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Pleistocene environments, climate, and human activity in Britain during Marine Isotope Stage 7: insights from Oak Tree Fields, Cerney Wick, Gloucestershire

JOSHUA T. HOGUE,[1,2]* KEITH N. WILKINSON,[2,3] ENID ALLISON,[4] THOMAS HILL,[5] MONIKA V. KNUL,[2,3] MATTHEW LAW,[6] MARTA PEREZ-FERNANDEZ,[7] HANNAH RUSS,[8] DANIELLE SCHREVE,[7] JENNIFER E. SHERRIFF,[9] PHILIP TOMS,[10] DANIEL YOUNG,[11] LISA WESTCOTT-WILKINS[1] and BRENDON WILKINS[1]

[1]DigVentures Ltd, 5 Witham Studios, Hall Street, Barnard Castle, DL12 8JB, UK
[2]ARCA geoarchaeology, University of Winchester, Winchester, SO22 4NR, UK
[3]Department of History and Archaeology, University of Winchester, Winchester, SO22 4NR, UK
[4]Canterbury Archaeological Trust Ltd, 92a Broad Street, Canterbury, Kent, CT1 2LU, UK
[5]Department of Earth Sciences, Natural History Museum, Cromwell Road, London, SW7 5BD, UK
[6]Museum of London Archaeology, Unit 11, M11 Business Link, Stansted, Essex, CM24 8GF, UK
[7]Department of Geography, Royal Holloway, University of London, Egham, Surrey, TW20 0EX, UK
[8]Archaeology.bizz Ltd, 24d Quaker Yard, Barnard Castle, DL12 8NG
[9]Department of Geography, King's College London, Bush House, 30 Aldwych, London, WC2B 4BG, UK
[10]School of Natural and Social Sciences, University of Gloucestershire, Swindon Road, Cheltenham, Gloucestershire, GL50 4AZ, UK
[11]Wessex Archaeology, Portway House, Old Sarum Park, Salisbury, SP4 6EB, UK

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ABSTRACT: Investigations at Oak Tree Fields, Cerney Wick, Gloucestershire, in western England have revealed a sequence of fluvial deposits dating from Marine Oxygen Isotope Stage (MIS) 7 to 5. At the base of the sequence, a series of gravel and sand facies were deposited, initially as part of a meandering river. Reductions in flow energy of the latter and avulsion led to the development of short-lived channels and episodic backwater environments, the deposits of which are recorded as Facies Associations 1–3. Poorly sorted, probably colluvial deposits formed beyond the limit of the channel (Facies Association 4). Mollusca, Coleoptera, plant macrofossils, pollen and vertebrates recovered from the channel facies indicate broadly similar climatic conditions throughout accretion. Temperature ranges derived from mutual climatic range analysis of the Coleoptera almost completely overlap with those of Cerney Wick at the present day, albeit that winters may have been cooler when the channel was active. Further, the floral and faunal data suggest that the meandering river flowed through an open grassland environment, the latter heavily grazed by large vertebrates, most notably mammoth. Most of the botanical and faunal remains, together with four optically stimulated luminescence (OSL) age estimates ranging from 225 ± 23 to 187 ± 19 ka, suggest correlation of the channel deposits with MIS 7. The basal deposits (Facies Association 1) yielded the majority of vertebrate remains and all the lithic artefacts, most of which seem likely to have travelled only a short distance. Although only a few artefacts were recovered, they add to the relatively limited evidence of human activity from the upper Thames. The channel deposits are overlain by sheet gravels (Facies Association 5) which are attributed to the Northmoor Member of the Upper Thames Formation. These were likely to have been deposited as bedload in a braided stream environment, while two OSL age estimates of 129 ± 14 and 112 ± 11 ka suggest accumulation during MIS 5.

KEYWORDS: Early Middle Palaeolithic; handaxe; mammoth; Middle Pleistocene; River Thames

Introduction

The Thames is the second longest river in Britain, stretching 337 km from its headwaters near Cirencester (Gloucestershire) to its confluence with the Medway and entrance to the Channel seaway at Sheerness (Kent) (Fig. 1). Despite its length, studies of the Pleistocene geology of the river are unevenly distributed and the lower reaches (defined as those east of Teddington in west London) have received the most attention (e.g. Bridgland 1994, Bridgland et al. 1995, 2014, Gibbard 1994). The middle (the stretch between Goring and Teddington [Gibbard 1985]) and eastern part (i.e. Oxford–Goring) of the upper Thames, have also been intensively studied (e.g. Gibbard 1985, Bridgland 1994), but the reach west of Oxford has been much less frequently examined. The reasons are primarily economic, i.e. the middle and lower Thames have seen greater development than the upper Thames, meaning more aggregate quarries and therefore exposures. Furthermore, the geomorphology has also been an important motivator given that altitudinally discrete staircases of fluvial terraces are found east of Oxford, but are much more poorly developed west of that city. In a previous paradigm where chronometric dating of Pleistocene sequences was either not possible or logistically and financially difficult, the possibilities for age control offered by varied terrace

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*Correspondence: Joshua T. Hogue, as above.
Email: mail@joshuathogue.com

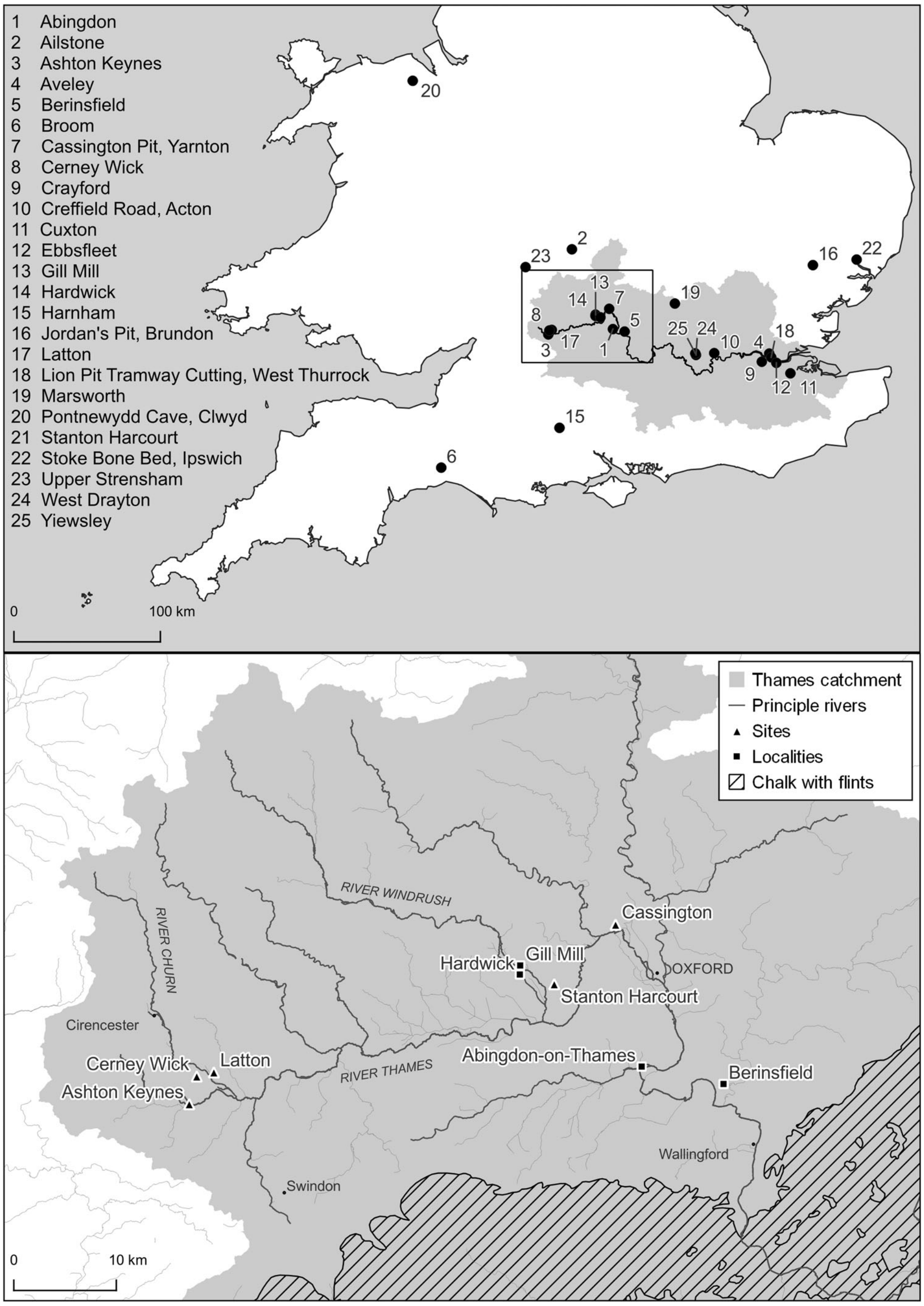

Figure 1. (a) The Thames basin in southern Britain and localities mentioned in text, (b) detailed representation of the upper Thames.

heights above the present channel were an advantage (e.g. Bridgland 1994, 2000, Westaway et al. 2002, Bridgland and White 2014).

The same investigation bias is also true of Palaeolithic archaeological studies. For example, the 212 km combined reach of the lower and middle Thames is represented by 905 Palaeolithic sites recorded on the English Rivers Palaeolithic Survey, but the 125 km course of the upper Thames has only 75 (Wymer 1999). Most of the known sites and associated collections were first recognised and amassed by antiquarians during industrialisation of the late 19th century and early 20th century. Not only was quarrying still carried out manually at this time, but the relative abundance of high-quality flint in the local geology of these regions provided ample opportunities for the creation of prototypical artefacts and consequently more easily recognisable artefacts (Harris et al. 2019).

Although barely exploited in the 19th or early 20th century and therefore largely unexplored by antiquarians, the Thames floodplain west of Oxford has seen intensive sand and gravel quarrying over the last 30 years. As a result, quarries in both the Northmoor–Stanton Harcourt–Standlake area and the Cotswold Water Park (CWP) (10 km and 46 km west of Oxford respectively) (Fig. 1), have been shown to contain fossiliferous and artefact-bearing deposits of late Middle Pleistocene age. This contribution describes investigations of the most recently worked-out quarry in the CWP, namely Oak Tree Field near the village of Cerney Wick in Gloucestershire (51.6642 N, 1.9088 W). Our aims are (a) to determine the formation processes that have resulted in the Pleistocene stratigraphic sequence found in the CWP, (b) reconstruct the environment and climate in which the Middle Pleistocene deposits were laid down, and (c) to consider the wider ramifications of the results for the Marine Isotope Stage (MIS) 7 record of Britain.

Background

The CWP is a 14 km^2 area of current and former sand and gravel extraction quarries between the towns of Cirencester and Swindon, while the area is also 5 km east of the source of the River Thames at Kemble (Fig. 1). Lakes infilling the former quarries are either maintained for water sports or left for wildlife, while over 500 000 people visit the CWP each year (Cotswold Waterpark 2022). Aggregate extraction has been focussed in the area that is now the CWP because of the considerable spreads (47 km^2) of Northmoor Member (*sensu* Gibbard 1999) sands and gravels between Poole Keynes and Kempsford (British Geological Survey 1998). The CWP area is relatively flat at the present day, varying in elevation between +89 m (in the west) and +82 m Ordnance Datum (OD) (east), but geotechnical surveys carried out prior to sand and gravel extraction, including at Oak Tree Field, demonstrate an undulating pre-Northmoor Member topography. Indeed, on the latter site, rockhead varies between +83.5 and +80.0 m OD, compared with a near constant surface elevation of +84 m OD at the present day. The CWP is bordered on its north, west and south by the Cotswold hills, an escarpment rising to +330 m OD at Cleeve Hill, 27 km to the north, and largely comprising limestones of Middle Jurassic age. These latter are the bedrock source for the Northmoor Member. However, the bedrock changes from limestones to mudstone lithologies of the Middle Jurassic Kellaways Clay Formation and the Middle–Upper Jurassic Oxford Clay Formation at the northern and western boundaries of the CWP.

The Northmoor Member is defined by Gibbard (1999) as comprising sands and gravels underlying the present Thames floodplain and is equated with both the Kempton Park and Shepperton Members (or formations following Bridgland's [1994] nomenclature of the Middle Thames). Although originally dated by ^{14}C of interbedded organic strata to MIS 3–2 (e.g. Briggs et al. 1985), luminescence measurements at Cassington and Ashton Keynes now suggest that the main body of the Northmoor Member accreted between MIS 5d and MIS 3, albeit that cut-and-fill episodes dating to MIS 2 are also known from some locations (Maddy et al. 1998; Lewis et al. 2001, 2006). Pleistocene fluvial strata have also been found beneath the Northmoor Member, 1.7 km northeast of Oak Tree Field at Latton (Fig. 1) and comprise 0.4 m thick gravel and bedded sand fills of a palaeochannel cut into the Kellaways Clay Formation (Lewis et al. 2006). The sands were fossiliferous and c. 200 vertebrate bones, mostly of mammoth, but including some specimens of horse, were collected during and after quarry operations. Several Palaeolithic handaxes and rich Coleoptera, molluscan and plant macrofossil assemblages were also recovered, while the biostratigraphy and U-series dating suggests an MIS 7 age for the channel deposits (Lewis et al. 2006).

In early 2017, the potential significance of Oak Tree Field, Cerney Wick, was brought to the attention of the scientific community by the discovery of a handaxe and vertebrate remains by two local enthusiasts (Neville and Sally Hollingworth). However, while the site had previously been the subject of limited archaeological investigation prior to aggregate extraction (Ford 2004), there had been no previous indication of its Pleistocene research potential. As a result of the Hollingworths' discoveries, DigVentures Ltd were granted funding by Historic England (the national cultural heritage agency) for an emergency investigation. Work commenced in 2019 and comprised an examination of the handaxe and vertebrate assemblage collected by the Hollingworths, together with a limited programme of fieldwork. The aim of the latter was to characterise the surviving deposits and provide an outline dating framework to help contextualise the previous discoveries. In 2021, further fieldwork was undertaken, this time with financial support provided by the National Lottery Heritage Fund, to refine the 2019 stratigraphic model and recover archaeological and palaeontological remains in a more controlled manner than previously possible.

Methods

Field

Initial fieldwork took place in April 2019 and comprised a walkover survey to record (using an RTK GPS) the position of vertebrate fossils left at the base of the quarry following completion of sand and gravel extraction. At the same time a 20 m grid was laid out and either boreholes or 0.3 × 0.3 m 'shovel' pit holes were drilled/dug down to rockhead on the nodes (Fig. 2b). This approach enabled the thickness and the nature of the remaining Pleistocene sediment stack to be determined. In May and June 2019, five section faces in two informal trenches (T1 and T2) previously excavated by the Hollingworths were cleaned using hand tools. A 3.6 × 2.3 m area was also excavated by hand to recover vertebrate remains from the base of one trench (T1), while a third trench (T3) was hand dug at a location where a borehole suggested survival of the greatest thickness of Pleistocene sediment (Fig. 2c). The cleaned sections from all trenches were photographed in detail. Next, the strata exposed in both the trench sections and the walls of the quarry (the latter exposing deposits of the Northmoor Member) were assigned unique lithostratigraphic unit (LU) identifiers and described using standard geological criteria (Jones et al. 1999, Munsell 2000, Tucker 2011). The trench sections were then 'drawn' by placing coloured pins at 0.05–0.10 m intervals along lithostratigraphic unit contacts and measuring the location of each pin with a Leica MS50 robotic total station. The same approach was also employed on the quarry walls, albeit that pins were placed at a 0.2–0.5 m spacing along contacts. The position of vertebrate finds made while cleaning and drawing sections was also recorded using the total station and each specimen allocated a unique identifying number.

