JOURNAL OF QUATERNARY SCIENCE (2023) 1–25 ISSN 0267-8179. DOI: 10.1002/jqs.3524

JQS Journal of Quaternary Science QRA Quaternary Research Association

Middle Palaeolithic occupation of the southern North Sea Basin: evidence from the Sandscaping sediments emplaced on the beach between Bacton and Walcott, Norfolk, UK

ROB DAVIS,[1]* NICK ASHTON,[1] RACHEL BYNOE,[2] JOHN CRAVEN,[3] ROB FERGUSON,[3] IAN GARDNER,[3] TIM GRIMMER,[3] CLAIRE HARRIS,[4] MARCUS HATCH,[4] COLIN JOHNSON,[3] JOANNE LEONARD,[5] SIMON LEWIS,[4] DARREN NICHOLAS[5] and MATT STEVENS[3]

[1]Department of Britain, Europe and Prehistory, British Museum, London, UK
[2]Department of Archaeology, University of Southampton, Southampton, UK
[3]Independent researcher, Happisburgh, UK
[4]School of Geography, Queen Mary University of London, London, UK
[5]Independent researcher, Norwich, UK

Received 13 December 2022; Revised 24 March 2023; Accepted 31 March 2023

ABSTRACT: During the summer of 2019, the Bacton to Walcott Coastal Management Scheme involved the emplacement on to the foreshore of 1.8 million cubic metres of sand and gravel dredged from the submerged sediments of the Palaeo-Yare in the southern North Sea 11 km off Great Yarmouth. During the following 2-year period, an active group of collectors identified Palaeolithic artefacts eroding from these sediments, including Levallois cores and flakes, and cordiform handaxes. In this paper, we present an analysis of the lithic artefacts, and consider the relationships between the different elements of the assemblage. We discuss its significance in the context of the Middle Palaeolithic record of northwest Europe and the light it shines on the human occupation of the submerged landscape of the southern North Sea during the later Middle Pleistocene. Interrogation of beach survey data shows the reworking of these sediments to the southeast towards Happisburgh where archaeologically significant exposures of the Cromer Forest-bed Formation are located. The implications of the introduction of a Middle Palaeolithic assemblage to this stretch of the North Norfolk Coast are considered, highlighting the importance of continuing dialogue between researchers, local authorities and local communities for capturing information and monitoring this critical Palaeolithic resource.

KEYWORDS: handaxes; Levallois; Middle Palaeolithic; North Sea; submerged landscapes

Introduction

The archaeological record of northwest Europe has been central to the understanding of the emergence of Neanderthal behaviour during the early Middle Palaeolithic, with the development of more complex technologies, extended territories and adaptation to cooler, more open environments (Scott & Ashton, 2011; Hérisson et al., 2016; Moncel et al., 2020; Scott et al., 2019). British evidence has made an important contribution, but the major sites have been predominantly in the lower reaches of the Thames valley (Scott, 2011; Scott et al., 2011). By comparison, East Anglia has an impoverished record with a handful of small, mixed assemblages mainly around Ipswich. Indeed, the near-coastal distribution of sites in southeast England has led to the suggestion of a northwestern limit to Neanderthal occupation in the early Middle Palaeolithic (Ashton et al., 2018). A clear gap in our knowledge are the submerged landscapes of the southern North Sea Basin (Roebroeks, 2014). Previous studies have tended to view it as just a routeway into Britain, but emerging work, including the evidence from this paper, shows that it was a major area of habitation that can enrich our understanding of the Neanderthal occupation of northwest Europe.

Furthering knowledge of these submerged landscapes has many challenges. Artefacts have previously been recovered during dredging for fishing and mineral extraction (Peeters et al., 2009). These typically lack contextual information, with dating often based on typology and/or technological features, or radiocarbon dating of tools made on organic materials, but indicate human occupation from the Middle Palaeolithic through to the Neolithic. Vast quantities of Pleistocene fossils have also been recovered during dredging activities, which have enabled the reconstruction of the mammalian communities (e.g. Van Kolfschoten & Van Essen, 2004; Glimmerveen et al., 2004, 2006; Mol et al., 2006; Bynoe et al., 2016; Amkreutz & van der Vaart-Verschoof, 2022).

Establishing the stratigraphic context of Middle Palaeolithic artefacts and refining the chronology of occupation is a significant challenge. Sediment cores, along with bathymetry and other survey data from the sea floor, have been used to model the topography and geology of the region, map river valleys, as well as identify features that record the key events in the evolution of the landscape (e.g. Gibbard, 1988, 1995; Velegrakis et al., 1999; Gupta et al., 2007, 2017; Busschers et al., 2008; Toucanne et al., 2009; Hijma et al., 2012; Missiaen et al., 2021). Adding humans to this picture can be

*Correspondence: Rob Davis, as above.
E-mail: rdavis@britishmuseum.org

achieved through targeted dredging or sampling of sedimentary units. Such work has been carried out on sediments of the Palaeo-Yare, the submerged downstream portion of the River Yare off the coast of Great Yarmouth, and the site of the East Coast aggregate extraction block (ECAEB). Following the discovery of Middle Palaeolithic artefacts in stockpiled gravels from Area 240 at the Flushing wharf in Vlissingen, Netherlands (Tizzard et al., 2014), a programme of work commissioned and funded by the operators of the marine aggregate licences in the ECAEB established the distribution and chronology of the Pleistocene sediments, and put in place a programme of archaeological sampling and wharf monitoring (Wessex Archaeology, 2011, 2013, 2015, 2021). This work demonstrated that the Middle Palaeolithic artefacts from Area 240 are likely to have originated in a complex unit of sand and gravel layers (Unit 3b) deposited by the Palaeo-Yare (Tizzard et al., 2014; Wessex Archaeology, 2015, 2021), dated by optically stimulated luminescence (OSL) to marine isotope stage (MIS) 7/6 (Marshall, 2020).

An important additional source of information is provided by beach finds. Sediments extracted from the southern North Sea have been used to reinforce sea defences along the Dutch coast and in major infrastructure projects at the Port of Rotterdam (Maasvlakte 2) and Ter Heijde (Zandmotor) (Amkreutz & van der Vaart-Verschoof, 2022), and in the UK in beach replenishment schemes at Clacton, Essex (Bynoe, 2018; Bynoe et al., 2022), and Bacton, Norfolk (see below). At each of these locations, communities of collectors have amassed large collections of artefacts and fossils that can be linked back to the offshore extraction sites. The scale of this work, with millions of cubic metres of sediment spread across large areas of the coast, repeatedly turned over by the sea, and searched by dedicated collectors over a long period of time, achieves a far greater archaeological visibility than commercially funded wharf monitoring or seabed sampling, albeit with a reduced level of contextual control. Through collaboration between collectors and professional archaeologists and heritage organizations, large collections of material that would otherwise be lost are added to the archaeological record of the southern North Sea basin.

The Bacton to Walcott Coastal Management Scheme

During the summer of 2019, ~1.8 million cubic metres of sand and gravel was emplaced on the beach between Bacton and Walcott, Norfolk, UK. The Bacton to Walcott Coastal Management Scheme (BWCMS; https://www.north-norfolk.gov.uk/sandscaping), or the "Sandscaping" scheme, was developed in response to the ongoing coastal erosion in the area, in particular the significant impact of storm events, such as the North Sea surge of 2013, and the threat to key infrastructure, such as the Bacton Gas Terminal, and coastal communities. The aim of this engineering solution was to protect this stretch of coastline by building up the beach levels to absorb the sea's forces before they reach the cliffs and pre-existing coastal defences.

The sediments used to replenish the beach were dredged from a series of licence areas adjacent to Area 240 within the ECAEB (Figs. 1 and 2). The dredged sediments were transported to Bacton and Walcott by a large trailer suction hopper dredger and pumped through large-diameter metal pipes onto the beach, where bulldozers equipped with GNSS (global navigation satellite system) moved the sediments into place. Within weeks of completion of the project, a number of collectors began to find Palaeolithic artefacts eroding from the sandscaping sediments (Fig. 3). Over the next 2 years, more than 1000 lithic artefacts were collected, including Levallois flakes and cores, and handaxes.

This paper presents the results of the analysis of the Bacton to Walcott lithic assemblage, describing its taphonomy, typology and technology. Comparisons are made with the Area 240 lithic assemblage, providing an enhanced view of the archaeological record of the Palaeo-Yare and of the southern North Sea more broadly. Comparisons are also made with the locally derived and *in situ* Lower Palaeolithic record from the foreshore in this area, which is derived from the Cromer Forest-bed Formation (CF-bF) and provides crucial evidence for the early human occupation of northwest Europe (Parfitt et al., 2010; Ashton et al., 2014; Lewis et al., 2019; Bynoe et al., 2021). The implications of the introduction of a Middle Palaeolithic assemblage to this archaeologically important coastline for future work on the archaeology of the CF-bF are also considered.

The geology, chronology and archaeology of the Palaeo-Yare

The Palaeo-Yare has been the subject of two projects undertaken by Wessex Archaeology: 'Seabed Prehistory' (Wessex Archaeology, 2011; Tizzard et al., 2014), funded via the Marine Aggregate Levy Sustainability Fund, and 'Palaeo-Yare Catchment Assessment' (Wessex Archaeology, 2013, 2015, 2021), which was funded by the operators of the marine aggregate licences in the ECAEB. The aim of this work was to understand the geology, palaeogeography, palaeoenvironment and archaeology of the ECAEB, and to develop methods for managing and mitigating the potential effects of dredging on the submerged archaeological record. This work consisted of the acquisition and study of existing geophysical data held by marine aggregate operators, assessment of existing vibrocore logs collected by industry, plus the recovery of new cores for geoarchaeological recording, OSL and radiocarbon dating, and palaeoenvironmental assessment. Alongside this was a programme of archaeological sampling and monitoring.

