeoloxodon* skeleton, although altitudinally it is at a higher level (Fig. 3). Some pieces of large bone were found amongst the flint artefact concentration, but the bone was very poorly preserved. This area may have been drier and less frequently flooded, perhaps making it more amenable for occupation and knapping activity. The flint assemblage from south of D is significantly larger than that associated with the elephant. Preliminary examination has established that the artefacts include a similar range of globular cores, large unworked flake-tools and a range of simple notched flakes. Even in this much larger assemblage, there is no sign of handaxe manufacture.

Handaxe-rich gravel

The grey clay was unconformably overlain by bedded gravel (unit 5), which contained abundant handaxes. Over 50 were found through careful machining and sieving of ca. 3000 litres. Typologically, they were mostly medium to large, with straight edges, a well-defined point and a thick, moderately worked butt. They are similar to those from the Swanscombe Middle Gravels, which are also dominated by pointed forms with thick butts (Wymer, 1968: 338–343). While some show signs of abrasion, many are in fresh or mint condition indicating a minimal amount of transport, if any, and swift burial.

Curiously, debitage was notably sparse, with less than a dozen pieces found. This cannot be explained by a bias in recovery during machining. A substantial amount of sieving and section cleaning also took place by hand, leading to recovery of several handaxes but hardly any flakes. Furthermore, investigations at Swan Valley School, where recovery took place from similar gravels using similar methods, produced a predominance of debitage in the assemblage (Wenban-Smith and Bridgland, 2001). The absence of debitage is also unlikely to be due to winnowing by fluvial action, since much debitage would probably have been of similar size to the smaller handaxes. Moreover, the gravels at Swan Valley School were generally coarser than those at Southfleet Road, reflecting higher energy fluvial activity and a greater potential for winnowing. Yet they still produced substantial quantities of debitage, far more abundant than handaxes. Therefore it seems inescapable that the dominance of handaxes is a behavioural organisational signal, reflecting a bias towards discard in the Southfleet Road vicinity following manufacture elsewhere.

Discussion and conclusions

The Southfleet Road site is important for several reasons. Firstly, *Palaeoloxodon* skeletons are rare in the British Pleistocene. The Southfleet Road specimen is only the fifth yet reported, after Upnor (Andrews, 1928), Selsey (Parfitt, 1998), Aveley (Stuart, 1982) and Deeping St. James (Langford, 1981). None of the four previous finds are reliably associated with evidence of human activity, although some flakes were reported in the vicinity of the Upnor and Selsey elephants. Furthermore, the Southfleet Road specimen is far older than the others, which are thought to date to MIS 7 (A. M. Lister, pers. comm.). There are, however, several mainland European finds from the Middle/Late Pleistocene of elephant skeletons associated with human activity, in particular from Ambrona and Torralba, Spain (Villa, 1990), Notarchirico, Italy (Piperno and Tagliacozzo, 2001), Aridos, Spain (Villa, 1990), Lehringen, Germany (von Adam, 1951) and Gröbern, Germany (Weber, 2000). With the possible exception of Torralba and Ambrona (Binford, 1987; Villa, 1990), these finds confirm that exploitation of elephant carcasses was an element of human adaptations of this time.

It remains to be considered, however, whether elephants were ever actively hunted or whether this exploitation was restricted to scavenging. Evidence from Boxgrove (Pitts and Roberts, 1997), Schöningen (Thieme, 1997) and Clacton (Wymer, 1985) establishes that wooden spears were made in the Middle Pleistocene and used for hunting large mammals. According to Haynes (1988) healthy adult elephants rarely become mired. At Southfleet Road, the sediments under the *Palaeoloxodon* remains were not disturbed, as one would expect if the elephant had been trapped in them. Consequently, it seems that miring played no part in its death. However, in the absence of an actual spear, as at Lehringen (von Adam, 1951) or of skeletal trauma reflecting spearing, as for a horse at Boxgrove (Pitts and Roberts, 1997), it is not possible to determine whether the Southfleet Road elephant was hunted or scavenged. The Lehringen find, although probably dating to the last interglacial, does, however, indicate that hunting an elephant with a wooden spear was feasible for Archaic humans, so the Southfleet Road elephant might well have been deliberately hunted.