Thirty-six samples, each of 10–40 L volume, were taken for 'general biological analysis' (GBA) purposes (*sensu* Dobney et al. 1992) by cutting out sediment blocks measuring 0.3 m (length across the section) by 0.3 m (depth into the section face) by 0.02–0.10 m (thickness depending on the stratum properties) in columns excavated into sections exposed in T1, T2 and T3. Samples for luminescence dating ($n = 7$) were taken from all three trenches and two of the quarry walls by hammering 0.05 m (diameter) by 0.20 m (length) plastic tubes (two per sample) into the sections, and then sealing both tube ends following removal. Bulk gravel samples ($n = 5$) for clast lithological analysis were also collected from two of the quarry walls by sieving to remove the <8 mm fraction and collecting 10 L of the coarser residue.

Further fieldwork took place in August 2021, when a 13 tonne tracked mechanical excavator was used to link the stratigraphy in T1 with T2 and T2 with T3. The same machine was also used to clear backfill from a further informal test pit dug in 2017 (T4) and connect it with T3 (Fig. 2). Additionally, a 4 × 2 m area was excavated by hand immediately to the north of T1. All excavated sediment from the latter was wet-sieved through a 6 mm mesh for the recovery of artefacts that might have otherwise been missed. Sections created by the mechanical excavator and by hand excavation were cleaned, photographed and recorded as previously described (Fig. 3).

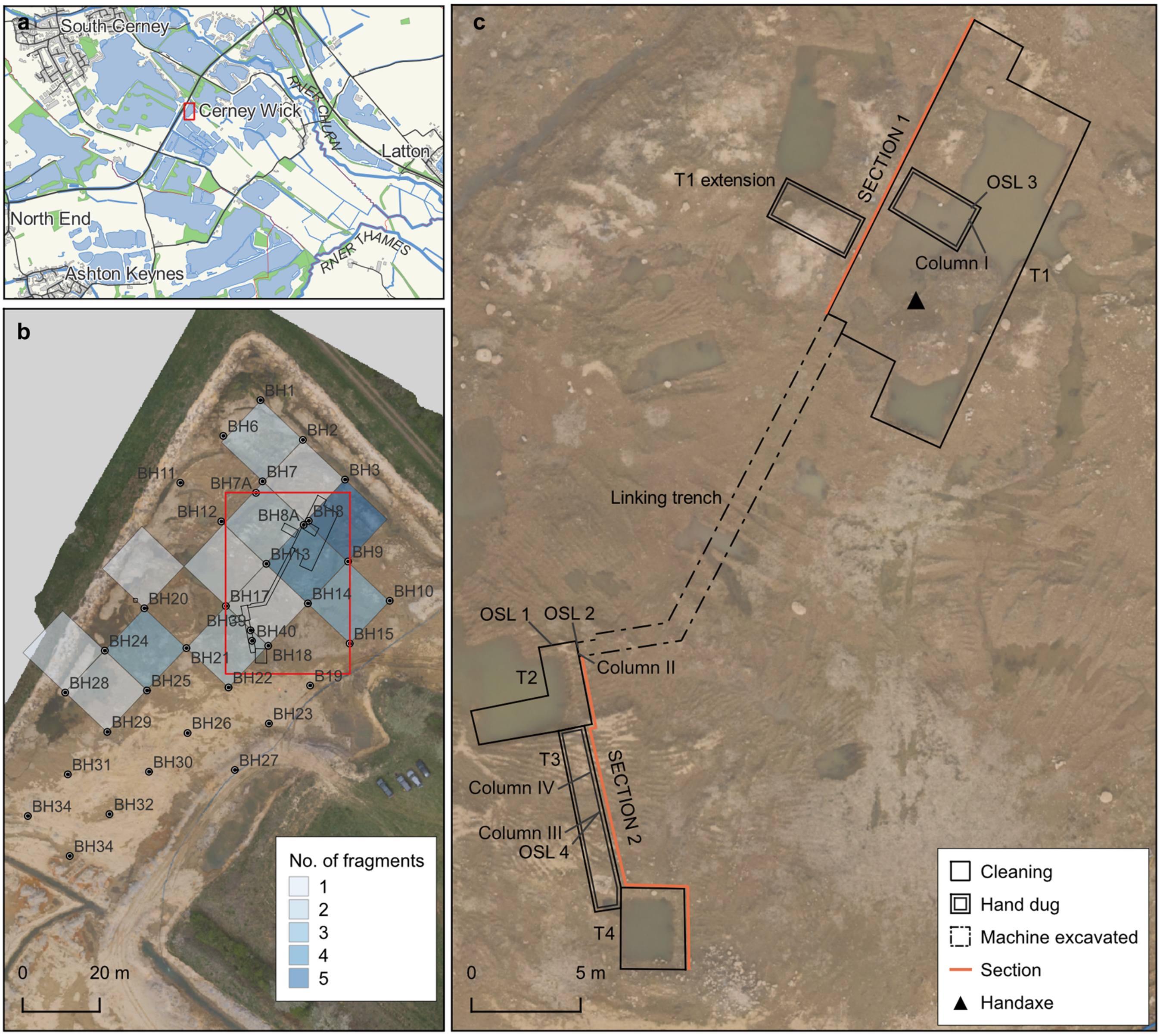

Figure 2. (a) Location of Oak Tree Field, (b) overview of borehole locations and density of vertebrates collected from the surface, and (c) location of trenches, GBA columns and OSL dates. [Color figure can be viewed at wileyonlinelibrary.com]

Laboratory

Clast lithology: Clast lithology was determined on the dried 11.2–16.0 mm fraction of the bulk samples taken from the quarry walls and selected GBA samples.

Optically stimulated luminescence: Full methodological details are provided in the supplementary material. Optical luminescence of six of the seven samples was measured.

Mollusca: Nine 5 L sub-samples extracted from the GBA samples were wet-sieved through a 0.5 mm mesh, the residue dried and then examined under a low-power microscope. Counts were made on the basis of intact shells and fragmentary non-repeating elements (e.g. shell apex or body whorl with mouth), with the minimum number of bivalve taxa taken as the highest number of left or right valves. Nomenclature follows Anderson and Rowson (2020).

Coleoptera: Five litre sub-samples from of the GBA samples were gently wet-sieved through a 0.3 mm mesh and the resulting residues examined either in their entirety, where the amount of organic material was very small, or further processed by paraffin flotation (Kenward et al. 1980). Insect fossils and other invertebrate remains from the residues and flots were identified using a 10–45× stereoscopic microscope. Minimum numbers of adult beetles and bugs were estimated from the major sclerites. Abundance of all other groups of insects was recorded semi-quantitatively on a four-point scale (+ 1–3; ++ 4–10; +++ 11–25; ++++ 25–99 individuals). Other invertebrates were simply noted as present, common or abundant. Nomenclature follows that of Duff (2018).

Plant macrofossils: Sixteen sub-samples from the GBA columns were wet-sieved through 125 μm, 300 μm and 1 mm mesh sieves before being systematically scanned using low-powered microscopy, with plant macrofossil remains picked and sorted into different categories based on their morphological characteristics. Identifications of waterlogged seeds were made using modern comparative reference collections and standard seed atlases, including Martin and Barkley (2000), NIAB (2004) and Cappers et al. (2006). Nomenclature follows Stace (2010).

Pollen: Ten sub-samples of 4 mL volume from sections in T1, T2 and T3 were studied for their palynological content. Pollen preparation followed standard techniques including potassium hydroxide (KOH) digestion, hydrofluoric acid (HF) treatment and acetylation (Moore et al., 1991). However, preservation was poor and none of the samples had

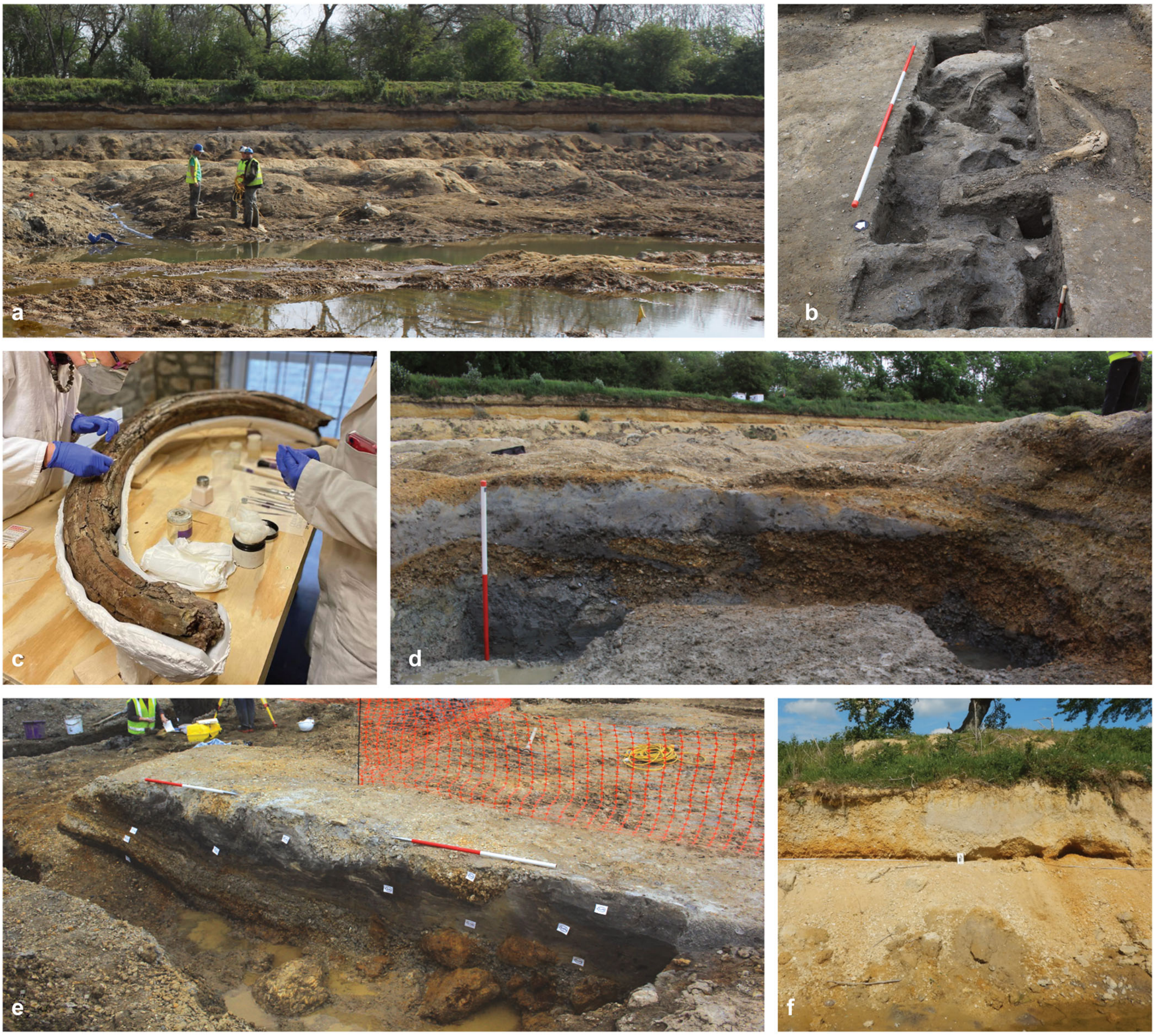

Figure 3. (a) General site overview immediately following dewatering, (b) Facies Association 1 with *in situ* tusk of *Mammuthus* sp. at base of Trench 1, (c) subsequently excavated tusk during conservation, (d) Facies Association 2 in Trench 2, (e) Facies Association 3 in Trench 3, and (f) Northmoor Member (Facies Association 5) in quarry wall. [Color figure can be viewed at wileyonlinelibrary.com]

sufficient pollen to enable useful palaeoenvironmental reconstruction. The abundance and excellent preservation of Jurassic palynomorphs from the surrounding bedrock further hindered study.

Microvertebrates: Nine sub-samples of the GBA samples, each equivalent to 10–20 L unprocessed sediment, were weighed, washed through a 0.5 mm mesh and dried, before being scanned under a low-power binocular microscope.

Vertebrates: Two collections of large vertebrate remains were recovered from Oak Tree Fields. Assemblage A was recovered in 2019 and 2021, mostly during archaeological excavation, but also during a survey of the quarry floor. Assemblage B was collected by the Hollingworths during visits to the quarry on completion of aggregate extraction in 2017. Vertebrate fossils from both assemblages were studied according to published standards and guidelines (Baker and Worley 2019). Following initial identification of species and element, fragmentation was assessed on the basis of the diagnostic zone method (Dobney and Rielly 1988). It should be noted that further vertebrate specimens were recovered from Oak Tree Fields by other private collectors who regularly visited during quarrying, but these fossils were not available for study.

Lithics: The lithic artefacts recovered from the 2021 excavations were recorded using standard typo-technological methods for describing Early Middle Palaeolithic assemblages in Britain (Scott 2006, 2011; and references within). The handaxe recovered by the Hollingworths was described according to standard criteria for Lower Palaeolithic technology (Davis 2013, modified after Ashton 1998, Wymer 1968, Roe 1968).

Results

Lithostratigraphy

In common with the approach taken by Lewis et al. (2001, 2006) for the nearby Latton and Ashton Keynes sites, the lithostratigraphic sequences exposed in the Oak Tree Field quarry have been divided into facies associations, five of which are recognised (Table 1). Facies associations are defined as a group of genetically related facies (Maddy et al. 1998) and are separated by third-order or higher bounding surfaces (*sensu* Miall 1996: 81–89), these latter representing unconformities.

Facies Association 1

T1 contains a shallow (<0.70 m) outcrop of Facies Association (FA) 1. The latter is overlain and separated from overlying FA5 by a sixth order bounding surface in the western part of the trench (the upper contact of FA1 had been removed during aggregate extraction in the eastern part). FA1 is composed of moderately to poorly sorted, matrix- and clast-supported gravel sheets and fills of scour hollows developing in the lee (west) of boulder-sized septarian nodules. The latter are sometimes associated with mammoth tusks and less frequently with other skeletal elements. Tusks rest on the west (upstream) side of the nodules, while non-tusk elements are similarly located, but also occasionally found unassociated with septarian nodules and towards the base of the sand and gravel strata. The scour hollows are cut into the underlying Oxford Clay, while the sand and gravel sheets lie horizontally on the bedrock. A thick (0.58 m) wedge of bedded shell-rich medium sand (LU 31006) was also found interbedded within the gravels and was the subject of the 2021 controlled excavation. Clast lithological analysis of FA1 has only been undertaken of a single sample, but this demonstrates that the majority of clasts are of rounded and sub-rounded limestone, while grey, Oxford Clay-derived mudstone clasts make up a small proportion of the total (Table 2). These last are relatively fragile and can only have survived as bedload if they had been moved a short distance. However, the limestone lithologies are derived from Jurassic rocks, of which the majority (crystalline and oolitic limestone) are from Cornbrash Formation, Forest Marble Formation and Athelstan Oolite Formation sources, all of which outcrop >3 km west of the site (Table 2) (British Geological Survey 2019a).