Geological context and chronology

Eight sedimentary units have been mapped within the ECAEB (Table 1; Tizzard et al., 2014, 2015). Units 1 and 2 pre-date the development of the Palaeo-Yare. Unit 2 is understood to be part of the Yarmouth Roads Formation. The main Palaeo-Yare channel is cut into Unit 2 and infilled with a coarse gravel (Unit 3a) followed by a complex series of fluvial sands and gravels (Unit 3b) deposited within the channel and beyond its margins, probably under cold conditions in a braided river setting. OSL age estimates for Unit 3b range between MIS 9 and 6, with a Bayesian chronological model indicating probable deposition of this unit between MIS 7 and 6 (Marshall, 2020). A molluscan assemblage recovered from the western part of Area 240 indicates a muddy, estuarine and intertidal environment, with pollen indicating boreal conditions (Limpenny et al., 2011; Tizzard et al., 2014).

Unit 4, dated by OSL to the latter part of MIS 5, consists of clayey, silty sand overlain by horizontally bedded sand and clay, infilling wide, shallow channels cut into the upper part of Unit 3b. Further small depressions in the surface of Unit 3b are infilled with sands with occasional interbedded clays (Unit 5), and sandy gravel (Unit 6). The former are likely to have been deposited during either the early or mid-Devensian, while Unit 6 has been dated by OSL to MIS 3. Units 5 and 6 have only

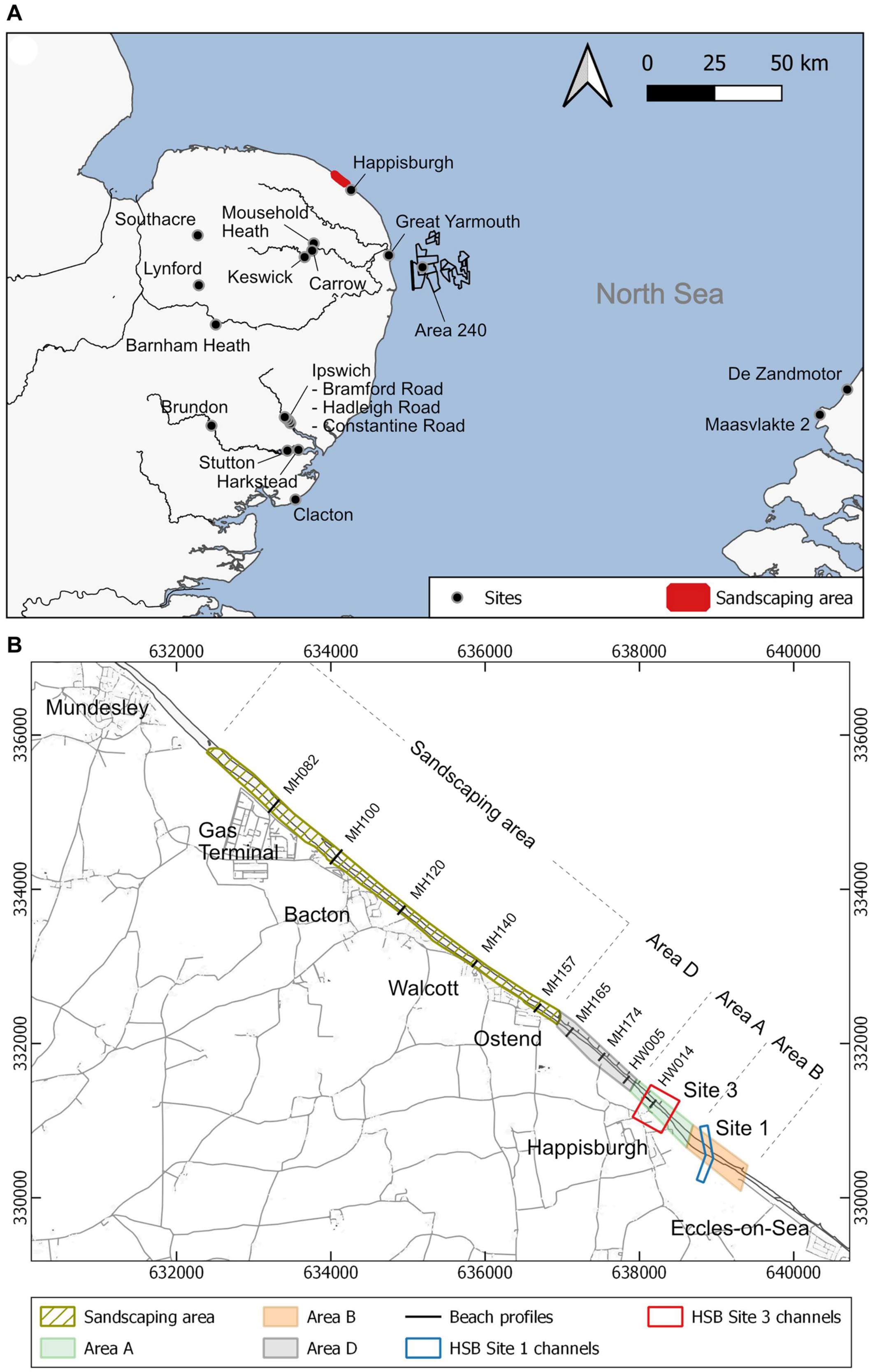

Figure 1. Location map. A: the southern North Sea region showing the location of the Bacton to Walcott sandscaping and the licence areas off the coast of Great Yarmouth, with sites/locations mentioned in the text. B: the North Norfolk coast between Mundesley and Eccles-on-Sea, showing extent of the sandscaping, collecting areas A, B and D, and the position of the channels at Happisburgh Site 3 and Site 1. Contains data provided by The Crown Estate that are protected by copyright and database rights. Contains Ordnance Survey data © Crown copyright and database right 2021. [Color figure can be viewed at wileyonlinelibrary.com]

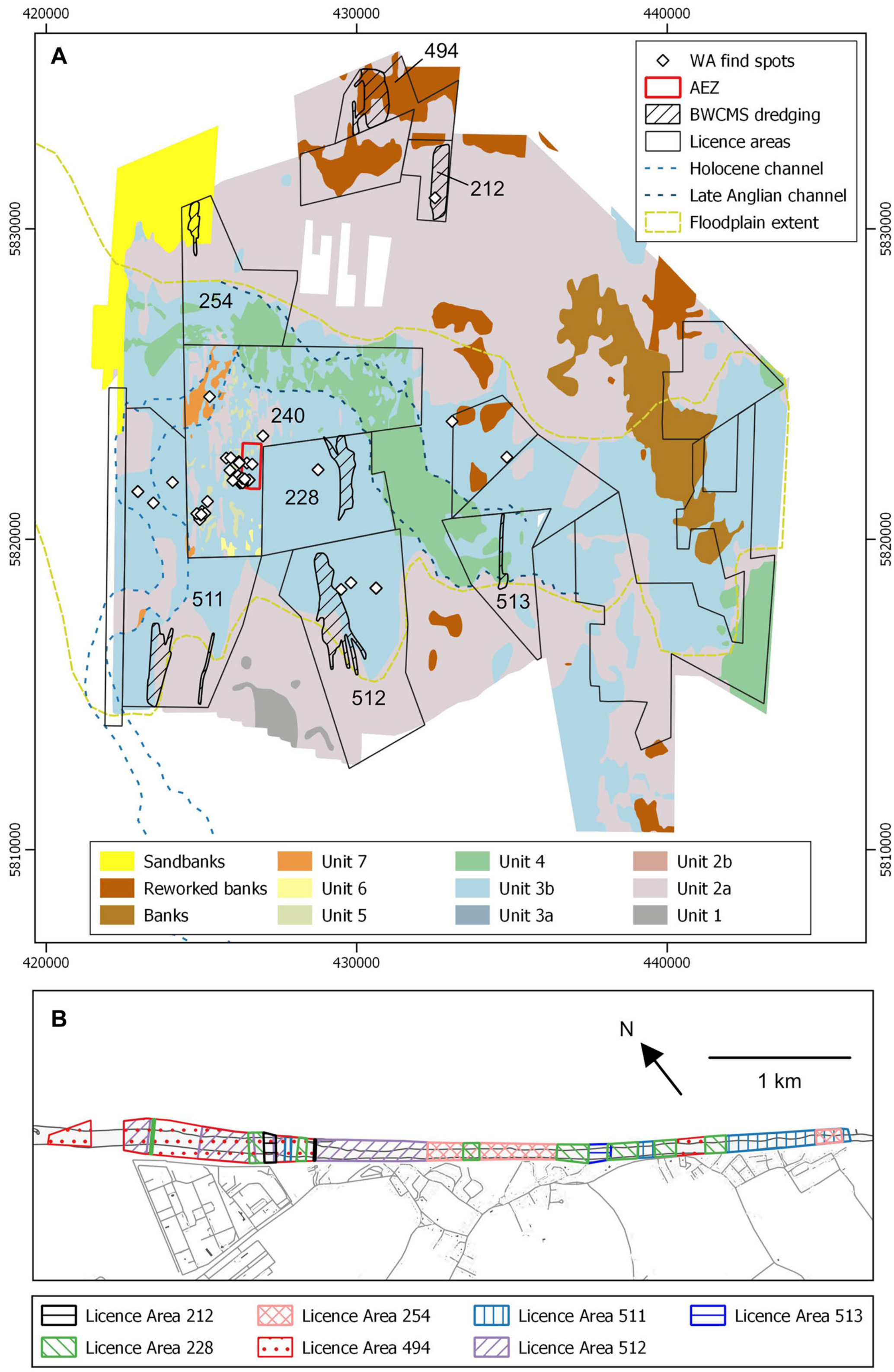

Figure 2. Palaeo-Yare superficial geology and licence areas for aggregate extraction. A: the main units of the Palaeo-Yare as mapped by Tizzard et al. (2015), with licence areas and the location of dredging for the Bacton to Walcott sandscaping. B: the distribution of sediments from different licence areas emplaced on the beach during the sandscaping work. Dredging and beach emplacement locations after Wessex Archaeology (2020). Contains data provided by The Crown Estate that are protected by copyright and database rights. Contains Ordnance Survey data © Crown copyright and database right 2021. [Color figure can be viewed at wileyonlinelibrary.com]

been identified in Area 240, although it is possible that they have not been detected elsewhere due to the low resolution of the datasets (Wessex Archaeology, 2015). The upper two units (Units 7 and 8) were deposited during the Holocene. Unit 7 partially infills a north–south channel that represents the diversion of the Palaeo-Yare during the early Holocene. Holocene seabed sediments (Unit 8) have formed a veneer over the Pleistocene sediments with some mobile bedforms such as ripples and larger sandwaves, as well as some bank features.