Secondly, the archaeological sequence has implications for the debate over the Clactonian. As at Barnfield Pit, there are lower levels exclusively containing flakes, cores and flake tools, underlying levels rich in handaxes. It has been suggested that the absence of handaxes at certain horizons at some MIS 11 sites does not reflect a non-handaxe cultural tradition—the Clactonian—but merely reflects the differential distribution across the landscape of different knapping practices by humans with a varied technological repertoire (McNabb and Ashton, 1992, 1995; Ashton *et al.*, 1994). This interpretation has, however, been rejected by many British Palaeolithic archaeologists (Wenban-Smith, 1995b and 1998; Wymer, 1998; Roe, 1996; White, 2000; Pope, 2002; M. B. Roberts, pers. comm.).

There are several key factors in this rejection:

1. there is no unequivocal evidence of handaxe manufacture in the prolific, primary context Clactonian horizons at Barnfield Pit (Lower Loam), Clacton and Barnham (Area I);
2. there is no unequivocal evidence of handaxe manufacture amongst the thousands of artefacts that accumulated in the fluvial Lower Gravel at Swanscombe. A reasonable proportion of debitage from handaxe manufacture would be recognisable as such, between 5% and 20%, depending upon the size and shape of handaxe (Wenban-Smith, 1996; Wenban-Smith *et al.*, 2000). Even allowing for fluvial winnowing (Ashton *et al.*, 2005), one would expect a fluvial deposit such as the Lower Gravel to contain *some* evidence of handaxe manufacture if any was taking place in the contemporary landscape;
3. investigations at Barnham (Wenban-Smith and Ashton, 1998) have shown that the raw material available to the knappers at the main Barnham Area I Clactonian horizon (the cobble layer) was perfectly suitable for handaxe manufacture. Furthermore, work at Red Barns (Wenban-Smith *et al.*, 2000) has shown that the poor quality frost-fractured raw material at Red Barns was nonetheless used for a handaxe-dominated industry, even in an area of Chalk bedrock where fresher flint nodules were probably abundant nearby. These observations reduce the impact of raw material availability/quality as an explanation for why handaxe-manufacturing humans should choose not to do so in certain places.

The discovery of a new site with a dated sequence of technological change duplicating that from Barnfield Pit, adds to the evidence supporting the Clactonian as a genuine industrial tradition in southeast England in the Hoxnian. The presence of artefactual evidence in units 1 (if confirmed) and 2 also provides important evidence for earlier occupation in the late Anglian and early Hoxnian.

Finally, the evidence from the site has great potential for the investigation of early human behaviour. It is already clear that, whether hunted or scavenged, the carcass of an adult elephant was being exploited. Further work, particularly artefact refitting, will shed light on any intra-site structural or behavioural patterns. Additional palaeontological analyses should also refine details of the palaeoenvironment, site formation processes and provide further evidence of its age. One important aspect of this work will be to explore more detailed correlation with specific horizons at key comparative sites in the region such as Barnfield Pit, Clacton, Hoxne, Barnham and Beeches Pit, as well as with sites on the adjacent continent.