Facies Association 2

FA2 is found as a c. 1 m thick sequence overlying Oxford Clay in T2 and is separated from FA1 to the north by a bedrock outcrop. As a result, it is presently unclear whether the two facies associations are lateral equivalents or one is earlier than the other (Fig. 4). A fourth order bounding plane separates FA2 from the overlying FA3 and is identified as an unconformity at the top of LU 31065. The basal facies of FA2 are massive shell-rich muds (LU 31059) with similar morphological characteristics to the Oxford Clay. The muds are overlain by horizontally bedded sheets of fine, matrix- and clast-supported gravel (LU 31061 and 31063), the latter including imbricated clasts indicating a south-southwest to north-northeast flow. Lenticular shell-rich beds of silts to medium sands (LU 31060 and 31062) are also found onlapping the gravel strata and in the lee of septarian nodules. A further wedge of massive muds (LU 31064), again with characteristics similar to the Oxford Clay, forms a thick lenticular bed towards the top of the gravels.

Facies Association 3

FA3 outcrops in T3 and overlies FA2 as described above, but also has a fifth order lower bounding surface with FA4 in the eastern part of the trench. FA3 comprises thin (<0.2 m) sheets of matrix- and clast-supported pebble gravels (LU 31067, 31068 and 31092), 0.1–0.4 m thick beds of horizontally laid fine sands and silts (LU 31069, 31070 and 21074) and a c.

Table 1. Facies associations recorded at Oak Tree Fields, Cerney Wick

Facies association	Facies	Component units	Lower boundary surface	Geometry/description	Interpretation	Planform
5	Gmm, Gcm, Gmg, Gh, Sm	31010, 31035, 31076. 31097, 31101, Quarry walls	(5) planar and erosional to FA1	Laterally persistent planar-bedded matrix and clast-supported gravels, and lenticular beds of massive sands	In channel (longitudinal) bars, slough channel fills	Braided
4	Gmm	31093, 31095, 31096	(8) planar and erosional to bedrock	Massive matrix-supported coarse gravels	Debris flow	(Colluvium)
3	Gmg, Sh, Fl, Fsm, Fr	31066–31075, 31092, 31098	(4) Planar and conformable to FA2 (5) Planar and erosional to FA4	Laterally impersistent thin sheets of planar-bedded fine gravels, sands, muds or organic muds	In channel (point) bars, abandoned channel fills, overbank	Meandering
2	Gmm, Gcm, Gh, Sh, Fm	31058–31065	(8) planar and erosional to bedrock	Laterally impersistent sheets of planar-bedded matrix- and clast-supported gravels, sands and muds	In channel (point) bars, abandoned channel fills	Meandering
1	Gmm, Gcm, Gh, Sp	31001–31003, 31006, 31012–31016, 31025, 31027–31034, 31099, 31100	(8) planar and erosional to bedrock	Laterally persistent planar-bedded matrix- and clast-supported gravels, and low angle lateral accretion deposits (sands)	In channel (point) bars and channel lag	Meandering

Table 2. Clast lithological counts of samples from FA1, FA3 and FA5

Sample Unit Facies association	183 31023 FA1	202 31066 FA3	 19† FA5	 32† FA5	 5† FA5	 2† FA5	 2† FA5
Limestone	170 (95.5)	90 (91.8)	549 (99.5)	742 (99.3)	662 (98.4)	488 (96.4)	547 (98.4)
Jurassic fossils		1 (0.1)		2 (0.3)	2 (0.3)	6 (1.2)	3 (0.5)
Brown sandstone			2 (0.4)		2 (0.3)	2 (0.4)	
Brown mudstone	1 (0.6)	4 (0.4)					
Grey mudstone	6 (3.4)						
Calcite		2 (0.2)		1 (0.1)	8 (1.2)	3 (0.6)	
Chert		1 (0.1)	1 (0.4)	1 (0.1)	1 (0.1)	7 (1.4)	6 (1.1)
Flint	1 (0.6)			1 (0.1)			
Total	178	98	552	747	675	506	556

†Lithological units in quarry wall Section D, numbers in parentheses are percentages.

0.15 m thick lenticular bed of organic mud (LU 31066). All deposits except the uppermost unit (31075) butt against the Kellaways Clay bedrock outcrop in the east of T3, while that unit passes over the rock outcrop to overlie FA4 further to the east (Fig. 5). It is assumed that the upper contact of FA3 was at a bounding surface with FA5, but that relationship has been lost as a result of truncation of FA3 by quarrying operations. Clast lithology of FA3 was examined in a single sample and, as with FA1, is dominated by rounded and sub-rounded limestone (Table 1). Oxford Clay clasts were not found, but Kellaways Clay-derived brown sub-rounded mudstone pebbles were present, as were a small number of calcite and chert clasts (Table 2).

Facies Association 4

FA4 is found in T4 and the eastern part of T3 where, as described above, it is overlain by FA3, while FA4 butts against the opposite (eastern) side of the Kellaways Clay outcrop that constrains FA3 (Fig. 5). Unlike the previous strata described above, FA4 is not comprised of facies that are characteristic of fluvial deposition. Rather it comprises a c. 0.2 m thick bed of massive, matrix-supported cobble and pebble gravels of sub-angular Kellaways Clay-derived clasts in a sand–clay matrix (LU 31093 and 31095), with interbedded c. 0.1 m thick wedges of grey sand/silt (LU 31096). A single mammoth tusk was found in one of the latter. FA4 is cut by minor channels filled by FA5 and has a fifth order bounding surface with the latter.

Facies Association 5

Deposits characterised as FA5 are present in the quarry walls and as remnants in minor cut-and-fill features in FA1 and FA4. Elsewhere, the sediments of FA5 have been removed during quarry operations – indeed they were the target of the aggregate extraction. The strata of FA5 unconformably overlie Oxford Clay and Kellaways Clay bedrock in the quarry walls and are assumed to have once overlain FA1–FA4 in the quarry itself. FA5 comprises clast- and matrix-supported gravels, forming massive, normally and lenticular bedded units, but lenticular bedded medium and coarse sands are also present. Most units have a horizontal bedform and are <0.5 m in thickness, but cut-and-fill features are present towards the top of the exposure, the latter filled by horizontally bedded, matrix-supported gravels. Clast lithological analysis was carried out on five samples from the quarry walls (Section D, Fig. 2). The vast majority (>96%) of clasts are limestones of the same lithologies as discussed for FA1 above, albeit that they are predominantly sub-angular suggesting a lower residence time than for FA1 and FA2 (Table 2). Other than the calcite, which has probably been sourced from travertine developed upstream limestone caves, the remaining lithologies are exotic to the catchment. The sandstone is likely derived from Triassic sources to the north or west, while the chert is probably of Carboniferous age and also from rocks to the west and north.

Geochronology

The results of optical dating are presented in Table 3. Of the six samples measured, five produced robust results, albeit that there is significant ^{238}U and ^{226}Ra disequilibrium in GL19031 and therefore this age is interpreted as a minimum. Excepting GL19031, the other optical ages from deposits of FA1–FA3 are indicative of an MIS 7 date for those strata. The base of the Northmoor Member (FA5) was dated by GL19032 and GL19033 and is of late MIS 6 and/or MIS 5 age.

Biostratigraphy

Mollusca

The three samples studied from deposits of FA1 contained variable quantities of mollusc shells (340 in total) from 13 taxa (Table 4). Two freshwater species dominate, these being *Valvata piscinalis* and *Ampullaceana balthica* (the latter formerly *Radix balthica* and *Lymnaea peregra*), while *Bithynia tentaculata*, *Euglesa* (*Pisidium*) sp. and *Pisidium amnicum* are present at lower frequencies. The assemblage falls equally within Sparks' (1964) moving water and catholic groups, while none of the taxa are indicative of the presence of aquatic vegetation. Terrestrial taxa are present at low frequencies and diversity, comprising only *Trochulus hispidus* (formerly *Trichia hispida*), *Pupilla muscorum* and *Vallonia excentrica*, these indicating the presence of open environments beyond the channel margin. The discovery of a single valve of *Pisidium clessini* has biostratigraphic implications given that the species is not known from Britain after MIS 7 (Preece 1995, Keen 2001). Of three samples from FA2 strata, two contained <30 shells and therefore palaeoenvironmental characterisation of the facies association is on the basis of a single sample (from Unit 31064). The latter contains a more diverse assemblage than samples of FA1, while the moving water taxa *B. tentaculata* and *V. piscinalis* collectively account for more than half of the shells. Other moving water species (*P. amnicum*, *P. clessini*) and taxa of the freshwater catholic group, i.e. *A. balthica*, *Euglesa casertana* (formerly *Pisidium casertanum*), *Euglesa nitida* (formerly *Pisidium nitidum*), are present at low frequencies, but as with FA1, there is little indication of aquatic vegetation from the molluscs recovered in the strata of FA2. Terrestrial taxa in deposits of FA2 are the same as in FA1, but with the addition of *Cochlicopa lubrica*, and indicate open environments. Both of the samples from deposits of FA3 contained >100 shells, while the assemblages recovered are similar to those described for FA1 and FA2, albeit that *V. piscinalis* is present as a higher proportion

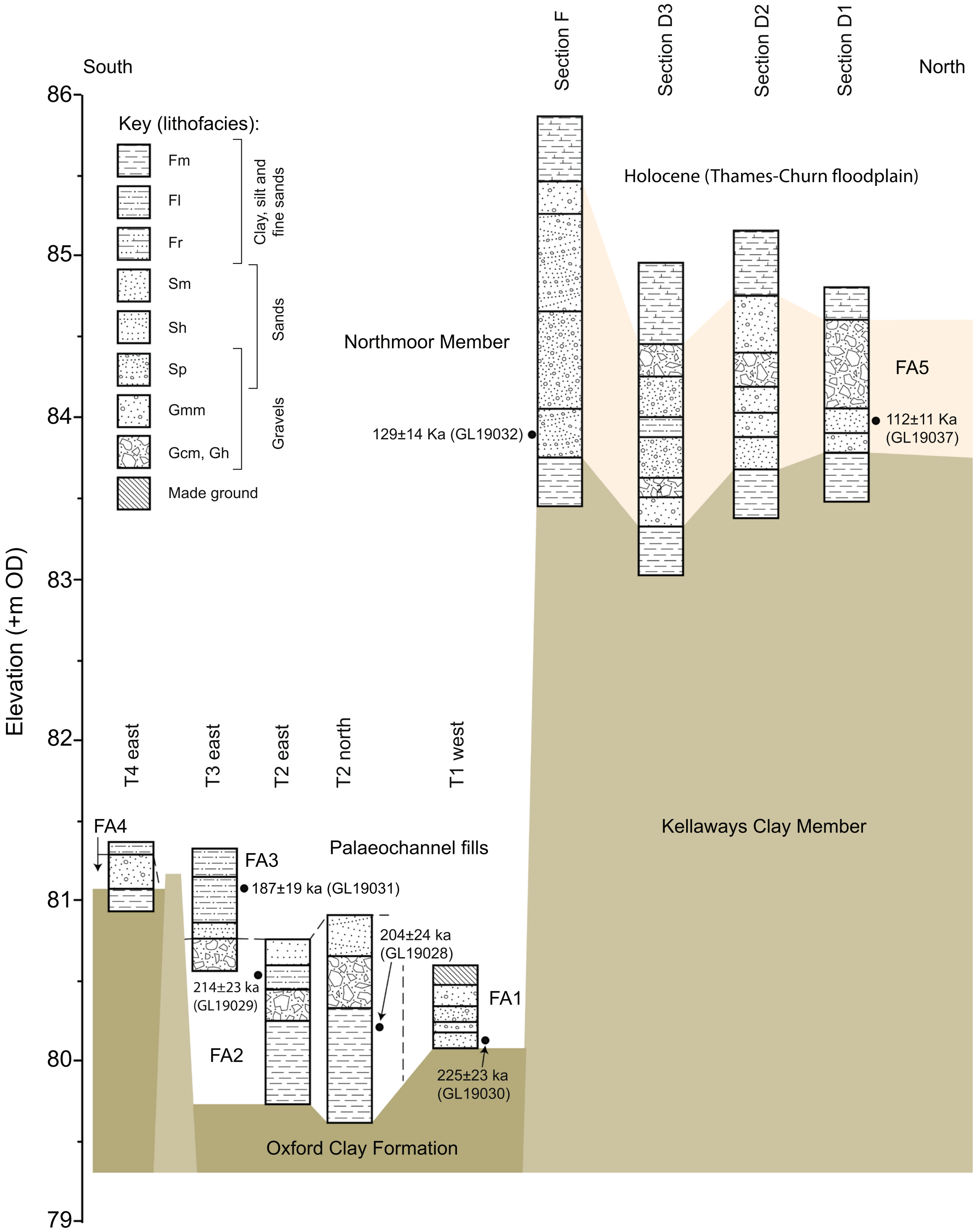

Figure 4. Schematic south–north cross-section through Oak Tree Field showing facies associations and OSL dates. [Color figure can be viewed at wileyonlinelibrary.com]

of the total (43–49%). *B. tentaculata* and *A. balthica* are found in low frequencies in the samples of FA3 strata and *P. clessini* not at all. However, planorbids are present in greater frequency and diversity in samples from FA3 compared with those of the other facies associations, thereby suggesting the presence of aquatic vegetation. Nevertheless, the appearance of the freshwater limpet *Ancylus fluviatilis* in the samples from FA3 indicates clear water and a hard substrate at the base of the channel.