Figure 3. Photographs of the beach between Bacton and Walcott following completion of the sandscaping. A: a view of the sand 'cliff' at the high-water mark near the Bacton Gas Terminal, illustrating the extensive erosion of the sandscaping sediments in this area (23 September 2020); B: a hard hammer flake found on the surface of the beach sands near Ostend (15 November 2019); C: a view of the beach between Ostend and Walcott, with the hard hammer flake next to the trowel in the foreground (15 November 2019) (photo credits: RD). [Color figure can be viewed at wileyonlinelibrary.com]

Archaeology

The Palaeo-Yare archaeological record (Table 2, Fig. 2A) is dominated by finds from Area 240. As well as the original discovery of 88 artefacts, which originated within an area of that licence that was subsequently protected by an archaeological exclusion zone (AEZ), a further 80 artefacts from within or immediately adjacent to the AEZ and a cluster of six artefacts from the southwestern part of Area 240 have been recovered (Wessex Archaeology, 2013, 2015, 2021). Sampling in other licence areas has produced just 14 lithic artefacts. The majority of the handaxes are cordiform or sub-cordiform in shape, and there are 32 Levallois artefacts. Of the remaining cores and flakes, most are not diagnostic of a particular technique or period. However, at least three are indicative of Upper Palaeolithic, Mesolithic or later Holocene technology: a bipolar blade core (Area 240 SW), a small blade core (Area 511) and a blade (Area 512). Many of the artefacts are in fresh condition, although there is also a more rolled element and there are varying degrees of patination and staining, suggesting a mixed assemblage from both (near) primary and secondary contexts.

There is a strong correlation between artefact recovery and areas mapped as Unit 3b (Tizzard et al., 2014). The age of Unit 3b is consistent with at least some of the artefacts, such as the Levallois material, being Middle Palaeolithic, although there remains the possibility that some Lower Palaeolithic material could have been reworked from older sediments. It is also clear that there is some mixing with younger artefacts being recovered. The density of artefacts is very low, as measured by the wharf monitoring, but there are much greater densities from the grab samples from the AEZ, so the overall distribution is unclear. However, the fresh condition of many of the artefacts, together with the large number of finds from the initial discovery, the grab samples and from the central part of Area 240, suggests that there are high concentrations of near primary context material in those areas of the AEZ (Wessex Archaeology, 2015).

BWCMS dredging areas

The source areas of the sediments used in the BWCMS, and the position of the sediments on the foreshore, has been reconstructed from GNSS data recorded during dredging and emplacement (Wessex Archaeology, 2020; Fig. 2). The dredging lane tracks can be overlain on the geological mapping to show which units were exploited (Fig. 2A). In most areas, this was Unit 2 and/or Unit 3b. Dredged sediments from Area 513 may also have included Unit 4, whilst a

Table 1. Summary of the stratigraphy and chronology of the Palaeo-Yare (after Limpenny et al., 2011; Tizzard et al., 2014, 2015).

Palaeo-Yare unit	Description	Dating	Proposed age	Sedimentary environment
Unit 8	Veneer of coarse sediments or bedforms		Holocene (post-transgression; MIS 1)	Marine
Unit 7	Transgressive sequence of intertidal mudflat/saltmarsh overlain by shallow marine/outer-estuarine sand, overlain by a shallow marine lag deposit	6310–5970 cal. BC, 6490–6230 cal. BC, 6730–6590 cal. BC, 7710–7560 cal. BC, 8050–7560 cal. BC, (radiocarbon)	Early Holocene (MIS 1)	Fluvial/inter-tidal/early transgression
Unit 6	Predominantly sandy gravel infill of localized depressions	36 ± 5 ka (OSL)	Possibly mid-Devensian (MIS 3)	Alluvium
Unit 5	Predominantly gravelly, silty sand infill of broad shallow depressions		Unknown (possible contemporary with Unit 6 or Unit 4)	Estuarine or near-coastal depositional environment
Unit 4	Fine-grained sequence infilling shallow cuts within the Anglian-cut channel	96 ± 11 ka, 109 ± 11 ka (OSL)	Early Devensian (MIS 5c)	Estuarine
Unit 3b	Complex unit of sand and gravel layers	175 ± 23 ka; 206.5 ± 29.5 ka; 188 ± 29 ka; 207 ±24 ka; 222 ± 29 ka; 243 ± 33 ka, 283 ± 56 ka; 418 ± 78 ka ka (OSL)	Middle Saalian (MIS 8/7/6)	Fluvial
Unit 3a	Coarse-grained deposit observed in the base of the Anglian Channel		Possible Middle Saalian (MIS 10 or late MIS 12)	Fluvial
Unit 2	Silty, gravelly coarse to fine sands (Unit 2a), and silty sand with frequent thin beds and laminae of clay and peaty organic clay	735 ± 134 ka (OSL)	Cromerian complex (MIS 16–26)	Delta top/shallow marine
Unit 1	Fine-grained deposit		Pliocene–Early Pleistocene	Shallow marine

sandbank was exploited in Area 254 and sheet deposits in Area 494. The distribution on the foreshore of dredged material from each licence area (Fig. 2B) helps in relating artefact findspots back to their source sediments. However, several factors hamper a direct correlation between the artefact distribution and their source deposits: (i) some parts of the BWCMS were supplied with sediments from more than one licence area; (ii) multiple sedimentary units may have been exploited within each licence area; (iii) sediments may have been further mixed during emplacement on the beach; and (iv) the ongoing erosion of the sediments by the sea, their longshore movement and redeposition on other parts of the beach. However, the most likely source of the artefacts can be inferred on the basis of their find-location and with reference to the previous archaeological sampling work described above, and artefact typology.

Recent collecting activities on the Norfolk coast between Bacton and Sea Palling

The north Norfolk coast has long been a popular search area for fossil hunters, due to the abundance of early Middle Pleistocene mammalian fossils eroding from exposures of the CF-bF. In recent years, collectors have also recovered significant quantities of lithic material (Fig. 4). While most of these finds are out of context and therefore difficult to interpret, some can be related to the known archaeological horizons at Happisburgh Site 1 and Happisburgh Site 3, while others indicate the presence of as yet unknown exposures of the CF-bF offshore (Bynoe et al., 2021).

Bynoe et al. (2021) identified three main areas (Areas A, B and C) for artefact recovery from the beach between Ostend and Eccles North Gap, based on the distribution of find spots between 2013 and 2017. Area A encompasses the majority of the known exposures of the CF-bF in the Happisburgh area, including Happisburgh Site 3, whilst Area B includes Happisburgh Site 1. Area C, which encompasses a c. 1300-m stretch of the beach between Eccles-on-Sea and Sea Palling, is an area with no known exposures of CF-bF. During 2018, artefacts began to be recovered from a fourth area, denoted here as Area D, found on a lag deposit of large flint cobbles and small flint boulders revealed by the scouring of beach sands during the storms of February 2018. Following the completion of the BWCMS in August 2019, significant numbers of artefacts have been recovered from a fifth area, defined by the original extent of the sandscaping works (Fig. 1B).

Materials and methods

Collecting methods

This study is based on a database of 2204 lithic artefacts compiled for the Pathways to Ancient Britain Project (PAB). The artefacts were recovered from the foreshore between Bacton and Horsey between January 2013 and September 2021. A detailed analysis of the material collected between 2013 and 2017 from Happisburgh to Eccles North Gap was undertaken by Bynoe et al. (2021) and is included in this study for comparative purposes. The majority of the artefacts (98%) were found by eight collectors (JC, RF, IG, TG, CJ, JL, DN, MS). The remainder were collected by others and reported to the Portable Antiquities Scheme (PAS). The collectors made frequent visits to the beach, often returning to productive locations, though no systematic 'field-walking' was undertaken and there is no complete record of the number of

Table 2. Summary of the results of the archaeological sampling and monitoring of sediments within the East Coast aggregate extraction block, with number of lithic artefacts and basic typology. See references for faunal and environmental finds from this work. Numbers in patentheses indicate number of Levallois artefacts. References: (1) Limpenny et al. (2011); (2) Wessex Archaeology (2013); (3) Tizzard et al. (2014); (4) Wessex Archaeology (2015); (5) Wessex Archaeology (2021).