Acknowledgements Excavation was carried out in conjunction with Oxford Archaeology Ltd, and thanks are due to all staff who worked on the project, particularly Richard Brown and Darko Maricevic. Work at the site was supported by London and Continental Railways, alongside a steering committee involving English Heritage, Kent County Council and Rail Link Engineering. We are grateful for the contributions of Helen Glass, Jay Carver, Mark Roberts, Peter Kendall and Lis Dyson, and for their support of the project following the initial discovery. We are also grateful for the considerable help provided by the engineers and other contractors on site, despite the inconvenience caused to the construction programme, particularly Jon Gold, section engineer for Rail Link Engineering. Many specialists have been involved with fieldwork or have given advice, in particular John Hutchinson, Jean-Luc Schwenninger, Gilbert Marshall, Adrian Lister and Robert Symmons (Ancient Human Occupation of Britain project, supported by the

Leverhulme Trust). We also thank Silvia Bello (AHOB) for her work on the figures. Thanks are also due to Nick Ashton, David Bridgland and an anonymous reviewer for helpful comments on the initial draft. Finally, although sadly he was never a visitor to the site, thanks are offered to John Wymer, in whose honour this volume is presented, for a lifetime of inspirational Palaeolithic research, and much convivial company and debate.

References

Adam KD von. 1951. Der Waldelefant von Lehringen, eine Jagdbeute des diluvialen Menschen. *Quartar* **5**: 79–92.

Andrews CW. 1928. *On a Specimen of* Elephas antiquus *from Upnor*. British Museum (Natural History): London.

Ashton NM, Cook J, Lewis SG, Rose J (eds). 1992. *High Lodge: Excavations by G. de G. Sieveking 1962–68 and J. Cook 1988*. British Museum Press: London.

Ashton NM, McNabb J, Irving B, Lewis SG, Parfitt SA. 1994. Contemporaneity of Clactonian and Acheulian flint industries at Barnham, Suffolk. *Antiquity* **68**: 585–589.

Ashton NM, Lewis SG, Parfitt SA (eds). 1998. *Excavations at Barnham 1989–1994*. British Museum Occasional Paper 125. British Museum Press: London.

Ashton NM, Lewis S, Parfitt S, Candy C, Keen D, Kemp R, Penkman KEH, Thomas G, Whittaker J, White M. 2005. Excavations at the Lower Palaeolithic site at Elveden, Suffolk, UK. *Proceedings of the Prehistoric Society* **71**: 1–61.

Binford LR. 1987. Were there elephant hunters at Torralba? In *The Evolution of Human Hunting*, Nitecki MH, Nitecki DV (eds). Plenum Press: New York; 47–105.

Bridgland DR. 1994. *Quaternary of the Thames*. Chapman and Hall: London.

British Geological Survey. 1998. *Dartford: England and Wales Sheet 271, Solid and Drift geology, 1:50,000*. British Geological Survey: Keyworth, Nottingham.

Burchell JPT. 1957. A temperate bed of the last interglacial period at Northfleet, Kent. *Geological Magazine* **94**: 212–214.

Carreck JN. 1972. *Chronology of the Quaternary deposits of south-east England, with special reference to their vertebrate faunas*. M. Phil thesis, University of London.

Conway BW, McNabb J, Ashton N (eds). 1996. *Excavations at Barnfield Pit, Swanscombe, 1968–72*. British Museum Occasional Paper 94. British Museum Press: London.

Green CP, Branch NP, Coope GR, Field MH, Keen DH, Wells JM, Schwenninger J-L, Preece RC, Schreve DC, Canti MG, Gleed-Owen CP. 2006. Marine Isotope Stage 9 environments of fluvial deposits at Hackney, north London, UK. *Quaternary Science Reviews* **25**: 89–113.

Havinga AJ. 1985. A 20-year experimental investigation into the differential corrosion susceptibility of pollen and spores in various soil types. *Pollen et Spores* **26**: 541–558.

Haynes G. 1988. Longitudinal studies of African elephant death and bone deposits. *Journal of Archaeological Science* **15**: 131–157.

Kerney MP. 1971. Interglacial deposits at Barnfield Pit, Swanscombe, and their molluscan fauna. *Journal of the Geological Society of London* **127**: 69–93.