Coleoptera

Of those samples with greater than 50 individuals, similar proportions of aquatic beetles were identified from FA1 (11–17%), FA2 (17%) and FA3 (16%), reflecting a diversity of water regimes (Table 5). *Agabus bipustulatus*, *Colymbetes fuscus* and *Hydrochus* sp. are typical of still and slowly flowing water, while other taxa indicate relatively bare, exposed marginal sediments with algae and moss (*Sphaerius acaroides, Georissus crenulatus*), and soft waterside mud (*Ochthebius bicolon, Ochthebius dilatatus, O.* cf. *minimus*, *Laccobius* and *Cercyon ustulatus*). *Lophopus crystallinus*, a crystal moss animal (Bryozoa) represented by occasional statoblasts from FA2 and FA3, also occurs in water with only a slight current. *Byrrhus* sp., *Chaetarthria seminulum* and *Coelostoma orbiculare* are specifically associated with moss. The latter two species, identified, respectively, in FA2 and FA3, usually occupy rafts of floating

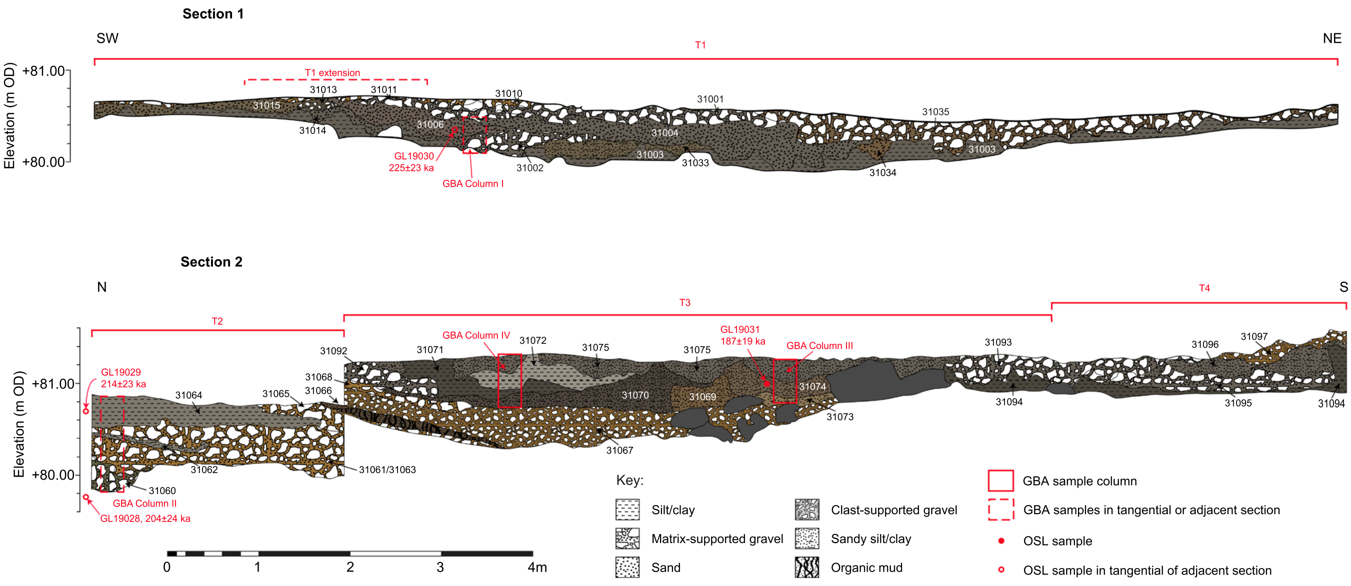

Figure 5. Section drawings of T1. [Color figure can be viewed at wileyonlinelibrary.com]

vegetation at the water margins. The leaf beetle *Donacia crassipes*, recovered from FA3, is found on the leaves of water lilies (*Nymphaea* and *Nuphar*) and is therefore indicative of still to slowly flowing water. Conversely, the riffle beetle, *Esolus parallelepipedus*, which was recovered from all three facies associations, is indicative of shallow, well-oxygenated, water, typically over a stony substrate. Other riffle beetles, *Elmis aenea* and *Limnius volkmari*, were recovered from FA3 and reflect similar conditions to *E. parallelpipedus*.

Of the terrestrial beetle fauna, taxa associated with damp ground and waterside habitats were similarly represented in FA1 (9–11%) and FA3 (10%), but were less common in FA2 (5%). Phytophages indicate a rich marginal vegetation during stages of FA1 through to FA3. For example, *Chaetocnema arida* lives on various rushes (*Juncus*), sedges (*Carex*) and grasses (Poaceae), *Donacia dentata* feeds on the leaves of arrowhead (*Sagittaria sagittifolia*), and *Donacia semicuprea* and *Notaris acridulus* on sweet-grasses (*Glyceria*), while *Tournotaris bimaculata* lives on a variety of wetland monocotyledons (Typhaeceae, Cyperaceae, Poaceae). The ground beetles *Pterostichus vernalis* and *Pterostichus niger* are typical of damp shaded ground, with shade probably provided by tall waterside vegetation rather than trees or shrubs. Additionally, a range of ground beetles typically found in permanently damp and muddy, open or only sparsely vegetated, ground (e.g. *Bembidion biguttatum, Chlaenius* sp., *Dyschirius globulus* and *Clivina fossor*) were recovered from FA1 and FA2, but not FA3.

Dry grassland is indicated beyond the immediate river margins in FA1–FA3. *Calathus fuscipes*, a smaller member of the *Calathus* genus, and *Amara* are suggestive of relatively dry ground. *Helophorus nubilus* is found at plant roots on sun-exposed grassland but also on disturbed ground. The click beetles *Agrypnus murinus* and *Agriotes* sp. are also characteristic of grassland where their larvae feed on grass roots. The weevil *Graptus triguttatus*, recorded only from FA2, lives at the roots of plants in open grassy places but shows a marked preference for ribwort plantain (*Plantago lanceolata*) in the British Isles at the present day. The weevils *Mecinus pascuorum* and *Mecinus pyraster*, only represented in FA3, are also associated with ribwort plantain, while *Tychius* sp., again only identified from FA3, is found on leguminous grassland plants such as clovers and trefoils.

Beetles associated with trees and shrubs were extremely rare. A single individual of *Orchestes hortorum* and a scale insect (Coccoidea: Diaspididae) provided the only evidence from FA1. The former is specifically associated with oak (*Quercus*), while the latter group is found on a variety of woody vegetation. A single record of *Crepidodera*, a small leaf beetle found on willows (*Salix*) and poplars (*Populus*), was the only evidence of trees in FA2, and insects specifically associated with trees were absent from FA3.

Beetles associated with foul decomposing matter, particularly herbivore dung, were common throughout, accounting for relatively high frequencies of the terrestrial fauna from FA1 (16–35%), FA2 (23%) and FA3 (35%). Indeed, scarabaeoid dung beetles (Aphodiinae spp., Geotrupinae) dominate the terrestrial fauna. *Euheptaulacus sus* and *Melinopterus* sp. were well represented throughout FA1–FA3, and several other unidentified Aphodiinae species were present among the numerous fragmentary remains in the samples. The *Anotylus gibbulus* group, which is no longer extant in Britain, is present throughout and also appears to be associated with the dung of large mammals (Hammond *et al.* 1979).

Palaeobotany

Limited numbers of plant macrofossils were identified and for this reason only the presence or absence of plant macrofossil taxa is noted here (Table 6). FA1 macrobotanical assemblages comprised buttercup (*Ranunculus repens/acris/bulbosus*) and rushes (Juncaceae), as well as oxtongues (*Picris* sp.) and sorrel (*Rumex acetosella*), all of which are indicative of open, disturbed or damp grassland. Aquatic taxa were also present, including pondweed (*Potamogeton* sp.) and yellow waterlily (*Nuphar lutea*). *Potamogeton* is a broad genus found in a range of aquatic environments, but the floating yellow waterlily indicates slow moving or still water, while plants of this taxon can survive in water depths of up to 5 m. Several taxa typical of waterside environments or damp ground were also present, including beaked sedge (*Carex* cf. *rostrata*), bulrush (sedges, cf. *Scirpus* sp.) and cinquefoil (*Potentilla* sp.). A fruit of *Betula* (birch) was the only plant macrofossil evidence for trees in FA1, while of the few palynomorphs identified, occasional grains of hornbeam (*Carpinus*) were the only indication of trees. FA2 contained a macrobotanical assemblage broadly similar to FA1, but with a greater diversity of taxa. A range of additional aquatic taxa were present, including pondweed, water crowfoots (*Ranunculus* subgenus *Batrachium*), common

Table 3. Dosimetry, De and optical age data from Oak Tree Field, Cerney Wick

Lab code	FA	Unit	Ge γ spectrometry (*ex situ*)			β D_r (Gy ka^{-1})	γ D_r (Gy ka^{-1})	Cosmic D_r (Gy ka^{-1})	Total D_r (Gy ka^{-1})	D_e (Gy)	Age (ka)
			K (%)	Th (ppm)	U (ppm)						
GL19028	FA2	31059	1.44 ± 0.09	9.80 ± 0.58	1.63 ± 0.13	1.20 ± 0.14	0.82 ± 0.10	0.10 ± 0.01	2.12 ± 0.18	432.1 ± 34.5	204 ± 24
GL19029	FA2	31064	0.76 ± 0.07	4.92 ± 0.41	1.62 ± 0.13	0.70 ± 0.09	0.49 ± 0.07	0.11 ± 0.01	1.30 ± 0.11	278.1 ± 19.2	214 ± 23
GL19030	FA1	31006	0.44 ± 0.05	2.92 ± 0.34	0.86 ± 0.14	0.44 ± 0.06	0.30 ± 0.06	0.10 ± 0.01	0.84 ± 0.07	189.5 ± 11.0	225 ± 23
GL19031	FA3	31074	0.85 ± 0.07	5.76 ± 0.47	3.58 ± 0.19	0.97 ± 0.11	0.72 ± 0.09	0.11 ± 0.01	1.81 ± 0.15	338.9 ± 20.7	187 ± 19
GL19032	FA5	49	0.14 ± 0.04	2.54 ± 0.29	0.49 ± 0.09	0.21 ± 0.05	0.20 ± 0.05	0.18 ± 0.02	0.59 ± 0.05	75.4 ± 4.7	129 ± 14
GL19033	FA5	28	0.28 ± 0.05	2.50 ± 0.31	0.62 ± 0.11	0.31 ± 0.05	0.24 ± 0.05	0.18 ± 0.02	0.74 ± 0.06	82.4 ± 4.5	112 ± 11

water-plantain (*Alisma plantago-aquatica*) and horned pondweed (*Zannichellia palustris*). The water crowfoot grows in still or flowing water, while common water-plantain is found growing on exposed mud at the shallow edge of still or slow-flowing water, or in marshes and swamps, and is indicative of mesotrophic or eutrophic conditions. Horned pondweed grows in a range of shallow-water habitats, including eutrophic and brackish environments. Further evidence of open environments, probably on the margins of a water body, was provided by rushes, sedges, willowherb (*Epilobium* sp.) and pondweed. Possible bud scales and broken catkins of birch, and a possible leaf fragment of heather (Ericaceae) were also recorded, these likely derived from woodland or heathland in drier areas of the wider stream catchment. Plant macrofossil preservation was particularly poor in deposits of FA3, but included some evidence for scrub vegetation in the form of a seed of elder (*Sambucus nigra/racemosa*) and fruits of dwarf evergreen shrubs (*Empetrum*).

Microvertebrates

The yield was extremely low (*n* = 15). A fin spine and a partial vertebra of three-spined stickleback (*Gasterosteus aculeatus*) and a pharyngeal tooth of a cyprinid fish were the only taxonomically identifiable microvertebrate specimens recovered, both from FA2 (Table 7).

Vertebrates

In total, 199 specimens have been recorded from Oak Tree Fields: 56 from Assemblage A and 143 from Assemblage B (Table 8; Fig. 6). Excluding the surface finds, Assemblage A overwhelmingly originates from FA1 and includes only one specimen from FA2, two from FA3 and a fragmentary tusk and three other bone fragments from FA4. Assemblage B cannot be assigned to a facies association albeit that at least some of the material found in the vicinity of the handaxe is likely to have been derived from FA1. Given the uncertain context of previously collected material, the focus of the following text is on Assemblage A.

That part of Assemblage A found on the quarry floor had been exposed by aggregate extraction, in and prior to 2017, and was consequently often fragmentary and with relatively poor surface condition. Many of these vertebrate fossils had undergone at least one cycle of dewatering and flooding of the quarry, further contributing to the relatively poor condition of the specimens. On the other hand, the preservation of vertebrate fossils found during controlled excavations was good and displayed limited evidence of weathering, possibly indicating a short exposure time prior to burial. Indeed, none of the bones were fully mineralised, while tusks were well preserved (Fig. 3) – such remains degrade rapidly if left exposed indicating rapid burial. However, most of the vertebrate fossils recovered during excavation and in sieving the GBA samples were relatively large and might indicate winnowing of smaller elements.

Mammuthus is currently the only genus identified amongst the large vertebrate fossils recovered during controlled excavation. Mammoth is a well-documented part of the MIS 7 vertebrate fauna (Schreve 1997, 2001a, 2001b). Indeed, MIS 7 or early MIS 6 is suggested as the time during which the relatively small form of steppe mammoth (*Mammuthus trogontherii*) was replaced by the woolly mammoth (*Mammuthus primigenius*) (Lister and Sher 2001, Lister et al. 2005), and is therefore a critical period in the population history of Elephantidae. *M. trogontherii* has been distinguished principally on the basis of the relatively small size and relatively low

Table 4. Mollusc shells recovered from Oak Tree Quarry, Cerney Wick

Sample	9	10	11	14	18	22	67	69
Unit	31002	31002	31006	31064	31064	31064	31074	31074
Depth (cm)	0–9	9–17	17–25	10–15	30–35	47–52	18–28	38–41
Facies association	FA1	FA1	FA1	FA2	FA2	FA2	FA3	FA3
Valvata piscinalis (Müller)	46	70	21	6	94	6	60	75
Bithynia tentaculata (Linnaeus)	1	1	4		36		10	4
B. tentaculata (operculae)	2	4			57	1	14	24
Galba truncatula (Müller)		2					3	1
Ampullaceana balthica (Linnaeus)	42	62	10	3	13	4	6	10
Myxas glutinosa (Müller)					1			
Gyraulus laevis (Alder)					1		5	8
Hippeutis complanatus (Linnaeus)							3	
Planorbarius corneus (Linnaeus)					1			
Ancylus fluviatilis (Müller)	1						4	1
Acroluxus lacustris (Linnaeus)					1		1	1
Cochlicopa lubrica (Müller)					1			
Pupilla muscorum (Linnaeus)	3	2		1	2			1
Vallonia excentrica (Sterki)	1	4	1	2				
Limacidae				1	1			1
Trochulus hispidus (Linnaeus)	3	11	3	3	3		2	2
Pisidium amnicum (Müller)†		3	4	1	18	1	3	4
Pisidium clessini (Neumayr)†			1		3			
Euglesa casertana (Poli)†			1	1	15		19	15
Euglesa supina (A. Schmidt)†		1	1		1			
Euglesa henslowana (Sheppard)†	4	9			1		1	
Euglesa nitida (Jenyns)†	2	6	1	3	6			
Total†	105	175	47	21	255	12	131	147

† Minimum number of individuals.

plate count of its dentition compared with that of *M. primigenius*, although there is considerable overlap in the morphological ranges. *In situ* mammoth teeth were not encountered during excavation although a single tooth was recovered *ex situ* from the surface of the Oxford Clay. Mammoth teeth were recorded from Assemblage B but, as noted above, their provenance with respect to facies association is unknown.

Apart from mammoth, no other genus was recovered *in situ* during the 2019 and 2021 excavations. Of the unstratified surface fossils recovered during the excavations, the only additional group identified was Bovidae. Neither of the fossils assigned to the latter could be more specifically identified to species, but it is notable that domestic cattle (*Bos taurus*) and steppe bison (*Bison priscus*), as well as other specimens broadly identified as Bovidae are part of Assemblage B (Table 8). Additionally, the latter collection includes a fragment of the left mandible of brown bear (*Ursus arctos*), the only other vertebrate group so far identified from the site.

Palaeolithic archaeology

Eight lithic artefacts have been recovered from Oak Tree Fields, a handaxe found by the Hollingworths and a member of the quarry workforce in 2017, and seven struck flints encountered during the 2021 excavation. The handaxe (H.001) was found in upcast resulting from machine excavation of a sondage (S. Hollingworth, personal communication, 2019) that was subsequently formalised as T1 during the 2019–2021 excavations. As the deposits of the Northmoor Member had been removed from this location prior to digging the sondage, it is almost certain that the handaxe originally sat in the sediments of FA1. However, it is unclear from which exact lithostratigraphic unit the handaxe was removed and whether it came from the vertebrate-bearing beds. While it is a possibility that the handaxe may have been transported by fluvial processes from its place of discard, the coarseness of gravels in strata comprising FA1 is significantly less (maximum of coarse pebble size) than the handaxe (medium cobble). Furthermore, the condition of the handaxe is relatively fresh. While it does show slight signs of abrasion, it is perceivably more abraded on one face than the other and this same abraded face is differently patinated. These latter characteristics may suggest that the artefact lay on a surface following discard and the exposed face was then weathered.