	Units sampled	Handaxes	Cores	Flakes	Total	Sediments tonnage	Density (artefact/ tonne)	Reference
Area 240								
Initial discovery (AEZ)		33	8 (3)	47 (20)	88	–	–	3
Seabed sampling (AEZ)		–	–	11	11	19	0.5789	2
Seabed sampling (AEZ)		–	–	1	1	–	–	1
Wharf monitoring (AEZ)		3	1	20 (1)	24	40 000	0.0006	2
Wharf monitoring (Area 240 SW)	3b, 2, 5	–	1	5 (2)	6	11 500	0.0005	4
Wharf monitoring (Area 240 S)	3b, 5	–	–	–	–	14 500	–	5
Wharf monitoring (Area 240 central)	3b, 5	9	1	27 (4)	37	20 867	0.0018	5
Wharf monitoring (Area 240 central)	3b, 5	5	–	2	7	–	–	5
Wharf monitoring (Area 240 E)	2, 3b, 5	–	–	–	–	2500	–	5
Area 212								
Wharf monitoring	2, ?3b, 8	–	–	2 (2)	2	3500	0.0006	4
Wharf monitoring	2	–	–	–	–	2666	–	5
Area 228								
Wharf monitoring	2, 3b	–	–	2	2	13 800	0.0001	4
Area 242/361								
Wharf monitoring	2	–	–	–	–	3000	–	4
Wharf monitoring	Bank feature	–	–	–	–	2867	–	5
Area 296								
Wharf monitoring	8, sheet deposit	–	–	–	–	12 800	–	4
Area 328								
Wharf monitoring	2, 8	–	–	–	–	3500	–	4
Area 360								
Wharf monitoring	2	–	–	–	–	6000	–	4
Area 401/2								
Wharf monitoring	8	–	–	–	–	6700	–	5
Wharf monitoring	4	–	–	–	–	900	–	5
Area 511 (incl. Area 319)								
Wharf monitoring	3b	–	–	3	3	8000	0.0004	4
Wharf monitoring	3b	–	1	2	3	12 360	0.0002	5
Area 512 (incl. Area 251)								
Wharf monitoring	3b	–	–	1	1	13 500	0.0001	4
Wharf monitoring	3b			3	3	13 878	0.0002	5
Area 513/1 (incl. Area 360)								
Wharf monitoring	2	–	–	–	–	6000	–	4
Wharf monitoring	3b	–	–	–	–	3100	–	5
Total		50	12 (3)	126 (25)	188			

collecting events, the amount of time spent searching for artefacts, or the areas searched during each visit. There is some variation in the way that location data were recorded by the collectors. Locations for 1790 artefacts were recorded using either smart phone apps or handheld GPS. Of these, 1411 artefacts were recorded to a GPS accuracy of 3 m. The other 379 objects were recorded using the WGS84 coordinate system in decimal degrees format, providing longitude and latitude to three decimal places (or to approximately the nearest 100 m). However, it is clear from the data that this app occasionally provided very inaccurate readings, placing at least 18 artefacts 500 m or more from the nearest conceivable find spot. Finally, general descriptions of findspots were provided for the remaining 414 artefacts, which enables them to be located to a particular part of the beach. This group includes much of the material collected during 2021.

Lithic recording methods

The lithic artefacts were recorded using a standard set of measurements and attributes (after Wymer, 1968; Roe, 1969; Ashton, 1998; Scott, 2011; see Appendix S1). In the absence of contextual information, artefact condition was used as a proxy for context type and post-depositional processes (e.g. fine-grained vs. coarse-grained sedimentary context, primary vs. secondary context), and as a means of grouping artefacts with similar taphonomic histories. Typological and technological attributes were used to characterize the lithic technology, and to compare and contrast different elements of the collection. Identification of Levallois cores was based on Boëda's (1995) volumetric definition of the Levallois method. Levallois flakes were identified from characteristics indicative of their removal from the flaking surface of a Levallois core. Simple prepared cores share some of the characteristics of Levallois cores, namely the hierarchical relationship between a striking platform surface and a flaking surface separated by a plane of intersection, where flakes have been removed by hard hammer percussion from the flaking surface and are broadly parallel to the plane of intersection (White & Ashton, 2003). However, they generally lack the maintenance of distal and lateral convexities, and surface preparation is minimal.

Defining the Palaeo-Yare assemblage

While the relationship between artefact and sandscaping sediments is clear in many cases, the continuing release of artefacts from local outcrops of the CF-bF into the foreshore system meant it was necessary to take a critical view of the collections to ensure

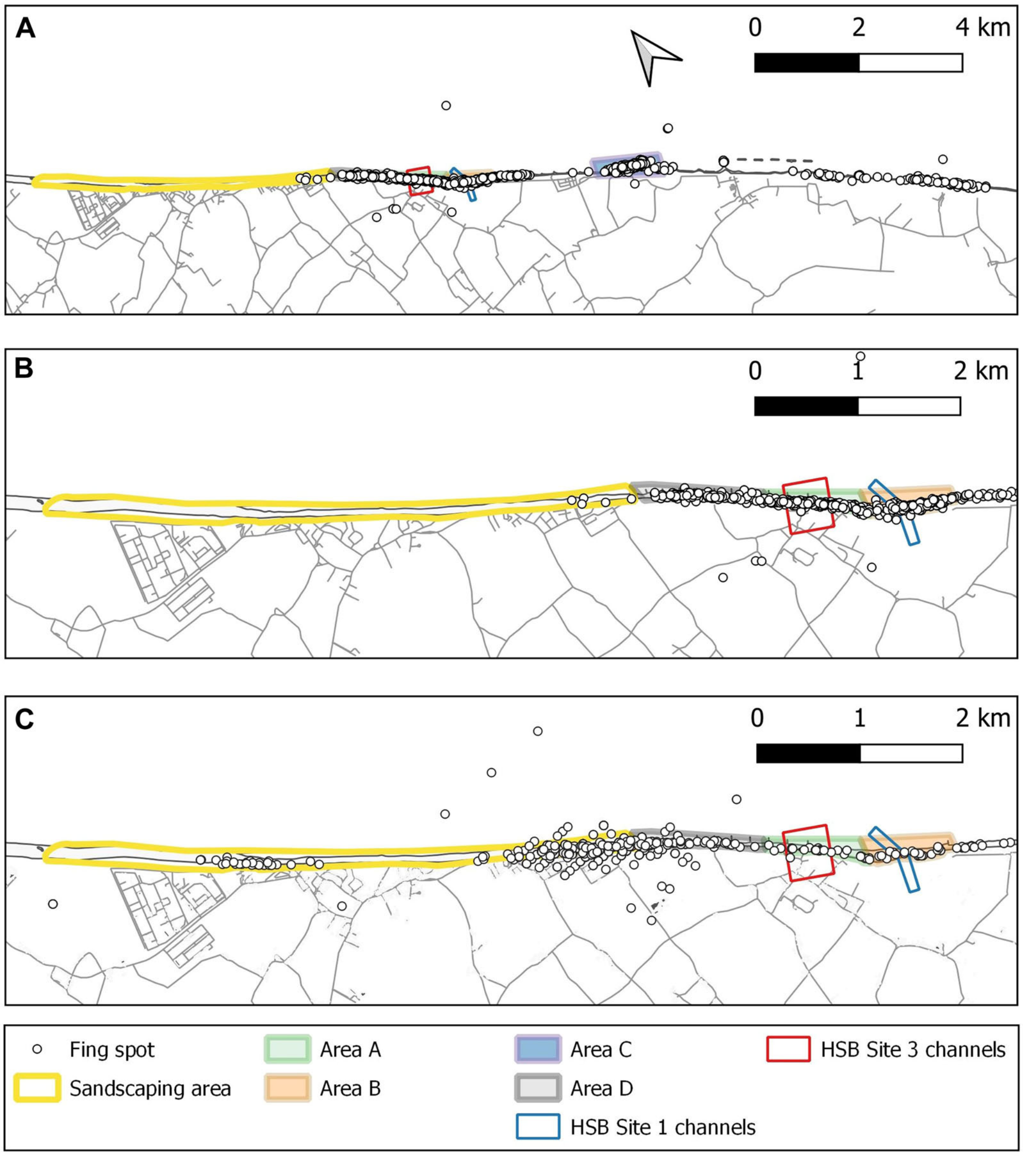

Figure 4. Distribution of find spots. A: all pre-sandscaping findspots between Bacton and Horsey; B: pre-sandscaping findspots between Bacton and Cart Gap; C: all post-sandscaping findspots. Contains Ordnance Survey data © Crown copyright and database right 2021. [Color figure can be viewed at wileyonlinelibrary.com]

Table 3. Typological breakdown of the Palaeo-Yare lithic assemblage. Handaxe types after Wymer (1968).

	n	Assemblage (%)	Retouched (*n*)	Retouched (%)
Flakes	772	89.5	24	3.1
Levallois flakes	71	8.2	2	2.8
Non-Levallois hard hammer flakes	610	70.7	18	3.0
Soft hammer flakes	28	3.2		
Indeterminate	63	7.3	4	6.3
Cores	37	4.3		
Levallois cores	12	1.4		
Non-Levallois cores	25	2.9		
Handaxes	41	4.8		
Crude (Type D and E)	5	0.6		
Pointed (Type F and FG)	3	0.3		
Sub-cordate/ovate (Type G and GK)	8	0.9		
Ovate (Type K)	2	0.2		
Cordiform (Type J, JK and JN)	12	1.4		
Cordiform (uniface)	4	0.5		
Roughout	5	0.6		
Indeterminate	2	0.2		
Other	13	1.5		