Kerney MP, Sieveking G de G. 1977. Northfleet. In *South East England and the Thames Valley*, Shephard-Thorn ER, Wymer JJ (eds). X INQUA Congress Excursion Guide A5. Geo Abstracts: Norwich; 44–49.

Langford H. 1981. Discovery of straight-tusked elephant bones near Peterborough. *Quaternary Newsletter* **81**: 25.

McNabb J, Ashton NM. 1992. The cutting edge: bifaces in the Clactonian. *Lithics* **13**: 4–10.

McNabb J, Ashton NM. 1995. Thoughtful flakers. *Cambridge Archaeological Journal* **5**: 289–298.

Mitchell-Jones AJ, Amori G, Bogdanowicz W, Kryštufek B, Reijnders PJH, Spitzenberger F, Stubbe M, Thissen JBM, Vohralík V, Zima J. 1999. *The Atlas of European Mammals*. Poyser Natural History: London.

Parfitt SA. 1998. Pleistocene vertebrate faunas of the West Sussex coastal plain: their stratigraphic and palaeoenvironmental significance. In *The Quaternary of Kent and Sussex: Field Guide*, Murton JB, Whiteman CA, Bates MR, Bridgland DR, Long AJ, Roberts MB, Waller MP (eds). Quaternary Research Association: London; 121–135.

Parfitt SA, Barendregt RW, Breda M, Candy I, Collins MJ, Coope GR, Durbidge P, Field MH, Lee JR, Lister AM, Mutch R, Penkman KEH, Preece RC, Rose J, Stringer CB, Symmons R, Whittaker JE, Wymer JJ, Stuart AJ. 2005. The earliest record of human activity in northern Europe. *Nature* **438**: 1008–1012.

Piperno M, Tagliacozzo A. 2001. The elephant butchery area at the Middle Pleistocene site of Notarchirico (Venosa, Basilicata, Italy). In *The World of Elephants*, Cavarretta G, Gioia P, Mussi M, Palombo MR (eds). Consiglio Nazionale delle Ricerche: Rome; 230–236.

Pitts M, Roberts MB. 1997. *Fairweather Eden: Life in Britain Half a Million Years Ago as Revealed by the Excavations at Boxgrove*. Century: London.

Pope MI. 2002. *The significance of biface-rich assemblages: an examination of the behavioural controls on lithic assemblage formation in the Lower Palaeolithic*. Ph.D. thesis, Department of Archaeology, University of Southampton.

Roberts MB, Parfitt SA (eds). 1999. *Boxgrove: A Middle Pleistocene Hominid Site*. English Heritage: London.

Roe DA. 1964. The British Lower and Middle Palaeolithic: some problems, methods of study and preliminary results. *Proceedings of the Prehistoric Society* **30**: 245–267.

Roe DA. 1968. British Lower and Middle Palaeolithic handaxe groups. *Proceedings of the Prehistoric Society* **34**: 1–82.

Roe DA. 1981. *The Lower and Middle Palaeolithic Periods in Britain*. Routledge & Kegan Paul: London.

Roe DA. 1996. The start of the British Palaeolithic: some old and new thoughts and speculations. *Lithics* **16**: 17–26.

Schreve DC, Bridgland DR, Allen P, Blackford JJ, Gleed-Owen CP, Griffiths HI, Keen DH, White MJ. 2002. Sedimentology, palaeontology and archaeology of late Middle Pleistocene River Thames terrace deposits at Purfleet, Essex, UK. *Quaternary Science Reviews* **21**: 1423–1464.

Singer R, Gladfelter BG, Wymer JJ (eds). 1993. *The Lower Palaeolithic site at Hoxne, England*. The University of Chicago Press: London.

Smith RA. 1911. A Palaeolithic industry at Northfleet, Kent. *Archaeologia* **62**: 515–532.

Smith RA, Dewey H. 1913. Stratification at Swanscombe: report on excavations made on behalf of the British Museum and H.M. *Geological Survey. Archaeologia* **64**: 177–204.