The lithic artefacts recovered in 2021 were all found during controlled excavation of FA1 in the T1 extension, while they were recovered either from the same lithostratigraphic unit as the vertebrate remains (31006/31012) or in the unit immediately overlying those fossils (31014). The size of the artefacts (coarse and very coarse pebble-sized) might suggest movement from their original place of deposition. However, as described above, the sediment matrix, especially Unit 31014, is predominantly sand-sized. Furthermore, the relatively unrolled condition of the finds (especially considering the rounded and sub-rounded nature of other gravel within the matrix) suggests that they had not been transported far. In other words, the handaxe and the flake artefacts recovered during the controlled excavations are likely to be broadly contemporary and date to the active phase of the channel.

While the assemblage is relatively small, it provides evidence for the adoption of two technological strategies. Firstly, and most evidently, the handaxe (H.001) is evidence of Acheulean technology. The handaxe (H.001) is relatively finely worked, although there appear to have been some difficulties in establishing symmetry (Fig. 7). One of the cutting edges is convex in plan but is relatively irregular in profile. However, the opposing cutting edge is slightly irregular in plan and is notably twisted, most likely as removals failed to continue into the body of the handaxe and as such the thickness has only been poorly reduced. Reduction was probably achieved by the use of the ‘soft hammer technique’, with the flaking angle and shallowness of removals consistent with such a method. Evidence of this technique is also retained

Table 5. Insects and other invertebrate taxa recorded from Oak Tree Fields, Cerney Wick

Sample	9	10	11	14	18	22	67	69
Unit	31002	31002	31006	31064	31064	31064	31074	31074
Depth (cm)	0–9	9–17	17–25	10–15	30–35	47–52	18–28	38–41
Facies association	FA1	FA1	FA1	FA2	FA2	FA2	FA3	FA3
CRUSTACEA								
Daphnia magna group ephippia					P	P		
Daphnia sp(p). ephippia	P		P					
Cladocera spp. ephippia					P			
Ostracoda spp. carapaces	P				C	C	C	C
INSECTA								
DERMAPTERA (earwigs)								
Dermaptera sp. [u]	+				+		+	
HEMIPTERA: HETEROPTERA (true bugs)								
Lygaeidae (ground bugs)								
Lygaeidae spp. [oa-p]			+	+	+		+	+
Corixidae (water boatmen)								
Corixidae spp. [oa-w]	+	+	+	+	+	+		
Saldidae (shore bugs)								
Saldidae sp(p). [oa-d]			+		+			+
Heteroptera sp. [u]		+						
HEMIPTERA: HOMOPTERA								
Auchenorhyncha spp. [oa-p]			+		+			
Psylloidea (jumping plant lice)								
Trioza sp. nymph [oa-p]			+					
Aphidoidea sp. (aphids)			+		+	+		
Coccoidea sp. (scale insects)	+							
COLEOPTERA (beetles)								
Sphaeriusidae								
Sphaerius acaroides Waltl [oa-w]	1		1			1		
Dytiscidae (diving beetles)								
Agabus bipustulatus (Linnaeus) [oa-w]	1							
Agabus or *Ilybius* spp. [oa-w]					1		2	
Colymbetes cf *fuscus* (Linnaeus) [oa-w]	1				1		1	
Hydroporinae spp. [oa-w]		1	1		3			
Dytiscidae sp. [oa-w]		1	1					
Carabidae (ground beetles)								
Loricera pilicornis (Fabricius) [oa]	1							
Clivina fossor (Linnaeus) [oa]	1							
Dyschirius globosus (Herbst) [oa]		1			2	1		
Bembidion (*Metallina*) *lampros* or *properans* [oa]	1							
Bembidion (*Ocydromus*) sp.	1							
Bembidion (*Philochthus*) *biguttatum* (Fabricius) [oa-d]					1			
Bembidion spp. [oa]		1			3		2	1
Pterostichus vernalis (Panzer) [oa-d]		1						
Pterostichus niger (Schaller) [oa]							1	
Pterostichus spp. [oa]					2		1	
Amara spp. [oa]	1	1			1		1	
Chlaenius sp. [oa-d]					1			
Harpalus rufipes (De Geer) [oa]					1			
Calathus fuscipes (Goeze) [oa]	2				1	1	1	
Calathus melanocephalus (Linnaeus) [oa]					1			
Calathus spp. indet. small species [oa]	2	1					2	
Microlestes or *Syntomus* sp. [oa]					1			
carab with poorly defined striae					1			
Carabidae spp. and sp. indet. [ob]	2	3	3	3	2	2	3	5
Helophoridae (grooved water scavengers)								
Helophorus nubilus Fabricius [oa]		3			3			
Helophorus spp. and sp. indet. [oa-w]	7	3	6	3	12	2	10	2
Georissidae								
Georissus crenulatus (Rossi) [oa-w]		1	2		1		1	
Hydrochidae								
Hydrochus sp. indet. [oa-w]	1				1		1	1
Hydrophilidae								
Berosus sp. [oa-w]	1							
Laccobius sp. [oa-w]	1							
Chaetarthria seminulum or *simillima* [oa-d]					1			
Coelostoma orbiculare (Fabricius) [oa-w]								1
Sphaeridium bipustulatum Fabricius [rf]					2			
Sphaeridium sp. indet. [rf]			1				2	
Cercyon impressus (Sturm) [rf]	1						1	

(*Continued*)

Table 5. (*Continued*)

Sample Unit Depth (cm) Facies association	9 31002 0–9 FA1	10 31002 9–17 FA1	11 31006 17–25 FA1	14 31064 10–15 FA2	18 31064 30–35 FA2	22 31064 47–52 FA2	67 31074 18–28 FA3	69 31074 38–41 FA3
Cercyon melanocephalus (Linnaeus) [rf]							4	
Cercyon pygmaeus (Illiger) [rf]	1		1					
Cercyon tristis group (Illiger) [oa-d]	1							
Cercyon ustulatus (Preyssler) [oa-d]			1		1		2	
Cercyon spp. and sp. indet. [u]	1		1	1	3			2
Cryptopleurum crenatum (Kugelann) [rf]	1	2			2		2	
Cryptopleurum minutum (Fabricius) [rf]					1			
Histeridae (clown beetles)								
Saprinus aeneus (Fabricius) [rt]						1		
Hister bissexstriatus Fabricius [rt]	4	2			2		1	1
Histerinae spp. and sp. indet. [rt]	1	1				1	2	
Histeridae sp. [u] isolated leg segments			1	1				
Hydraenidae								
Hydraena spp. [oa-w]	1				1		2	
Limnebius?nitidus (Marsham) [oa-w]					2			
Ochthebius bicolon Germar [oa-w]					2			
Ochthebius bicolon or *dilatatus* [oa-w]							1	
Ochthebius dilatatus Stephens [oa-w]	1				2			
Ochthebius c.f. *minimus* [(Fabricius) oa-w]	1				2		1	
Ochthebius sp. indet. [oa-w]			2	1				
Ptiliidae (featherwing beetles)								
Ptenidium sp. [rt]	1							
Acrotrichis sp. [rt]			1		1			
Silphidae (sexton beetles)								
Silphidae spp. [u]	1				1		1	
?Silphidae sp. [u]			1					1
Staphylinidae (rove beetles)								
Acrolocha sulcula (Stephens) [rt]	1				1		2	
Micropeplus sp. [rt]				1				
Pselaphinae spp. [u]			1	2	1			
Tachyporus spp. [u]			2	1	2			
Tachinus?rufipes (Linnaeus) [u]		1						
Tachinus spp. and sp. indet. [u]	2		1		2	1	2	
Aleochara sp. [rt]					1			
Aleochariinae spp. [u]	2	3	1	3	7		1	
Bledius sp. [oa]			1		1			
Carpelimus spp. [u]				1	2	1	1	1
Platystethus cornutus group [oa-d]		1						
Platystethus nitens (Sahlberg) [oa-d]	2		3		1		2	
Platystethus nitens or *nodifrons* Mannerheim [oa-d]							1	
Platystethus?nodifrons Mannerheim [oa-d]				1				
Platystethus (*Craetopycrus*) sp. [oa-d]	2							
Platystethus arenarius (Geoffroy in Fourcroy) [rf]	1				1		1	
Anotylus complanatus (Erichson) agg. [rt]				1	1		1	1
Anotylus gibbulus group [rt]	1	1	3		3		1	
Anotylus nitidulus (Gravenhorst) [rt-d]		1	1					
Anotylus rugosus (Fabricius) [rt]	2							
Anotylus tetracarinatus (Block) [rt]			1					
Oxytelus?piceus (Linnaeus) [rf]	2		1			1		1
Scydmaeninae spp. [u]		1	1		1			
Stenus spp. [u]	4		3		3		1	
Lathrobium sp. [u]	1				1		1	
Astenus sp. [rt]					1			
Paederinae sp. [u]							1	
Xantholinus gallicus or *linearis* [rt]		1	1					
Neobisnius sp. [rt]	1				1			
Gabrius sp. [rt]	1							
Staphylininae spp. [u]	3	2	3		3	1	4	1
Geotrupidae (dor beetles)								
Geotrupini sp. [oa-rf]			1		1		1	
Scarabaeidae (dung beetles and chafers)								
Euheptaulacus sus (Herbst) [oa-rf]	2	1	1		2		2	
Melinopterus sp. [ob-rf]	10	3	5		6		21	4
Aphodiinae spp. [ob-rf]	11	4	2	3	13	4	8	1
Serica brunnea (Linnaeus) [oa-p]								1
Scirtidae (marsh beetles)								

(*Continued*)

Table 5. (*Continued*)

Sample	9	10	11	14	18	22	67	69
Unit	31002	31002	31006	31064	31064	31064	31074	31074
Depth (cm)	0–9	9–17	17–25	10–15	30–35	47–52	18–28	38–41
Facies association	FA1	FA1	FA1	FA2	FA2	FA2	FA3	FA3
Scirtidae sp. [oa-d]							1	
Byrrhidae (pill beetles)								
Byrrhus sp. [oa]					1			
Byrrhidae sp. [u]							1	
Elmidae (riffle beetles)								
Elmis aenea (Müller) [oa-w]								1
Esolus parallelepipedus (Müller) [oa-w]	1				1		2	
Limnius volckmari (Panzer) [oa-w]							1	1
Dryopidae (long-toed water beetles)								
Dryops sp. [oa-d]					1			
Elateridae (click beetles)								
Agrypnus murinus (Linnaeus) [oa-p]	1	1					1	
Agriotes sp. [oa-p]	1	2						
Elateridae spp. and sp. indet. [ob]	1		1		3	1	4	1
Cantharidae (soldier beetles)								
Cantharidae spp. [ob]					1			1
Nitidulidae (sap and pollen beetles)								
Meligethes sp. [oa-p]		1	1				1	
Coccinellidae (ladybirds)								
Propylea quattuordecimpunctata (Linnaeus) [oa]							1	
Corylophidae								
Orthoperus sp. [rt]			1					
Latridiidae (minute brown scavenger beetles)								
Enicmus sp. [rd]	1				1			
Corticariinae spp. [rt]	1	1			1			
Anthicidae (ant-like flower beetles)								
Anthicidae sp. [rt]			1		1		2	
Chrysomelidae (seed and leaf beetles)								
Donacia crassipes Fabricius [oa-p-d]							2	
Donacia dentata Hoppe [oa-p-d]	1						1	1
Donacia semicuprea Panzer [oa-p-d]	1							
Donacia spp. and sp. indet. [oa-p-d]		1		1	2	1		
Donacia or *Plateumaris* sp. indet. [oa-p-d]			1				1	
Lema or *Oulema* sp. [oa-p]							1	
Crepidodera sp. (Fabricius) [oa-p-t]					1			
Chaetocnema arida group [oa-p]	1	2			1	2	3	
Chaetocnema concinna or *picipes* [oa-p]	1				1		1	
Longitarsus sp. [oa-p]			1					
?*Longitarsus* sp. [oa-p]					1			
Phyllotreta sp. [oa-p]					2			
Alticini spp. [oa-p]			1	1	3		3	1
Chrysomelidae sp. [oa-p]			1					
Apionidae								
Apionidae spp. [oa-p]	2	2	1	2	4			1
Erirhinidae (wetland weevils)								
Notaris acridulus (Linnaeus) [oa-p-d]							2	
?*Notaris acridulus* (Linnaeus) [oa-p-d]		1						
Notaris sp. [oa-p-d]								1
Tournotaris bimaculata (Fabricius) [oa-p-d]				1			1	1
Curculionidae (weevils)								
Limnobaris sp. [oa-p-d]							1	
Mecinus pascuorum (Gyllenhal) [oa-p]							1	
Mecinus pyraster (Herbst) [oa-p]							1	
Orchestes hortorum (Fabricius) [oa-p-t]	1							
Tychius spp. [oa-p]							3	
Ceutorhynchus spp. [oa-p]		1	1				1	
Rhinoncus perpendicularis (Reich) [oa-p]					1			
Ceutorhynchinae spp. [oa-p]					1		4	
Graptus triguttatus (Fabricius) [oa-p]					1			
Sitona sp. [oa-p]				1				1
Curculionidae spp. and sp. indet. [oa-p]	3	1	3	2	4	4	6	4
Coleoptera spp. and sp. indet. [u]	5	2	1	1	6	2	7	4
DIPTERA (flies)								
Chironomidae spp. larval head capsules	+							
Diptera spp. puparia	+	+		+	+	+	+	-
HYMENOPTERA (bees, wasps and ants)								

(*Continued*)

Table 5. (*Continued*)

Sample	9	10	11	14	18	22	67	69
Unit	31002	31002	31006	31064	31064	31064	31074	31074
Depth (cm)	0–9	9–17	17–25	10–15	30–35	47–52	18–28	38–41
Facies association	FA1	FA1	FA1	FA2	FA2	FA2	FA3	FA3
Hymenoptera Parasitica spp.	+	++	+		+		+	+
TRICHOPTERA (caddis flies)								
Trichoptera sp. larval fragments			+		+		+	
ARACHNIDA								
Acarina spp. (mites)	C	P	P	P	P	P	P	P
Aranae sp. (spiders)				P	P			
BRYOZOA								
Lophopus crystallinus (Pallas) statoblasts				P		P		P
Total[†]	108	56	69	31	155	27	149	42

Ecological codes shown in square brackets are: d – damp ground/waterside, oa – taxa occurring in outdoor habitats and not usually in accumulations of decomposing matter, ob – probable outdoor taxa, p – plant-associated taxa, rd – dry decomposers, rf – foul decomposers, rt – eurytopic decomposers, t – tree, u – uncoded, w – aquatic.