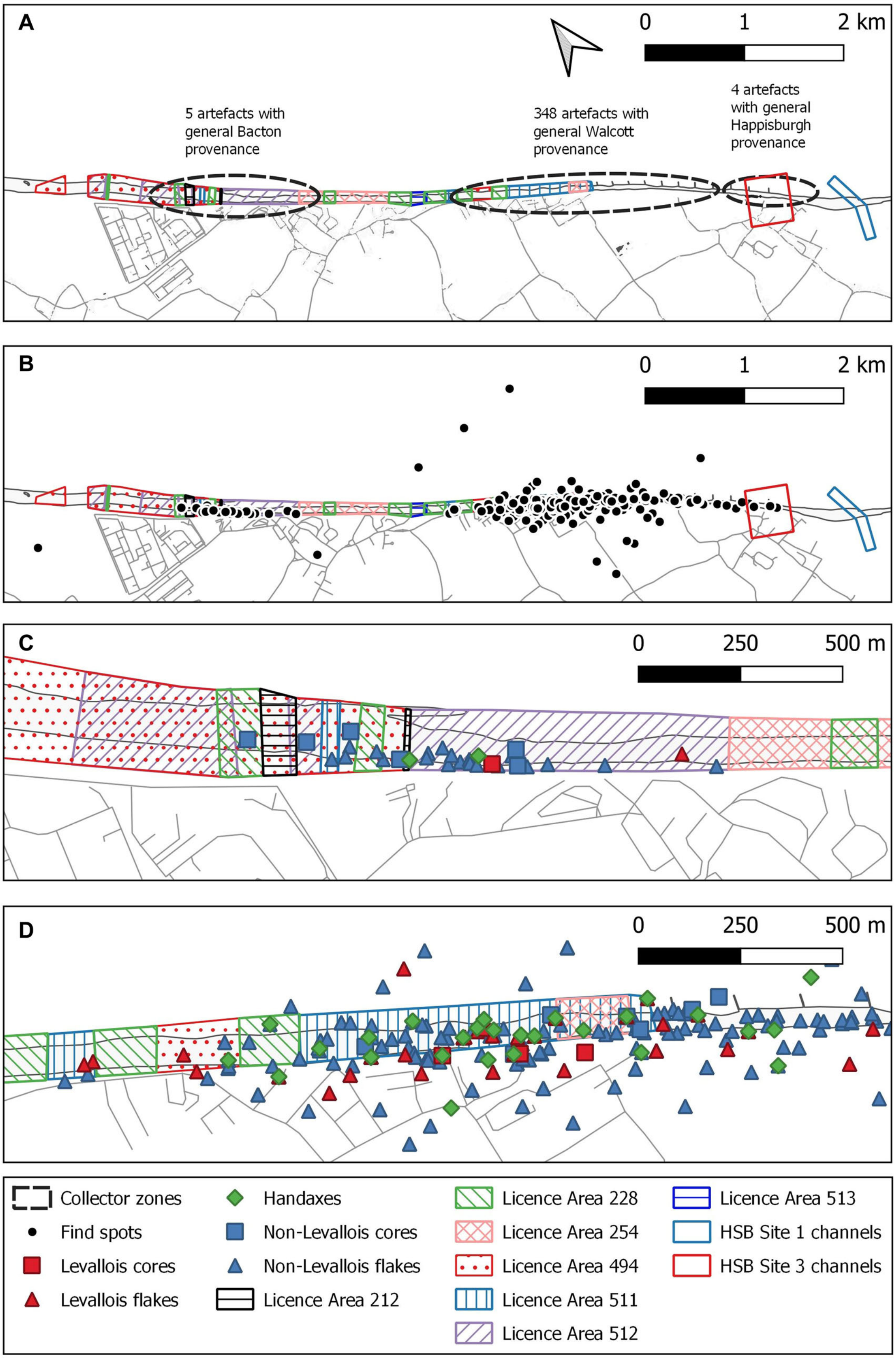

Figure 5. Location of find spots. A: collection zones for artefacts without GPS location data; B: distribution of find spots; C: distribution of artefact types at Bacton; D: distribution of artefact types at Walcott. Contains Ordnance Survey data © Crown copyright and database right 2021. [Color figure can be viewed at wileyonlinelibrary.com]

only artefacts that could be confidently assigned to the Palaeo-Yare sediments were taken forward into the analysis. This was achieved by comparing the artefacts recovered before and after the completion of the sandscaping in different areas of the foreshore (see Supporting Information Appendix S1).

Assessment of beach profile changes and long-shore sediment movement

The emplacement of Palaeo-Yare sediments into an active sedimentary environment with its own archaeological record will inevitably lead to mixing of artefacts derived from the sandscaping and CF-bF sediments. The stretch of coast from Mundesley to Eccles-on-Sea has a high rate of longshore drift, which is typically oriented to the south and east (HR Wallingford, 2002). It can therefore be expected that some of the beach replenishment sands would be redistributed both seawards and to the beaches down-drift of the sandscaping area (i.e. towards Happisburgh). The extent to which this may already have happened, and the potential future impact of the BWCMS on the extant archaeological record, is assessed through analysis of changes in beach levels since completion of the sandscaping scheme, and through comparison between pre- and post-sandscaping foreshore finds.

Data on beach levels between Bacton and Happisburgh were downloaded from the National Network of Regional Coastal Monitoring Programmes (https://coastalmonitoring.org/). These data consist of biannual beach profiles and LiDAR surveys. LiDAR data were processed in QGIS using the calculate raster and raster volume tools to show net changes in beach level through time. In addition, shore-normal profiles were constructed at various points along the coastline to visualize the changes in beach elevation. Data from four time-slices – immediately pre-sandscaping (August 2018 or March 2019), immediately post-sandscaping (August-December 2019) and a further 6 and 12 months after sandscaping – were used to show the impact of the sandscaping scheme on beach elevation, and also the subsequent changes in beach profiles as wave action reshaped the emplaced sediments and redistributed them down-drift.

Results

There is a clear change in the archaeology of the foreshore along this section of the North Norfolk coast after August 2019 (see Appendix S1, Tables S1 and S2, Fig. S2), and this change can only be due to the import of artefacts from the Palaeo-Yare during the BWCMS. There is a shift in the distribution of find spots with a significant increase in the number of finds from the sandscaping area and Area D (Fig. 4). There are also a number of characteristics that can be used to distinguish artefacts from local CF-bF and non-local, sandscaping contexts. Any artefacts related to the Levallois technique, any refined cordiform handaxes made on flakes, and more generally, artefacts that are both patinated and stained are likely to be from the Palaeo-Yare, whilst unpatinated and unstained artefacts are more likely to be from the CF-bF. Combined, these factors provide a collection of 863 artefacts (Table 3) that can be assigned to the sandscaping sediments and can therefore provide information about human occupation of the Palaeo-Yare.

The lithic assemblage from the Palaeo-Yare

The sandscaping collection consists entirely of artefacts made on flint with thin, weathered cortex, and it is dominated by flakes produced by hard hammer percussion. Most are not diagnostic of a particular technology, but there are a significant number of Levallois flakes, plus a smaller number of soft hammer flakes. Levallois cores occur alongside unprepared cores, and handaxes are also present, with cordiforms being the most common handaxe type. There are generally low levels of retouch, although there is extensive recent damage to edges, presumably caused during the sandscaping operations, which could have removed marginally retouched edges in some cases.

The artefacts were recovered from two distinct areas of the beach, with a group of 37 artefacts recovered from the Bacton end of the sandscaping area, and a much larger group of 826 artefacts from an area that extends from Walcott to Happisburgh Site 3 (Fig. 5). The relative size of the two groups of artefacts is likely to reflect collecting behaviour, with the majority of collectors focusing their efforts on the Walcott to Happisburgh stretch of the foreshore. Although few in number, it is clear that the Bacton artefacts represent a secondary source of artefacts at the northwestern end of the sandscaping area (Fig. S1). Of the 32 Bacton finds with GPS coordinates, 21 are from an area of the sandscaping supplied with sediments from Licence Area 512, dredged from the pre-Anglian Unit 2 and Unit 3b of the Palaeo-Yare (Fig. 2). The remaining 11 are from an area supplied from multiple licence areas: 228 (Unit 3b); 511 (Units 2 and 3b); 212 (Unit 2); and 494 (Unit 2 and Holocene bank feature).

The Walcott group is mainly associated with sediments from Licence Area 511, although sediments from Licence Areas 228, 254 (Unit 2 and Holocene sandbank) and 494 are also present in small quantities at this end of the sandscaping area. Given the ages of the various units exploited in these areas (see above), it is likely that the majority of the artefacts originated in areas mapped as Unit 3b in Licence Areas 511 and 512, and to a lesser extent in 228.

The typological composition of artefacts derived from the different licence areas appears to be broadly similar, indicated by the similar distribution of findspots for the different artefact types (Fig. 5). The core to flake ratio is higher in the Bacton group (Table S3), although it is possible that this is the result of differing collection practices (JL and DN contributed 89% of the Bacton finds compared to 2% of the Walcott finds), rather than variation across the Palaeo-Yare floodplain. There are, however, differences in the condition of the artefacts. The Bacton group is typically moderately rolled with relatively low levels of patination and staining, whereas the Walcott group includes fresher and more heavily rolled material, and most artefacts are both patinated and stained, with ~12.5% showing differential patination and/or staining on opposing faces. This may indicate that there is some variation in the condition of artefacts from different areas of the Palaeo-Yare. Most artefact types also show the full range of conditions (Table 4), the exceptions being the absence of fresh artefacts amongst the handaxes, soft hammer flakes and non-Levallois cores, and the limited range of surface conditions of the cordiform handaxes. There are hints that the Levallois artefacts and cordiform handaxes have generally undergone less extensive reworking than the non-Levallois cores and other handaxe types.

It is clear that the process of emplacing and distributing sediments on the beach during the sandscaping and any subsequent reworking of those sediments by the sea would lead to changes in the condition of the associated artefacts. This is apparent from extensive recent edge damage, and increases in the degree of rolling with date of recovery (Fig. 6). Therefore, the degree of rolling of each artefact may not be indicative of the post-depositional processes that led to its emplacement within the Palaeo-Yare sediments, nor the nature of those sediments (e.g. fine-grained/primary context vs. coarse-grained/secondary context). However, the fact that the earliest material recovered shows the same range of conditions suggests that the assemblage is broadly representative of the range of conditions of artefacts present in the source sedimentary units, albeit with an over-representation of more rolled material.

The typological composition of the Palaeo-Yare assemblage shows that there are a number of different reduction sequences represented in the assemblage. Most notable are: Levallois flake production; handaxes made on flakes; and handaxes

Table 4. Comparison of artefact type and condition.

	Lev (n = 83)	Cord (n = 16)	Oth (n = 18)	SHF (n = 28)	NLCs (n = 25)	UF (n = 672)
Rolling (%)						
Fresh	1.2	–	–	–	–	2.1
Slightly rolled	37.3	12.5	16.7	39.3	20.0	21.7
Moderately rolled	43.3	68.8	38.9	35.7	40.0	42.3
Very rolled	18.1	18.8	44.4	25.0	40.0	33.9
Patination (%)						
Unpatinated	24.1	6.3	33.3	21.4	32.0	22.3
Moderately patinated	60.2	68.8	50.0	50.0	52.0	54.3
Very patinated	15.7	25.0	16.7	28.6	16.0	23.4
Staining (%)						
Unstained	6.0	6.3	27.8	17.9	12.0	16.4
Moderately stained	71.1	68.8	61.1	60.7	64.0	59.1
Very stained	22.9	25.0	11.1	21.4	24.0	24.6
Surface condition (%)						
Unpatinated and unstained	2.4	6.3	16.7	7.1	8.0	4.3
Unpatinated and stained	21.7	–	16.7	14.3	24.0	18.0
Patinated and unstained	3.6	–	11.1	10.7	4.0	12.1
Patinated and stained	72.3	93.8	55.6	67.9	64.0	65.6

Lev = Levallois cores and flakes; Cord = cordiform handaxes; Oth = other handaxes; SHF = soft hammer flakes; NLC = non-Levallois cores; UF = undiagnostic flakes.

made on cobbles/nodules. There are also a number of other core types, and a large group of undiagnostic hard hammer flakes. The key characteristics of the assemblage are presented below (see Appendix S1 for further details).