Stuart AJ. 1982. *Pleistocene Vertebrates in the British Isles*. Longman: London.

Sutcliffe AJ. 1964. The mammalian fauna. In *The Swanscombe Skull: a Survey of Research on a Pleistocene Site*, Ovey, C (ed.). Occasional Paper No. 20. Royal Anthropological Institute: London; 85–111.

Thieme H. 1997. Lower Palaeolithic hunting spears from Germany. *Nature* **385**: 807–810.

Turner C. 1970. The Middle Pleistocene deposits at Marks Tey, Essex. *Philosophical Transactions of the Royal Society, Series B* **257**: 373–437.

Villa P. 1990. Torralba and Aridos: elephant exploitation in Middle Pleistocene Spain. *Journal of Human Evolution* **19**: 299–309.

Weber T. 2000. The Eemian *Elephas antiquus* finds with artefacts from Lehringen and Gröbern: are they really killing sites? *Anthropologie et Préhistoire* **111**: 177–185.

Wenban-Smith FF. 1995a. The Ebbsfleet Valley, Northfleet (Baker's Hole). In *The Quaternary of the Lower Reaches of the Thames: Field Guide*, Bridgland DR, Allen P, Haggart BA (eds). Quaternary Research Association: Durham; 147–164.

Wenban-Smith FF. 1995b. Another one bites the dust. *Lithics* **16**: 99–108.

Wenban-Smith FF. 1996. *The Palaeolithic archaeology of Baker's Hole: a case study for focus in lithic analysis*. Ph.D. thesis, Department of Archaeology, University of Southampton.
Wenban-Smith FF. 1998. Clactonian and Acheulian industries in Britain: their chronology and significance reconsidered. In *Stone Age Archaeology: Essays in Honour of John Wymer*, Ashton N, Healy F, Pettitt P (eds). Oxbow Books: Oxford; 90–97.
Wenban-Smith FF. 2002. *Eastern Quarry, Swanscombe: Preliminary Palaeolithic/Pleistocene Field Evaluation Report.* Unpublished client report for CGMS Consulting submitted to Kent County Council.
Wenban-Smith FF, Ashton N. 1998. Raw material and lithic technology. In *Excavations at the Lower Palaeolithic Site at East Farm, Barnham, Suffolk 1989–94*, Ashton N, Lewis SG, Parfitt SA (eds). British Museum Occasional Paper 125. British Museum Press: London; 237–244.
Wenban-Smith FF, Bridgland DR. 2001. Palaeolithic archaeology at the Swan Valley Community School, Swanscombe, Kent. *Proceedings of the Prehistoric Society* **67**: 219–259.
Wenban-Smith FF, Gamble CS, ApSimon AM. 2000. The Lower Palaeolithic site at Red Barns, Portchester, Hampshire: bifacial technology, raw material quality and the organisation of Archaic behaviour. *Proceedings of the Prehistoric Society* **66**: 209–255.
West RG. 1956. The Quaternary deposits at Hoxne, Suffolk. *Philosophical Transactions of the Royal Society of London, Series B* **239**: 265–356.
White MJ. 2000. The Clactonian question: on the interpretation of core-and-flake assemblages in the British Lower Palaeolithic. *Journal of World Prehistory* **14**: 1–63.
Wymer JJ. 1968. *Lower Palaeolithic Archaeology in Britain as Represented by the Thames Valley*. John Baker: London.
Wymer JJ. 1974. Clactonian and Acheulian industries in Britain—their chronology and significance. *Proceedings of the Geologists' Association* **85**: 391–421.
Wymer JJ. 1985. *Palaeolithic Sites of East Anglia*. Geo Books: Norwich.
Wymer JJ. 1998. Review of 'Excavations at Barnfield Pit, Swanscombe, 1968–1972'. *Journal of Quaternary Science* **13**: 179–181.