[†] Minimum number of individuals for beetles. All other insects have been recorded semi-quantitively as + 1–3, ++ 4–10, +++ 11–50. Other groups of invertebrates have been recorded as present (P) or common (C).

on an elongated flake (i.e. lipped butt and diffuse bulb) (SF127), while the thickness of the flake fragment (SF185) is consistent with careful manufacture. No evidence of the initial stages of handaxe manufacture was recorded, as would be suggested by the presence of large debitage flakes with cortex.

Secondly, and less conspicuous, is a group of flake or miscellaneous fragments (i.e. lacking attributes consistent with having been intentionally struck [Lubinski et al. 2014]) with evidence of having been intentionally modified to form crudely made retouched tools (SF139, SF142, SF156, SF157, SF162) (Table 9; Fig. 8). None of these artefacts fit clearly within standardised tool categories (e.g. Bordes 1961) and are relatively heterogeneous. Each artefact has retouch which was formed by continuous removals along at least one edge. These originated from a single face and were seemingly systematically applied, thereby likely excluding potential non-human causes, such as mechanical damage resulting from cryoturbation, trampling, etc., that can be mistaken for intentional retouching (Stapert 1976). Furthermore, in all cases the retouched surfaces are relatively fresh, and there is limited evidence for subsequent abrasion, rolling and edge-rounding that would be consistent with the objects having been subsequently moved in a high-energy fluvial environment. Given the paucity of locally available raw materials, suitable natural 'blanks' of size and shape appear to have been selected from the immediately available river gravel and modified as necessary to form a range of tools.

Flint was only rarely observed within any of the lithological units, while even when present it comprises pebble-sized heavily rolled and abraded clasts, often with relict frost-fractured surfaces. Given these observations, the handaxe must have been made of raw material found further afield – today, the nearest flint source is ~20 km south of the site in the Marlborough Downs (BGS 2022). On the other hand, the artefacts recovered from the T1 extension in 2021 might have been made on flint found in the FA1 gravels. If so, differences in raw material and the variable condition of the artefacts might be suggestive of multiple phases of activity at the site.

Discussion

Depositional setting

Lewis et al. (2006) interpreted Northmoor Member and underlying interglacial strata at Latton as accretion products of an alluvial fan, the latter emanating from the valley of the River Churn and prograding into that of the Thames. The Churn is a north bank tributary of the Thames with its headwaters 20 km north of Cerney Wick at Seven Springs, while the Churn's confluence with the Thames is presently at Cricklade, 4.5 km south of the site (Fig. 1). The argument for formation in an alluvial fan is the relatively steep gradient of the Churn (5 m km^{-1}) relative to the Thames (0.7 m km^{-1} between the CWP and Lechlade; the latter 14 km to the east of Oak Tree Field), bifurcation of gravel strata around bedrock islands at Latton and palaeoflow measurements (Lewis et al. 2006). However, while the Northmoor Member (FA5) at Cerney Wick may have formed in such a setting, it is less likely that the same is the case for the palaeochannel and its infills (FA1–FA3). Even so, it is probable that FA1–FA3 are lateral equivalents of facies association A at Latton given their similar stratigraphic position and, in the case of FA1, similar morphological properties (Lewis et al. 2006). Clast and bed orientation of FA1 strata suggest flow on a west–east axis and parallel with the present course of the Thames, while the bedform appears to be that of a sinuous stream running through a channel cut into bedrock reveals the incorporation of some mudstone particles that would not survive long-distance transport. Indeed, the strata of FA1 are likely a mixture of debris (gravel facies) and sediment gravity flows (sand facies) (*sensu* Miall 1996: 79), while the accumulation of the thick sand wedge that was the subject of the 2021 excavation (LU 31006) was probably on a point bar. The coincidence of medium–coarse boulder-sized vertebrate fossils with medium boulder-sized septarian nodules as the base of deposits of FA1 suggests that both are channel lags that have subsequently been onlapped by sands and gravels. Further, given the absence of articulation it is likely that the bone within the main body of the FA1 sediment succession is reworked, albeit good preservation and lack of abrasion of all such vertebrate fossils suggests a local derivation, e.g. from an adjacent bar similar to that represented by LU 31006. As the lithic artefacts were recovered from strata that accumulated in conditions of high-energy flow, it is also likely that they are reworked, although given their relatively fresh condition they may not have travelled far and may even have been lost or deliberately discarded on the emergent bar (i.e. 31006/31012).

Strata forming FA2 were probably deposited as bedflow flowing in a single or series of shallow, short-lived channels that developed across a floodplain west of the Kellaways Clay outcrop. Although gravel strata are included in FA2, the

Table 6. Plant macrofossils recorded at Oak Tree Fields, Cerney Wick

Sample		9	10	11	12	14	15	17	18	21	22	25	26	67	69	72	74
Unit		31002	31002	31006	31006	31064	31064	31064	31064	31064	31064	31060	31060	31074	31074	31072	31070
Column		I	I	I	I	II	II	II	II	II	II	II	II	III	III	IV	IV
Depth (cm)		0–9	9–17	17–30	30–35	10–15	15–20	25–30	30–35	45–47	47–52	70–75	75–80	18–28	38–41	5–10	15–20
Facies association		FA1	FA1	FA1	FA1	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA2	FA3	FA3	FA3	FA3
Aquatic																	
Ranunculus subgenus *Batrachium*	fruit									+							
Nuphar lutea	seed				+												
Potamogeton sp.	fruit		+		+				+	+			+		+	+	
Alisma plantago-aquatica	fruit									+							
Zannichellia palustris	fruitlet									+						+	
cf. *Nymphaea*	seed					+											
Waterside and damp ground																	
Carex cf. *rostrata*	nutlet				+					+							
Carex spp.	fruit	+	+	+	+		+		+	+	+	+	+	+	+		+
cf. *Scirpus* sp.	nutlet				+												
Juncaceae	seed	+		+	+	+	+	+	+	+	+			+	+		+
Grassland/open, disturbed ground																	
Ranunculus repens/acris/bulbosus	achene				+		+			+							
Picris sp.	fruit				+												
Cirsium/Carduus sp.	fruit									+							
Allium carinatum	seed									+							
cf. *Luzula* sp.	seed									+							
Trifolium sp.	seed									+							
Rumex acetosella	nutlet				+					+							
Asteraceae	fruit													+			
Brassicaceae	seed								+								
Epilobium sp.	fruit								+					+			
Silene sp.	seed	+		+		+					+		+	+			
Thalictrum sp.	fruitlet	+		+		+			+		+		+	+	+		
Woodland/scrubland																	
Sambucus nigra/racemosa	seed																+
Betula	fruit			+													
Empetrum	fruit														+		
Unclassified																	
Potentilla sp.	achene				+					+							
Cyperaceae	fruit		+									+	+				
Chenopodiaceae	seed		+	+						+				+	+		
Polygonaceae	fruit		+						+								
Indet. seed casings					+					+						+	
Unknown (corroded/broken)					+		+	+		+		+				+	
Budscales									+								
Catkins									+								

Table 7. Microvertebrates from the 2019 and 2021 excavations at Oak Tree Fields, Cerney Wick (catalogued by D. Schreve)

Facies association	Sample	Unit	Column	Depth (cm)	Taxon and element
FA1	11	31006	I	17–30	Small mammal, indet. long bone (shaft frag.)
FA2	18	31064	II	30–35	Indet. bone frag. 3 × fish, indet. bone frag. *Gasterosteus aculeatus*, fin spine and one partial vertebra
	22	31064	II	47–52	Fish, indet. bone frag. 3 × Indet. bone frags
	26	31060	II	75–80	Small mammal, femur (epiphysis frag.) 3 × fish, indet. frag. Cyprinidae sp., pharyngeal tooth

Table 8. Large vertebrate remains identified from Oak Tree Fields, Cerney Wick (catalogued by H. Russ and K. Scott)

Faunal assemblage	Facies association	Number of specimens	Taxa identified
A	FA1	40	*Mammuthus* sp.
	FA2	1	*Mammuthus* sp.
	FA3	2	–
	FA4	4	*Mammuthus* sp.
	Indeterminate	9	*Mammuthus* sp. *Bovid* sp.
B	Indeterminate	143	*Mammuthus* sp. *Bovid* sp. *Bos taurus* *Bison priscus* *Ursus arctos*
Total		199	

component deposits are characterised by units of finer grain sizes than those of FA1 and are indicative of small point bars, drapes forming as flow energies dropped and fills of shallow abandoned channels. The trend of decreasing flow energy seen from deposits of FA1 to those of FA2 is continued in strata of FA3, which are predominantly fine-grained and suggest deposition by moderate-energy sediment gravity flow (sands and gravels) while channels were active, and during waning flood events (silts and clays) and in backswamp environments (organic muds) following channel abandonment. Vertebrate fossils greater than pebble size have yet to be found in deposits of FA2 and FA3, while Palaeolithic artefacts are so far absent from both the latter facies associations. These characteristics might suggest that the flow energy during the deposition of sediment of both facies associations was insufficient to transport coarse and/or dense particles, hence explaining the absence of lithic artefacts.

The poorly sorted nature, extra-local derivation of particles and angular shape of gravel clasts in strata of FA4 suggest a colluvial mechanism of deposition and formation as products of the erosion of the Kellaways Clay bluff and overlying Oxford Clay in the eastern part of the site. Nevertheless, it is likely that the FA4 deposits formed coevally with the FA1–FA3 strata, given that strata of FA3 overlie those of FA4, while a single mammoth tusk of similar taphonomic status to those in deposits of FA1 was found in FA4.

FA5 is comparable to facies association B of Latton (Lewis et al., 2006) and facies association B of Ashton Keynes (Lewis et al., 2001), albeit that deposits corresponding to fine-grained channel infills of facies association C and D at Ashton Keynes and facies association C at Latton have yet to be observed at Oak Tree Field. The predominantly sheet gravels that characterise FA5 strata were likely deposited in multiple shallow channels during high-energy flow and as inertial bedload, both in a braided stream environment (Miall 1996: 79). Nevertheless, it should be noted that none of the FA5 strata exposed at Oak Tree Field, either in test pit sections or the quarry walls have any indication of periglacial deformation. This absence suggests either that strata were sufficiently isolated from such conditions by deposits that were later removed.

Chronology, palaeoclimate and palaeoenvironment

The strata of FA1 that were sampled for OSL dating and palaeobiological investigation are stratigraphically later than the vertebrate fossils at the base of the palaeochannel but, as argued above, it is unlikely that the time separation was great. When plotted at one standard deviation the optical luminescence dates from strata of FA1–FA3 encompass the entirety of MIS 7 as well as early MIS 6, while at two standard deviations late MIS 8 is also included (Fig. 9). However, botanical and faunal remains recovered from the relevant deposits indicate a temperate climate and therefore suggest that deposits of FA1–FA3 accreted entirely during MIS 7. Indeed, a biostratigraphic indication that deposition was in a temperate stage not later than MIS 7 are the shells of *P. clessini* found in samples of strata from FA1 and FA2. Other mollusc taxa also suggest temperate climates during the accretion of deposits of FA1–FA3, i.e. *P. amnicum* and *E. henslowana* are only known from interglacials and interstadials of the British Pleistocene (Keen 2001), while the *Carpinus* pollen from deposits of FA1 indicates a pre-Holocene interglacial (Jones and Keen 1993). The nature of the temperate climate is further discriminated by a mutual climatic range (MCR) (*sensu* Atkinson et al. 1987) analysis of Coleoptera data from samples of all three facies associations using the BugsCEP software (Table 10) (Buckland and Buckland 2006). The reconstructed temperature ranges almost completely overlap, the only difference being that winter temperatures might have been cooler during accretion of deposits of FA1 than those of FA2 and FA3. It is notable that the ranges encompass the present local averages (16.6°C for July and 4.4°C for January between 1991 and 2021 at Cirencester [Climate-Data.org 2022]), albeit hinting at slightly cooler winter conditions during accretion of FA1–FA3 than today. Table 10 also includes MCR data for Latton, but while temperatures appear to have been warmer at the latter compared with Oak Tree Field in MIS 7, it should be noted that the Latton reconstruction is on the basis of only three species.

Samples from strata of FA1–FA3 can be discussed collectively with regards to the palaeoenvironment, as the variation is only in terms of detail. Molluscan and coleopteran remains

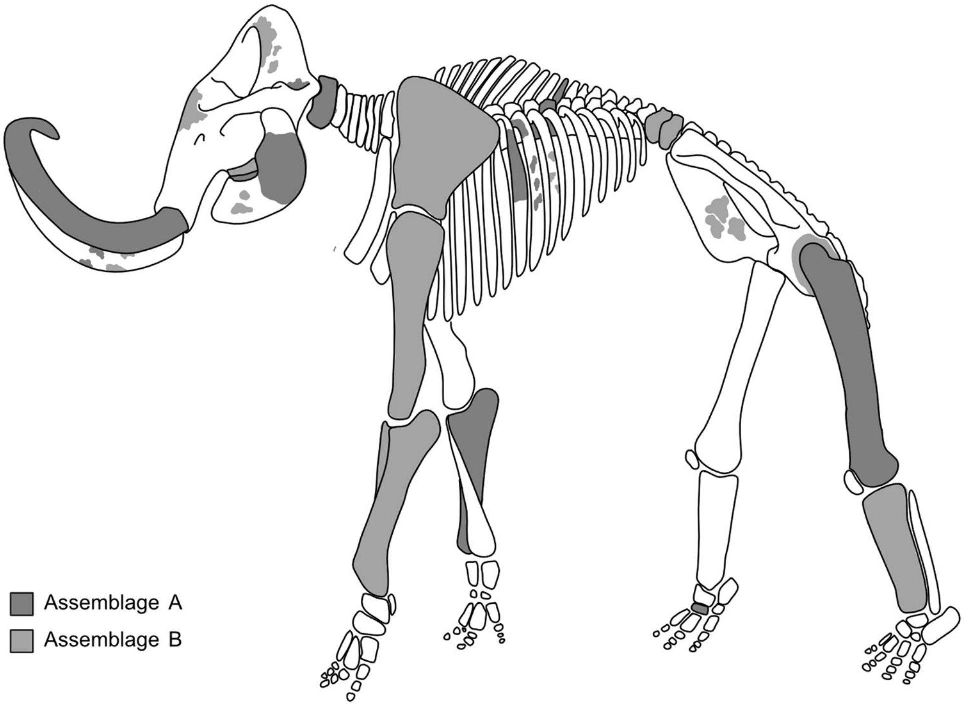

Figure 6. Schematic representation of the mammoth remains.