Levallois technology

There are 12 Levallois cores and 71 Levallois flakes (Figs. 7 and 8; Tables S4–S6). The cores have all been knapped using a hard hammer, and they all display a clear hierarchy between a striking platform surface and a flaking surface separated by a plane of intersection. There is considerable variation in the extent to which the striking platform surface has been worked, ranging from just three minimally invasive removals at the proximal end to invasive flaking of the whole surface. Regardless of the extent of the working of the striking platform surface, in all cases it has created a near-perpendicular junction between the two surfaces on at least one section of the circumference of the core, from which the preferential flake(s) could be removed. In most cases a single preferential flake scar extends across much of the flaking surface, but one core bears two preferential flake scars and another has three. The products are flakes, except for one of the Bacton cores which produced a narrow blade.

The preparation of the flaking surface is only evident on four of the cores, including the three from the Bacton group and one from the Walcott group. Two have been flaked centripetally, one has been worked from the proximal and distal ends (bipolar), while the flaking surface of the blade core has been prepared by unipolar flaking from the proximal end. In these cases, the flaking surface preparation has imposed the necessary lateral and distal convexities to predetermine the morphology of the preferential flake.

The method of preparation of the flaking surface is unclear for the remaining eight Levallois cores, which have a final preferential removal that has removed the majority of the flaking surface up to and including at least one of the core edges. It is possible that these cores were discarded due to the detachment of flakes that removed too much of the flaking surface, which would have required a new phase of preparation to impose the distal and lateral convexities required for further production of preferential flakes. Four of these are also very thin (flattening <0.4) and therefore

Figure 6. The degree of rolling of artefacts recovered during 2-month periods between 8 September 2019 and 7 September 2021. [Color figure can be viewed at wileyonlinelibrary.com]

unsuitable for further reduction. Of these, one shows evidence of re-preparation in a series of marginally invasive scars at the distal end cutting into a large scar interpreted as a preferential scar. However, the core was abandoned before the re-preparation was completed. Re-preparation scars can also be identified on one of the Bacton cores, also at the distal end and without a subsequent preferential removal.

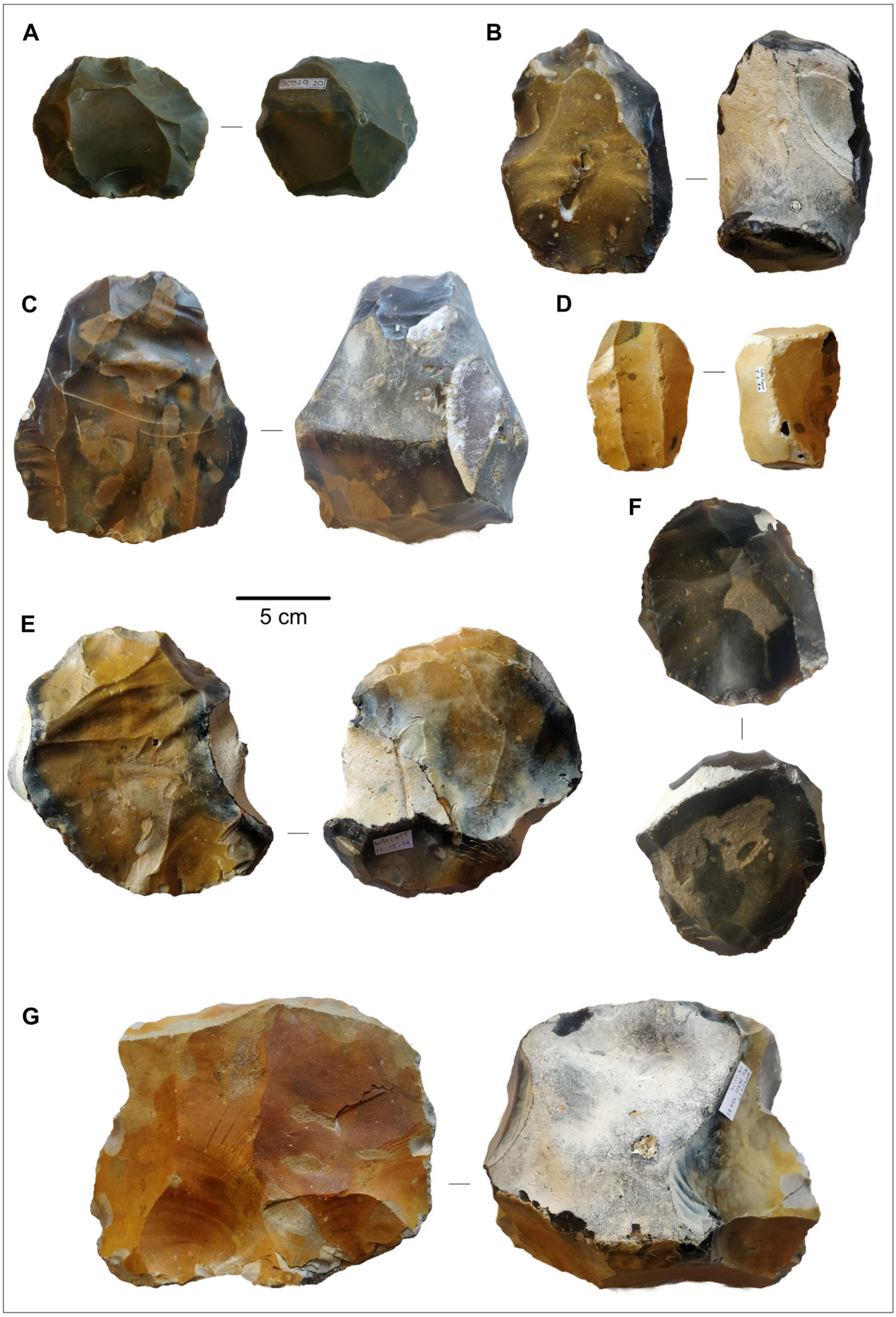

Figure 7. Examples of Levallois cores from the Palaeo-Yare assemblage. A: Levallois flake core from Bacton with centripetal flaking surface preparation and repreparation scars at the distal end; B: Levallois flake core from Walcott with repreparation scars at the distal end; C: Levallois flake core from Walcott with bipolar flaking surface preparation; D: Levallois blade core found near Bacton; E–G: Levallois flake cores from Walcott with final preferential flake scars that have removed much of the flaking surface. [Color figure can be viewed at wileyonlinelibrary.com]

These two examples suggest that re-preparation of the flaking surface to exploit the core's volume may have been a feature of the reduction of the other cores, but with the re-preparation scars removed by subsequent flaking.

The majority of the Levallois flakes have a scar pattern indicating centripetal preparation of the flaking surface, which may indicate that this was more common than is evident from the cores. Unipolar preparation is also common, and there are occasional examples of bipolar, convergent unipolar and non-proximal unipolar surface preparation. In the majority of cases, exploitation was from a single platform, either as single removals, or sequences of up to three removals. In ~10% of cases, it is clear that the flake has removed the majority of the flaking surface, so that the core would have had to have been re-prepared if further flakes were to be removed. This process is evident on 12 examples, where the scar from a previous