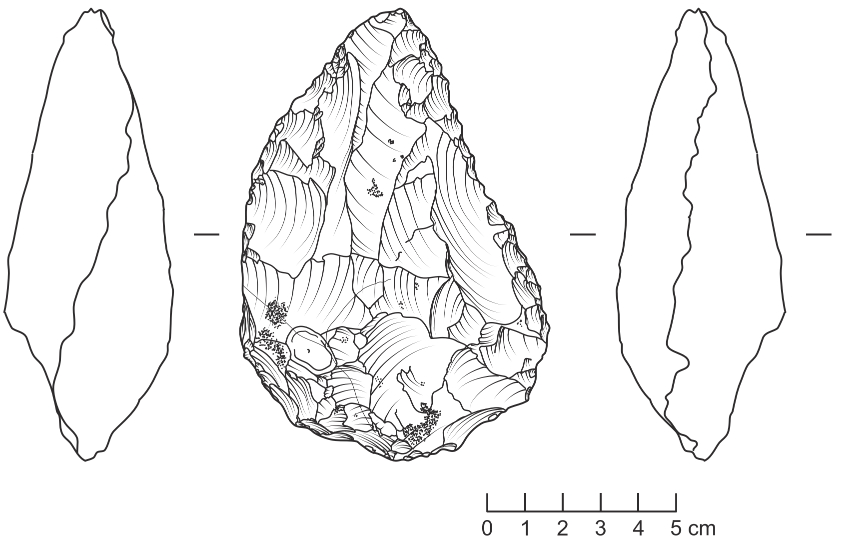

Figure 7. Sketch of handaxe found by the Hollingworths.

indicate the presence of shallow, flowing water throughout, while there seems to have been only minor bank erosion as evidenced by low frequencies of terrestrial Mollusca and plant macro remains, and the absence of identifiable terrestrial small vertebrates. Small numbers of Elmidae riffle beetles (*E. parallelepipedus* in FA1–FA3, but also *L. volkmari* and *E. aenea* in strata of FA3) throughout the sequence and the *V. piscinalis–B. tentaculata–P. amnicum* mollusc association suggest a moderately fast-flowing stream, probably with a stony bed, the latter also evidenced by freshwater limpets (*A. fluviatilis* and *A. lacustris*) in strata of FA3. The beetles *Georissus crenulatus*, recorded from deposits of FA1–FA3, and *Oulimnius bicolon*, identified in strata of FA3, are typically found in mud adjacent to stream channels. Both *E. parallelepipedus* and *G. crenulatus* favour substrates with abundant algae within the channel bed and in marginal sediments, respectively. Water beetles associated with slowly flowing or still water were present throughout the sequence, also in small numbers, while occasional statoblasts of *Lophopus crystallinus*, a bryozoan indicative of water with only a slight current, was recorded in deposits of FA2 and FA3. These invertebrate indicators of different current strength might reflect temporal (e.g. seasonal) or spatial variation in flow, both of which are characteristics of low-gradient meandering streams.

Floating aquatic vegetation is represented by willowherbs (*Epilobium*), pondweed (*Potamogeton*) and horned pondweed (*Zannichellia palustris*) macrofossil remains in samples from FA2, and bankside vegetation in samples from FA2 and FA3, by rushes (*Carex* sp.), bulrushes (*Scirpus* sp.), water crowfoots (*Ranunculus* subgenus *Batrachium*) and common water-plantain (*Alisma plantago-aquatica*) in FA1 and FA2. However, phytophages (herbivorous insects) are indicative of further specific emergent and marginal vegetation including arrowhead (*Sagittaria sagittifolia*), reed sweet-grass (*Glyceria maxima*) and perhaps other

Table 9. Lithic artefacts from Oak Tree Fields, Cerney Wick

ID	Unit	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	Description
H.001	–	118.4	81.3	42.3	321.8	Medium-sized sub-cordate handaxe. Bifacially worked using 'soft hammer' technique. Fully worked around the circumference with one edge twisted in profile. Slightly abraded. Unevenly patinated and stained brown to orangey-yellow, notably more so on one face. Fresh damage on one edge. Made on pale grey high-quality flint.
SF127	31012	41.7	16.3	11.7	6.2	Elongated flake. Plain butt with slight lip and diffuse bulb of percussion. Triangular in cross-section. Moderately abraded and damaged edges and arises. Mottled pale brown-grey-black glossy stained poor quality flint.
SF139	31012/14	41	30.8	10.1	9.9	Retouched thermal flake. Denticulated semi-abrupt scaled retouch at end. Precisely made. Abraded cortex is retained along one edge. Large frost-pit scar on the surface forms a convenient 'thumb-sized' impression. Made on pale grey high-quality flint. Extremely fresh, where retouched, with dark greyish brown staining. Heavily stained dark grey-black with white speckles on the other face. Heavily rolled and rounded, where the cortex is retained.
SF142	31012/14	25.2	15.4	8.3	3	Retouched flake? Poorly established butt with relict point of percussion, possibly naturally fractured. Abraded cortex retained at butt and right margin. Inverse semi-abrupt scalar removals along the majority of the left edge. Fresh removals, otherwise stained brown to orangey-yellow.
SF156	31014	23.4	26.3	8.3	3.5	Retouched fragment. Modified primarily by abrupt scalar retouch that converges forming 'piercer-like' projection. Fresh. No clear signs of rolling. Break at tip of projection. Moderately stained dark greyish brown flint.
SF157	31012/14	53.1	23.3	13.1	15.5	Retouched fragment. Moderately invasive semi-abrupt scaled retouch along both edges, one of which has slight edge-rounding. Heavily abraded cortex retained on dorsal surface. Moderately stained mid-brown flint.
SF162	31014	45.4	28.7	12.5	17.2	Retouched fragment? Modified primarily by inverse semi-abrupt scalar removals. Delineation of retouch is almost 'point-like' at one end, formed by converging convex/concave retouch on opposing edges, while at the other end an almost 'stem-like' project is formed by converging concave retouched edges. Abraded cortex on the entirety of the dorsal surface. Moderately stained poor quality pale greyish brown flint with cherty inclusions.
SF185	31012	22.8	13.1	2.6	0.8	Flake fragment. Moderately edge-damaged, although no signs of abrasion or rolling. Missing proximal end. Dorsal scars orientated in the same direction of the debitage axis. Mostly heavily patinated by bluish-white patina, although partial break at distal reveals original pale grey colour of flint.

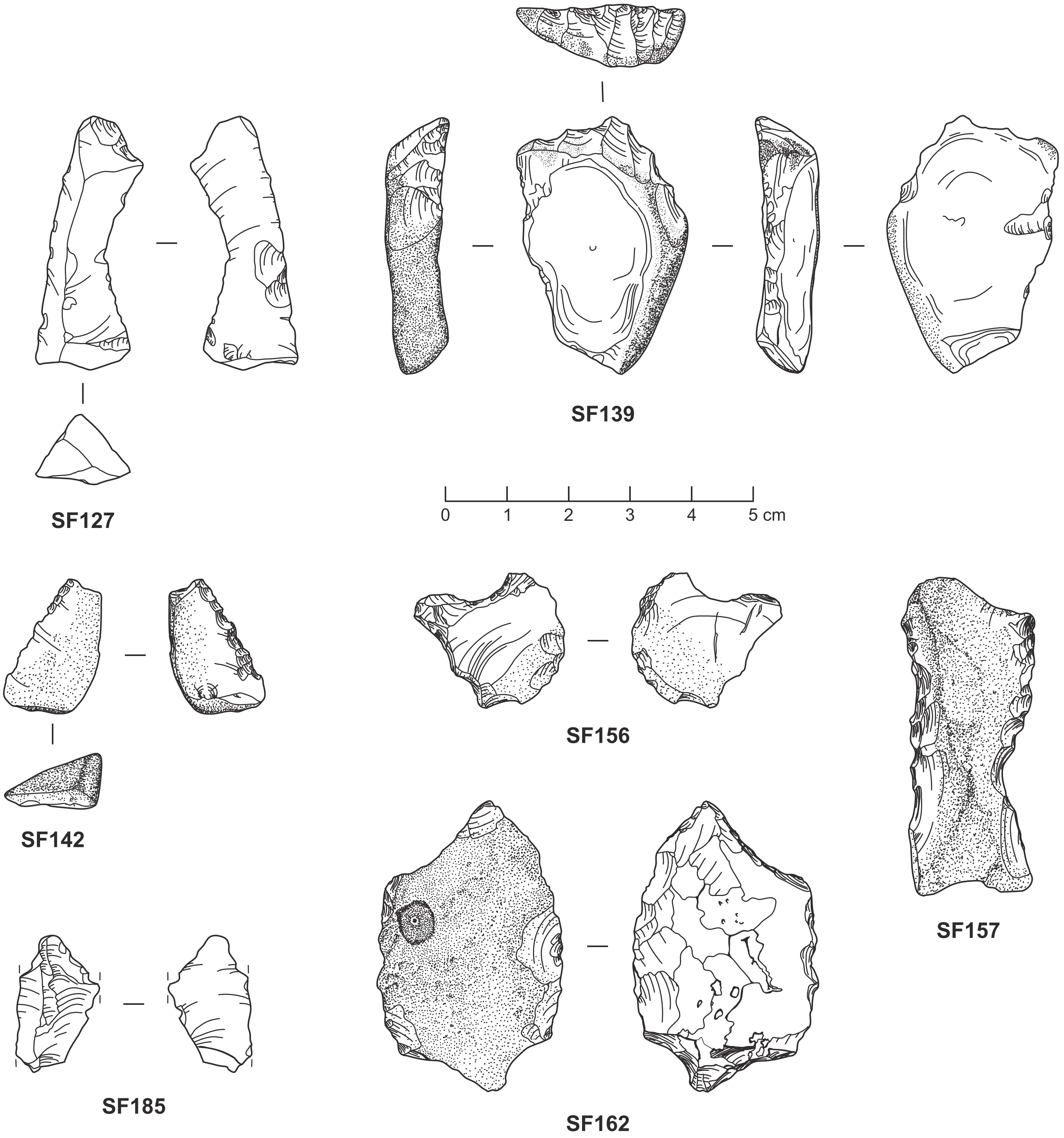

Figure 8. Lithic artefacts recovered from controlled excavations at Oak Tree Fields.

Glyceria species, as well as various forms of tall waterside vegetation suggestive of ‘reed-swamp’ communities. Water lilies (*Nymphaea* or *Nuphar*), i.e. floating plants living in still or slow-moving water, are also indicated by macrofossil remains in a sample from FA1 and the beetle *Donacia crassipes* in deposits of FA3. The molluscan evidence also suggests that the greatest density of aquatic vegetation is associated with deposits of FA3, although poor plant macrofossil preservation in deposits of this facies association means the exact composition of aquatic plants cannot be determined.

The albeit limited terrestrial mollusc fauna indicates that short vegetation communities occurred adjacent to the stream in all its phases, while plant macrofossil remains indicate the presence of buttercup (*Ranunculus repens/acris/bulbosus*), oxtongues (*Picris* sp.) and sorrel (*Rumex acetosella*) in samples from FA1 and FA2. Phytophage insects further indicate terrestrial ruderals not found as macrofossils such as knotweeds (*Polygonum*) and crucifers (Brassicaceae) in samples of FA1 and FA3. Nevertheless, grassland appears to have been the dominant terrestrial habitat, this developing on mainly dry, well-drained soils, but also in damper places, the latter probably close to the channel. Ribwort plantain (*Plantago lanceolata*), usually regarded as an indicator of disturbed grassland, is the host of the weevils *Mecinus pascuorum* and *M. pyraster* (FA3), and probably the main host of *Graptus triguttatus* (FA2). The mammoth fossils are a further indication of a grazed grassland habitat during the development of the FA1 sequence at least, but further indications of the presence

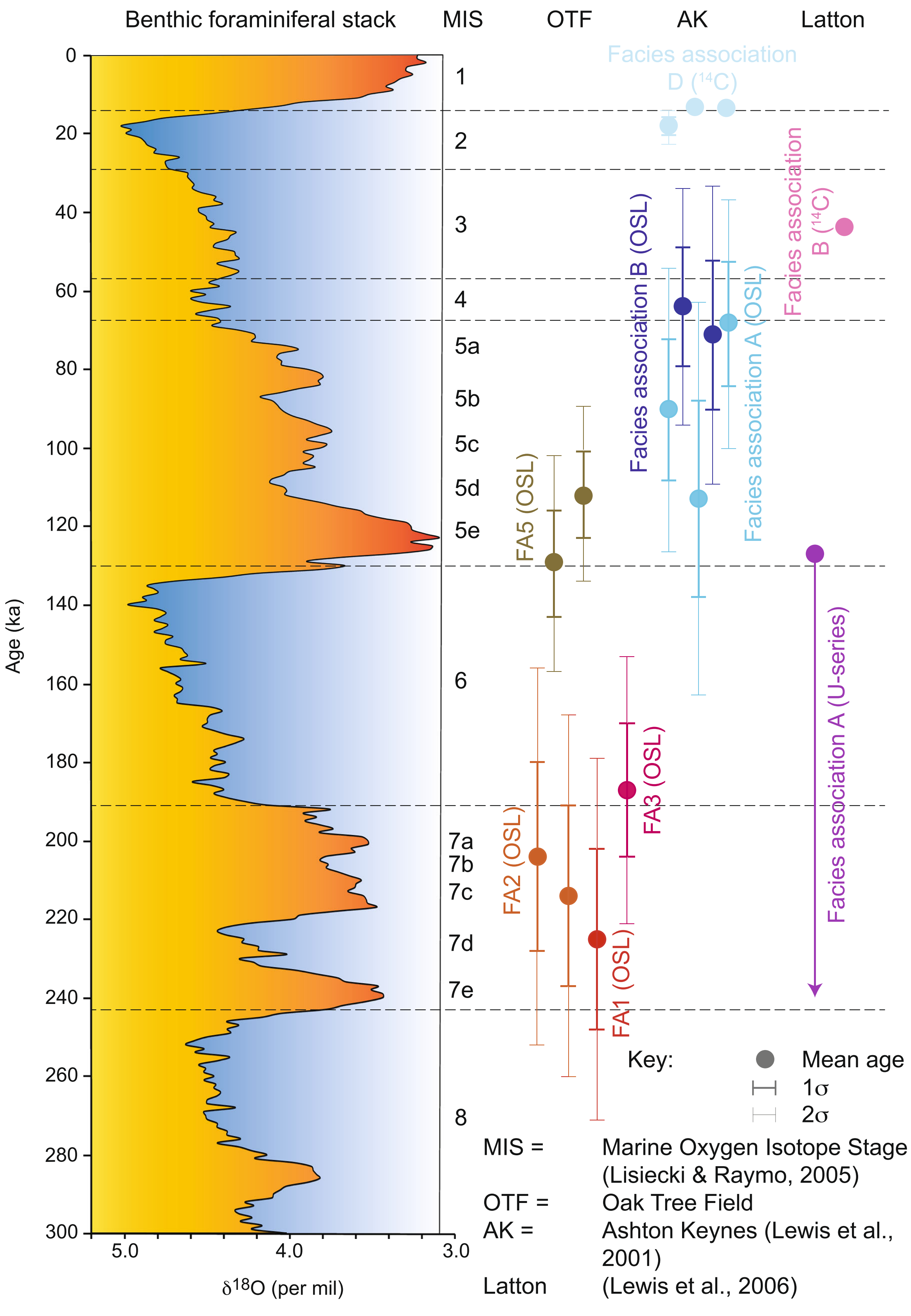

Figure 9. Chronometric dates from Oak Tree Fields, Latton and Ashton Keynes, plotted against global benthic foraminiferal stack $\delta^{18}O$ and marine oxygen isotope stage boundaries (Lisiecki and Raymo, 2005). [Color figure can be viewed at wileyonlinelibrary.com]

of herd animals are the substantial numbers of scarabaeoid dung beetles and other taxa associated with herbivore dung in FA1–3. Most of the relevant Coleoptera taxa identified are dependent on the dung of large mammalian herbivores, but some species will more rarely also exploit other forms of foul decaying vegetable matter or overwinter in flood debris (Jessop 1986: 19–25). Nevertheless, the abundance of various Staphylinidae, Histeridae and Hydrophilidae that are also primarily associated with herbivore dung is significant and it is clear that substantial amounts of dung were present locally. Despite the fact that the majority of dung beetles have very good dispersal abilities and, if necessary, will fly to find new

Table 10. Mutual climate range data for facies associations at Oak Tree Field (OTF) and Latton (L) (Lewis et al. 2006)

Site/facies association (Age)	No. species in MCR	T_{MAX}	T_{MIN}
OTF FA1 (MIS 7)	15	+18 to +15°C	+6 to −12°C
OTF FA2 (MIS 7)	14	+18 to +15°C	+6 to −6°C
OTF FA3 (MIS 7)	10	+18 to +15°C	+6 to −7°C
L FA A (MIS 7)	3	+26 to +17°C	+11 to −17°C
L FA Ba (MIS 5–4)	42	+19 to +15°C	+6 to −18°C
L FA Bb (MIS 4–3)	7	+14 to +9°C	−14 to −26°C

sources of fresh dung, modern analogue studies suggest that most taxa recorded in samples from small water bodies will have been feeding on dung within a 100–200 m radius, although a channel containing flowing water is likely to have had a greater catchment than a still water body. The same modern studies indicate that the relative abundance of dung beetles is strongly correlated with the density and proximity of locally grazing herbivores (Smith et al. 2010, 2014). There is no evidence from the molluscs for the presence of trees and very little from the beetle or botanical remains. The latter two classes might indicate occasional oak, willow/poplar, hornbeam and birch trees in an otherwise open grass meadow environment.

Oak Tree Field in an MIS 7 context

Flora and fauna

The similarity of the biological remains from the Oak Tree Field palaeochannel deposits (FA1–FA3) and facies association A at Latton is another argument for lateral and chronological continuity. The vertebrate assemblages from both sites are dominated by mammoth, with horse the only other taxon at Latton and bovid the only other taxon collected during the 2019 and 2021 excavations at Oak Tree Field. Although the number of fossils is small and lacking in diversity in both cases, and there is a consequent danger of an argument based on absences, the vertebrate faunas are broadly consistent with Schreve's (2001) Sandy Lane Mammal Assemblage Zone (MAZ). The latter equates to a late temperate stage of MIS 7, i.e. MIS 7c and/or MIS 7a, which in southern Britain is characterised by grassland habitats (Schreve 2001, Candy and Schreve 2007). Such an open environment is also indicated by the plant macrofossil, molluscan and coleopteran assemblages described for Cerney Wick and by Lewis et al. (2006) for Latton. Indeed, similar vertebrate, invertebrate and plant macrofossil assemblages to those at Oak Tree Field and Latton are also reported at Strensham (Worcestershire) in the Avon valley (de Rouffignac et al. 1995) and in the later layers (1 and 2) of the lower channel at Marsworth (Buckinghamshire) (Green et al. 1984, Schreve 1997, Murton et al. 2001). Woodland indicators at all these sites are few and restricted to very occasional phytophage beetles indicative of particular tree species (oak [*Quercus*], poplar [*Populus*] and willow [*Salix*] at Oak Tree Field), small numbers of arboreal pollen grains (hornbeam [*Carpinus*] at Oak Tree Field and Strensham; pine [*Pinus*], birch [*Betula*], oak, alder [*Alnus*] and beech [*Fagus*] at Strensham) and occasional plant macrofossils (birch at Oak Tree Field; yew [*Taxus baccata*] at Latton). Vertebrate indicators of woodland that are part of the Sandy Lane MAZ, e.g. straight-tusked elephant (*Palaeoloxodon antiquus*) and Merck's rhinoceros (*Stephanorhinus kirchbergensis*) are absent from the sites listed above. Overall, the impression from Oak Tree Field, Latton, Strensham and the later MIS 7 layers at Marsworth is of isolated stands of trees in an environment even more open than that envisaged for the Sandy Lane MAZ-type sequence at Aveley (Essex) (Schreve 1997, 2001) or the geographically closest (to Oak Tree Field) manifestation of the MAZ at Stanton Harcourt (Oxfordshire) (Scott and Buckingham 2021). Another notable absence from Oak Tree Field, Latton, Strensham and layers 1 and 2 of the lower channel at Marsworth is the bivalve mollusc *Corbicula fluminalis*, which is distinctive of MIS 7 (Keen 1990, 2001, Meijer and Preece 2000) and found with vertebrate fossils of the Sandy Lane MAZ in fluvial deposits, including in profusion at Stanton Harcourt (Scott and Buckingham 2021). It is of course possible that ecology might be the reason for the lack of *C. fluminalis* at the four sites. The species is characteristic of warm climates and large streams with a muddy substrate into which it can burrow (Kennard 1944). Oak Tree Field, Latton and Marsworth are relatively small channels in proximity to headwaters, while the Strensham deposits are thought to have accumulated in a floodplain pool. However, the species is known from MIS 7 deposits in an Avon tributary upstream of Strensham at Ailstone (Keen 1990, Maddy *et al.* 1991), while other mollusc species indicative of moving water are found in deposits at Strensham (e.g. *V. piscinalis, A. fluviatilis*). It is also notable that *C. fluminalis* is recognised as an efficient coloniser over its present Asian range (Kennard 1944), while its upstream expansion along the Rhine and connected streams in the 20th century is well documented (e.g. Bernauer and Jansen 2006). In other words, its absence and indeed the lack of vertebrate taxonomic diversity might be chronologically determined and the deposits at Oak Tree Field, Latton, Strensham and layers 1 and 2 of the lower channel at Marsworth could date from a different MIS 7 sub-stage than other Sandy Lane MAZ sites.

Palaeolithic archaeology

Artefacts from Oak Tree Fields, Cerney Wick, indicate the use of varied lithic technology, including potentially handaxes, in the upper Thames during MIS 7. No evidence of Levallois technology has yet been found from the site. Unfortunately, there are few other well-dated sites of a comparable age from the region, although there are some tentative indications for contemporary handaxe assemblages. At nearby Latton, a number of handaxes were recovered from the fossiliferous deposits correlated with MIS 7 (Lewis et al. 2006). Those handaxes were mostly described as rolled and stained, and were interpreted as having been redeposited from older deposits, although one (2001.144/2) was stated as having been found *in situ* and was only slightly abraded. No evidence of the use of the Levallois technique was recorded at Latton.

Further downstream, Stanton Harcourt produced derived artefacts from the base of MIS 6 gravels (referred to the 'Gravelly Guy' quarry) (MacRae 1990) and artefacts in near primary context from excavation of the MIS 7 'Stanton Harcourt Channel' deposits, these latter associated with a significant vertebrate assemblage (Buckingham et al. 1996, Buckingham 2007, Scott and Buckingham 2021). Thirty-six artefacts made of flint and quartzite have been reported from the channel deposits, including 15 handaxes, cores (one of which is 'Levallois-like') and flakes. Although there is variation in artefact condition, indicating some reworking, many of artefacts (including handaxes) are barely worn and as such are thought to have moved very little within the channel.

Cassington Pit, Yarnton, provides a relatively large assemblage (~100 artefacts) of derived artefacts comprising handaxes, cores and flakes, primarily made of quartzite, with no evidence of Levallois technology (Hardaker 2001; Maddy et al. 1998). Most of the artefacts are from MIS 5 gravels at the base of the Northmoor Member. However, given the lack of convincing evidence for the occupation of Britain during MIS 6–3 (Ashton and Lewis 2002, Currant and Jacobi 2002), the artefacts most likely date from MIS 7 or earlier. Hardaker (2001) notes that Oxford Clay adhered to many of the artefacts, indicating that they lay on the interface of that geological unit and the overlying Northmoor Member, plausibly suggestive of a lag. A similar depositional context has been suggested for the artefacts from 'Gravelly Guy' Stanton Harcourt, Berinsfield (MacRae 1987) and cannot be excluded for the handaxe from Cerney Wick.

Other derived assemblages dominated by handaxes, cores and flakes found while quarrying gravels belonging to Northmoor Member and Summertown-Radley Member have been recorded at Hardwick, Gill Mill and in the vicinity of Abingdon (all in Oxfordshire) (Hardaker 2001), and which may also provide evidence of human activity before MIS 6. Notably, no convincing Levallois products have been reported from these sites. A large assemblage (~200 artefacts) including handaxes and handaxe trimming flakes, but also two Levallois cores and several Levallois flakes, was amassed from gravel pits at Berinsfield, (Oxfordshire) (MacRae 1982). Unfortunately, the context of this material is poorly understood, while the artefacts are likely to derive from at least two terraces.

Although the upper Thames assemblages tentatively indicate the continuation of handaxe technology into MIS 7, recent work has conversely shown the dominance of Levallois technology largely, if not entirely, to the exclusion of handaxe manufacture, in the middle and lower Thames during late MIS 8 and early MIS 7 (Scott 2006, 2011, White et al. 2006). Assemblages from the middle and lower Thames sites were almost entirely amassed during the 19th and early 20th century, and current understanding of the archaeological record is mostly drawn from a reappraisal of antiquarian collections from gravel pits in the London area. These include Creffield Road, Acton (Brown, 1887); West Drayton and Yiewsley in West London (Brown, 1895); the Lion Pit Tramway Cutting, West Thurrock (Essex) (Dibley and Kennard 1916, Warren 1923, Bridgland and Harding 1994, Schreve et al. 2006), deposits infilling the Ebbsfleet Valley, including the locality often referred to as 'Baker's Hole' (Smith 1911, Burchell 1935, 1936a, 1936b, 1957, Kerney and Sieveking 1977, Wenban-Smith 1995, Scott et al. 2010) and a number of brickearth pits near Crayford (Kent), most notably Stoneham's Pit, which provides an extraordinary set of refitting knapping sequences (Spurrell 1880, 1884). Aveley (Essex) provides a more recently excavated sequence (Candy and Schreve 2007, Schreve 1997, 2001a, 2001b) but only a small assemblage of artefacts ($n = 8$) was recovered, which included a small, extensively worked Levallois core (White et al. 2006). Beyond the Thames Valley, reanalysis of existing assemblages has also led to the suggestion that Levallois technology dominated to the exclusion of handaxes during MIS 8–7 in East Anglia (Scott 2006, 2011, White et al. 2006), as evidenced by Levallois cores and flakes from Jordan's Pit (Brundon, Suffolk) (Moir and Hopwood 1939), but also a single Levallois core from the 'Stoke Bone Bed' (Ipswich, Suffolk) (Layard 1920). It is notable that the majority of the Levallois assemblages listed above include handaxes, yet these have been suggested to be derived from earlier deposits at the same localities and differentiated from the Levallois artefacts largely on the basis of condition (Scott 2006, 2011, White et al. 2006). It is also notable that all of these Levallois assemblages are located immediately nearby or in relatively close proximity to plentiful good-quality raw material which may have been an important factor in the technological strategies adopted locally (Scott 2006, 2011, White et al. 2006).

Elsewhere in Britain, studies have shown evidence for the continuation of handaxe technology beyond MIS 9 (Ashton and Hosfield 2010, Ashton et al. 2018), seemingly reflecting similarities with the upper Thames. Cuxton (Kent) in the Medway Valley stands out for having a handaxe-dominated assemblage, including *in situ* debitage, with no evidence of Levallois material and is OSL dated to the end of MIS 8 or early MIS 7 (Wenban-Smith et al. 2007) but based on handaxe typology has been attributed to MIS 9 (Bridgland and White 2014, 2015). For the Solent and its ancient tributaries to the west, handaxe technology seemingly continues in use into MIS 8. Evidence from Harnham (Wiltshire) is argued to show the late persistence of handaxe technology into later MIS 8, possibly early MIS 7 and, notably, without any signs of Levallois technology (Bates et al. 2014). Reappraisal of museum collections from the Solent region indicates that while Levallois technology is only sparsely recorded it may coincide with the major phase of Early Middle Palaeolithic occupation inferred from the middle and upper Thames during late MIS 8 or early MIS 7, although handaxes may persist into MIS 8 (Davis 2013, Davis et al. 2016, 2021). Further west in the Axe Valley, Broom (Devon and Dorset) has yielded significant handaxe-dominated assemblages (~1800 artefacts), with only limited evidence of the Levallois (two flakes and one core), while associated OSL dates indicate deposition during late MIS 9, MIS 8 and MIS 7 (Hosfield 1999, Hosfield and Chambers 2002, 2009, Toms et al. 2005). Pontnewydd Cave (Clwyd, Wales) represents a particularly northerly assemblage and is significant for not only having handaxe assemblages dating from MIS 7 but also evidence of Levallois technology from the same deposits (Aldhouse-Green et al. 2012).

There are various ways of interpreting the artefact evidence of late MIS 8 to early MIS 6 in southern Britain. One extreme viewpoint is that handaxes were not made after MIS 9 and all handaxes from MIS 8 and MIS 7 sites reflect poorly understood taphonomic situations. In other words, all handaxe material in MIS 8/7 strata has been reworked from MIS 9 and earlier deposits (Pettitt and White 2012, White et al. 2018). An alternative is that handaxes do genuinely occur in assemblages dating from MIS 8 and MIS 7, albeit with limited evidence for the co-occurrence of handaxes and Levallois technology at the same localities. Rather, the separation of handaxe and Levallois sites represents varied cultural geographies. It has been highlighted that there is a concentration of handaxe-dominated assemblages in the west of Britain, possibly indicating that hominin populations persisted from MIS 9 through to late MIS 8 in these areas (Bates et al. 2014) or that Neanderthals with handaxe-dominated technology repopulated Britain from elsewhere in northwest Europe during MIS 8 (Ashton and Hosfield 2010, Ashton *et al.* 2011; Scott and Ashton 2011). It has also been suggested that the Levallois industries of southeast Britain reflect the subsequent spread of populations from continental Europe during late MIS 8 or early MIS 7, possibly following extirpation of handaxe-making populations (Bates et al. 2014). Alternatively, cultural exchange might have led to the spread of Levallois technology in surviving handaxe-making populations (Ashton et al. 2018). Given the scant evidence, new findings may confirm or refute current hypotheses, yet the tentative evidence for MIS 7 handaxe assemblages and the general lack of Levallois technology in the Upper Thames valley would appear broadly consistent with emerging regionality suggested for the Early Middle Palaeolithic in Britain.

Conclusions

This paper presents lithostratigraphic, chronometric, palaeontological and archaeological findings from Oak Tree Fields, Cerney Wick, and has demonstrated the following:

- A palaeochannel forming in a meandering stream environment developed and was filled in MIS 7, and is possibly the same feature as found 1.5 km northeast at Latton (Lewis et al. 2006). The palaeochannel is overlain by fluvial deposits of the Northmoor Member and which are dated to the middle and late sub-stages of MIS 5.
- Biological proxies demonstrate a slow-moving and shallow stream, bordered by grassland habitats during accretion of the channel fills in MIS 7. These open habitats were occupied by mammoth, some of which died in or in close proximity to the channel.
- The handaxe, flakes and retouched tools were found in the same sediments. These likely reflect different episodes of activity in the vicinity of the channel.
- The presence of handaxe technology in the upper Thames highlights regional and/or chronological variation in the technological repertoire in Britain during MIS 7.
- The site provides potential for exploring chronological variation in the palaeoenvironmental and archaeological record during MIS 7.

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Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Supporting information

Additional supporting information can be found in the online version of this article.

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