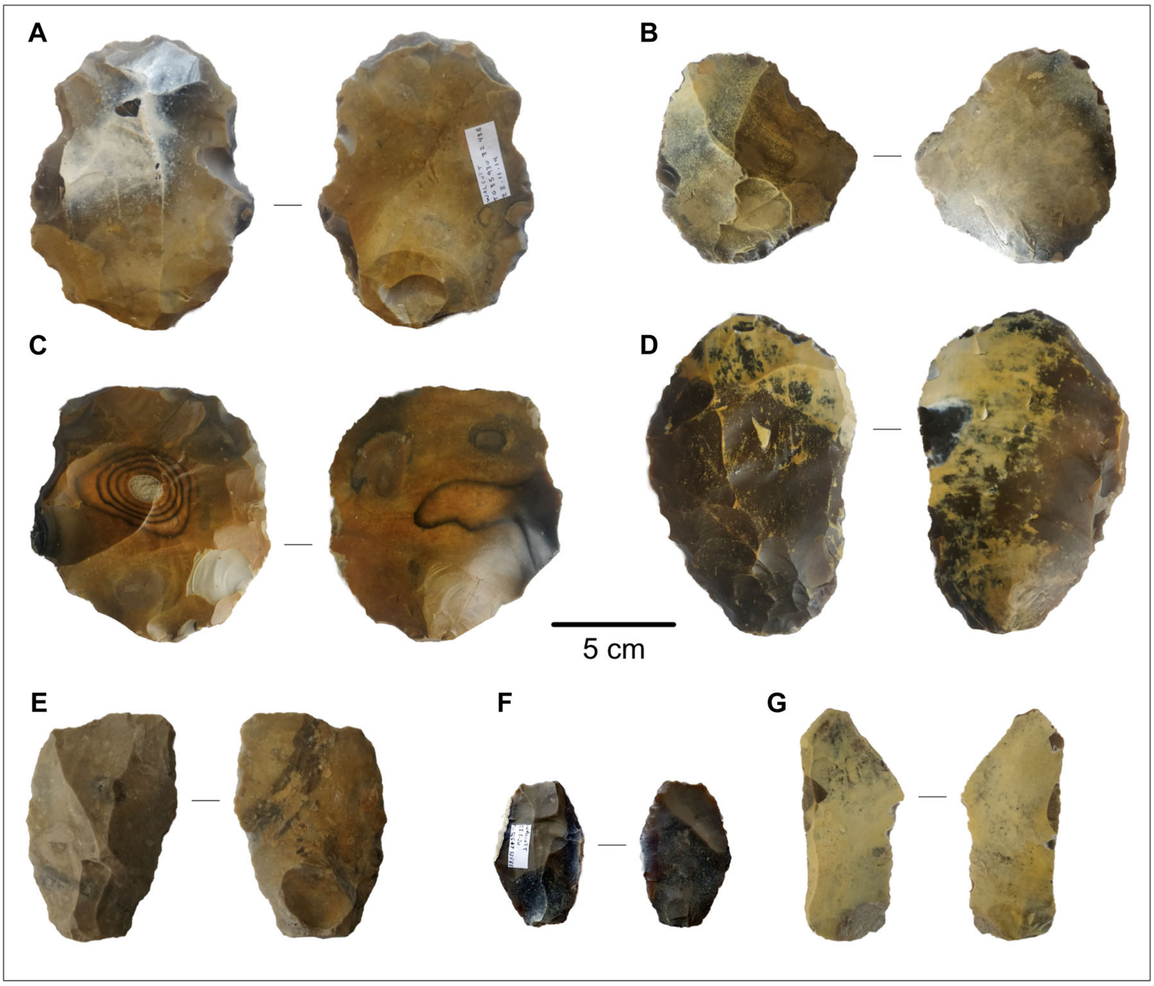

Figure 8. Examples of the Levallois flakes from the Palaeo-Yare assemblage. A–E: Levallois flakes with centripetal flaking surface preparation; F: Levallois flake with bipolar flaking surface preparation; G: Levallois blade. [Color figure can be viewed at wileyonlinelibrary.com]

preferential flake is cut by subsequent preparatory scars. There is also one *debordant* flake, which was removed from the core edge, presumably as part of a phase of core rejuvenation. Two Levallois blades were identified in the Walcott group and not from the same part of the beach as the blade core. There are just two retouched Levallois flakes. One is a side-scraper with marginal scalar retouch to the right side of the dorsal face. The other has a notch formed in the distal edge.

Handaxes

There are 36 handaxes and five handaxe roughouts in the assemblage (Fig. 9; Table S9). Two-thirds of the handaxes have a cordiform planform, including 12 cordates (Wymer Type J and JK), four unifaces and eight sub-cordates. The cordates and unifaces form a coherent group, in terms of both their condition, and their typology and technology. They are generally made on large flakes, with extensive shaping of the dorsal face and varying degrees of working to the ventral face, resulting in highly refined handaxes with cutting edges that extend round most, if not the entire circumference, of the piece. They all have rounded tips, with no evidence of tranchet-sharpening. Two have scraper retouch applied to one edge. The sub-cordiforms show some similarities to the cordiforms, the principal difference being less intensive flaking, particularly to the butt, resulting in less refined handaxes with shorter cutting edges, and some remnant cortex on the butt. The blank type could only be identified for one sub-cordiform handaxe, which was made on a flake. Tranchet flaking is also absent, and there is one example with scraper retouch to one edge. All of the cordiform and sub-cordiform handaxes are found in the Walcott group.

There are two ovate handaxes and three pointed handaxes, also from Walcott, and also highly refined despite their different planforms. The ovates are heavily rolled and patinated, made on flakes, with broad tips. The pointed handaxes are elongated with narrow tips, with at least one made on a cobble. Two of the three are unpatinated and stained, thereby displaying a surface condition that is not present among the cordiform handaxes. Finally, there are five crude handaxes, shaped through the removal of relatively few flakes by hard-hammer, resulting in thick, unrefined forms. Both Bacton handaxes fall into this category. These show the full range of surface conditions.

Other cores, undiagnostic flakes and retouched flakes

Of the remaining 25 cores (Table S7, Fig. S3), 16 are migrating platform cores. These have multiple knapping episodes, representing the turning of the core to exploit new platforms created by previous removals. The flaking during each episode is either alternate or parallel from the same platform, and several cores have been reduced by both parallel and alternate knapping episodes. There are two cores that have been classified as simple cores, where two or three flakes have been removed from the same portion of the core via alternate flaking in a single knapping episode. There are two simple prepared cores, distinguished from the

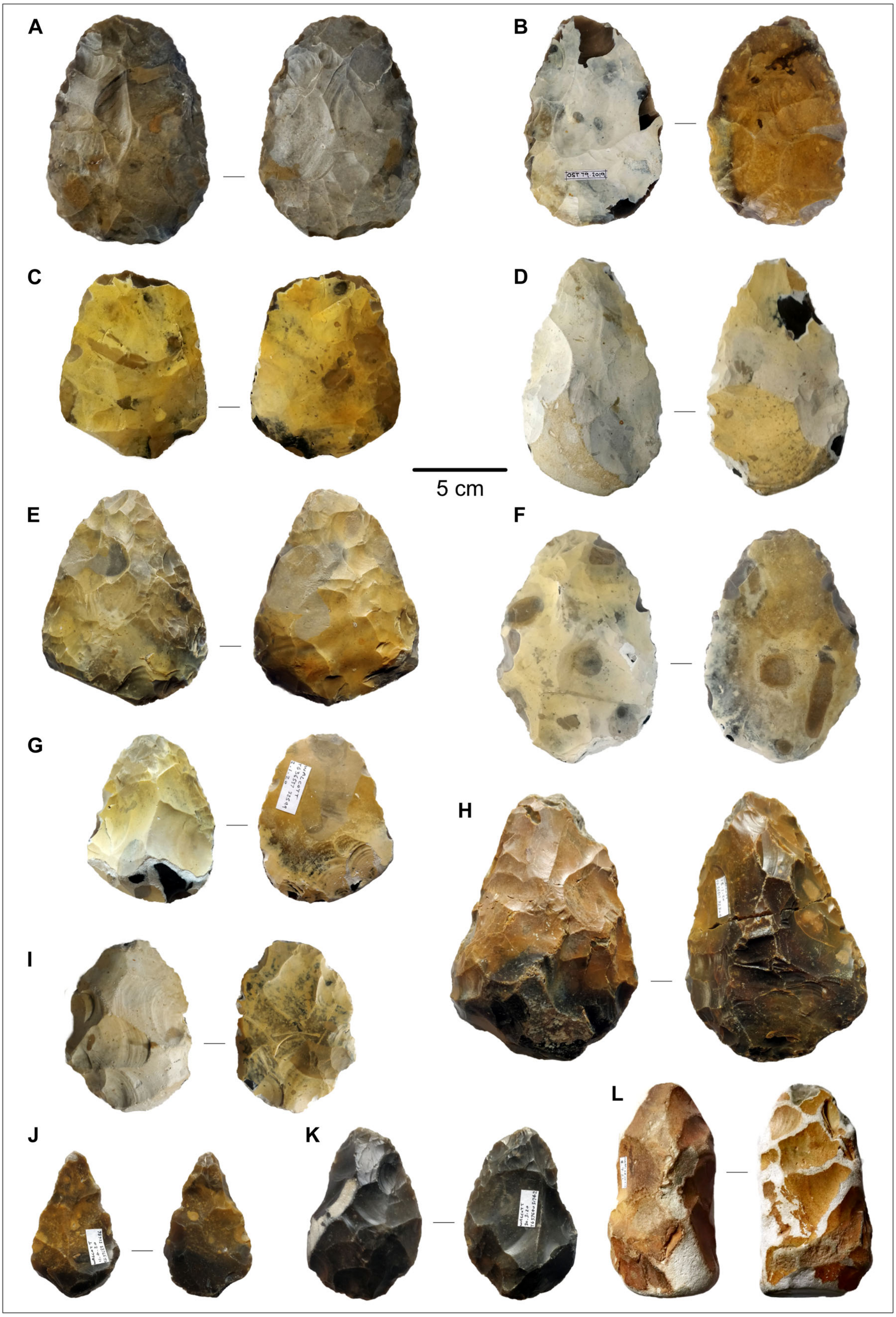

Figure 9. Examples of the Palaeo-Yare handaxes in the Walcott group. A: type JK cordiform handaxe made on a flake; B: type JK cordiform handaxe; C: type JN cordiform handaxe made on a flake; D: type G sub-cordiform handaxe made on a recycled flake or thermal spall; E: type J cordiform handaxe made on a flake; F and G: uniface cordiform handaxes made on flakes; H: type FG pointed handaxe made on a cobble; I: type K ovate handaxe made on a flake; J: type F pointed handaxe made on a flake; K: type G sub-cordiform handaxe; L: type D crude handaxe. [Color figure can be viewed at wileyonlinelibrary.com]

Levallois cores because they lack any evidence of shaping of the flaking surface. There are two cores in the Walcott group that are difficult to classify in a mixed assemblage such as this, and could represent unexploited/unfinished prepared cores, discoidal cores or handaxe roughouts. There are also two core fragments in the Walcott group, for which the core reduction strategy cannot be determined. Finally, there is one core on a flake. In this case, a flake has been removed from the ventral surface of a hard hammer flake.

The most common artefacts in the assemblage are undiagnostic hard hammer flakes (Tables 3; Table S5). There are also 60 flakes for which the hammer type could not be determined, most being broken flakes that are missing the proximal end. The majority have simple dorsal scar patterns typical of simple or migrating platform cores, or from the early stages of Levallois core preparation or handaxe manufacture. However, there are some with more complex scar patterns, which could relate to later stages of core reduction or handaxe shaping. Flakes from all stages of reduction are present, with the majority coming from later stages of reduction. The flakes are occasionally retouched (Tables 3; Table S8), predominantly scrapers, but also notches and denticulates. There are also a small number of soft hammer flakes, which are likely to be related to handaxe manufacture.

Reworking of sandscaping sediments and its implications for the archaeology

It is clear from the comparison of the pre- and post-sandscaping collections (Fig. 5; see Appendix S1) that by September 2021, artefacts deposited on the foreshore as part of the sandscaping sediments had already travelled as far as Happisburgh Site 3. This process is apparent from the LiDAR and beach profile survey data from 2019 and 2020, which clearly show changes in beach elevation resulting from emplacement of the sandscaping sediments and their subsequent erosion and reworking to the southeast by the longshore current (Figs. 10 and 11). Following completion of the scheme in August 2019, for the first 6 months beach levels dropped across the sandscaping area (Fig. 10). In the northwest sector (profiles MH082 and MH100), this loss was from the seaward portion of the beach only, creating a bench in the beach and a sand 'cliff' along most of the length of the sandscaping area reaching c. 2–3 m in height at the northern end (Figs. 3A and 10). In parts of the southeast sector, beach levels dropped more uniformly across the beach profile (e.g. profile MH140), whilst in other parts the greatest loss was from the seaward portion (e.g. profile MH157). During this same period, there was an increase in beach elevation immediately to the southeast of the sandscaping area (profiles MH165 and MH174; Fig. 11).

The profiles indicate less dramatic change in the beach elevation of the sandscaping area in the 6-month period between February and August 2020, although comparison of the February and December 2020 LiDAR surveys of the sandscaping area reveal a loss of ~270 000 m^3 of sediment. In some places beach levels actually increased during this period, along the seaward edge of the foreshore in front of the Bacton gas terminal (profile MH100), and at the southeastern end of the sandscaping area (profile MH157). By December 2020, increased beach elevation could be observed further to the southeast, including at Happisburgh Site 3 (HW014; Fig. 11). The gradual reworking of sediments to the southeast is indicated by the increased volume of beach sediment by December 2020, calculated from LiDAR surveys (Fig. 11E): an increase of ~42 000 m^3 in Area D, 24 000 m^3 in Area A, and 5250 m^3 in Area B.

The redistribution of the sandscaping sediments will have important implications for the archaeology contained within these sediments, first through changes in the condition of artefacts, in particular an increase in the degree of rolling through time (Fig. 6), and second through the redistribution of artefacts, which, most significantly, will lead to mixing with artefacts locally derived from the CF-bF.

Discussion

Palaeolithic archaeology of the Palaeo-Yare

The BWCMS assemblage expands both the number and the distribution of artefacts from the Palaeo-Yare. Based on the assessment of the location of findspots in relation to the distribution of dredged sediments emplaced on the foreshore and the source areas for those sediments in the Palaeo-Yare, the majority of the 863 artefacts described above are likely to be derived from Licence Areas 511 and 512 of the ECAEB. These are located to the south of and adjacent to Area 240, from which a collection of 174 artefacts has previously been recovered (Wessex Archaeology, 2013, 2015, 2021; Table 2). These collections are remarkably consistent, despite both being 'typologically heterogeneous' (Tizzard et al., 2014). They are characterized by the presence of diagnostic Middle Palaeolithic artefacts, in the form of Levallois cores and flakes, cordiform and sub-cordiform handaxes often made on flakes, as well as non-prepared cores and undiagnostic flakes. These occur in a range of conditions, from fresh to rolled, with varying degrees of patination and staining, and some with weathering to one side only. The range of conditions suggests a range of taphonomic processes, from fresher material from minimally disturbed contexts to more rolled material that has been reworked into coarse-grained secondary contexts. The similarities in typology and condition between the sandscaping assemblage and the Area 240 finds suggest a similar set of taphonomic environments exist in these neighbouring licence areas.

There is a consistent pattern of artefact recovery from areas where Unit 3b is the principal sedimentary unit, dated by OSL to MIS 7/6 (Marshall, 2020). It is therefore reasonable to assume that a significant portion of the artefact collections originated in this deposit (Tizzard et al., 2014; Wessex Archaeology, 2020). However, it is clear that there is at least occasional mixing of artefacts of different ages. In particular, the recovery of Upper Palaeolithic and Mesolithic blade cores from some of the bulk loads monitored at the wharfs provides clear evidence that younger material is present. This may reflect either reworking of Unit 3b sediments into later Pleistocene deposits, or the presence of unrecognized Late Pleistocene and early Holocene deposits overlying Unit 3b, or artefacts of different ages being reworked into the Holocene seabed sediments that form a veneer across the area. In Area 240, Devensian deposits (Units 5 and 6) may have been incorporated within the bulk loads, and could be a source of at least some of the artefacts.

This uncertainty raises questions regarding the association of the different elements of the Palaeo-Yare artefact collections. Most pertinent to the Middle Palaeolithic record is the relationship between the cordiform handaxes and the Levallois cores and flakes. Tizzard et al. (2014) argue that it is unlikely that the majority of the handaxes from Area 240 are Lower Palaeolithic in age. They note the typological similarities with late Middle Palaeolithic handaxes, and that the fresh condition and typological homogeneity of the

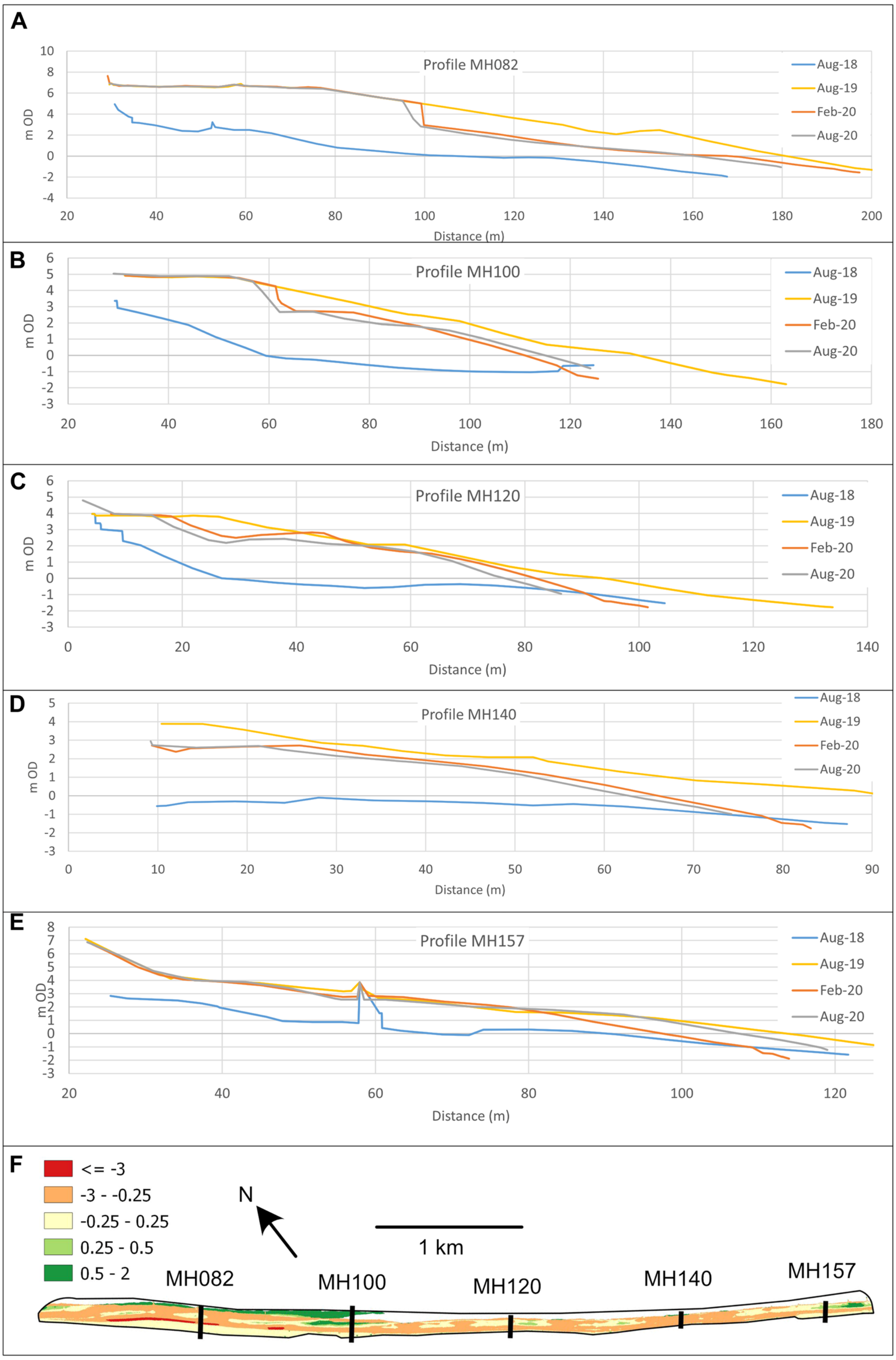

Figure 10. Changes in beach elevation within the sandscaping area following completion of the BWCMS. A–E: beach profiles at four points in time: 23 August 2018 (pre-sandscaping); 29 August 2019 (beach level on completion of sandscaping); 5 February 2020; and 28 August 2020. F: comparison of LiDAR surveys showing changes in beach level (in metres) between 10 February 2020 and 14 December 2020. See Fig. 1 for location of beach profiles. Data courtesy of Channel Coastal Observatory. [Color figure can be viewed at wileyonlinelibrary.com]

cordiform handaxes suggest a primary context. Fine-grained sediments of Lower Palaeolithic age have not been identified in the Palaeo-Yare, and the handaxes would not have remained in a fresh condition if they had been reworked into younger sediments. Equally, the cordiform handaxes from the sandscaping assemblage are in similar condition to the Levallois artefacts, and therefore unlikely to represent a background distribution of reworked Lower Palaeolithic handaxes. Tizzard et al. (2014) argue that both the cordiform handaxes and Levallois artefacts are associated with Unit 3b and are therefore geologically contemporary, and could either be components of a single population's technological repertoire, or represent a succession of groups with different technological practices who occupied the Palaeo-Yare valley

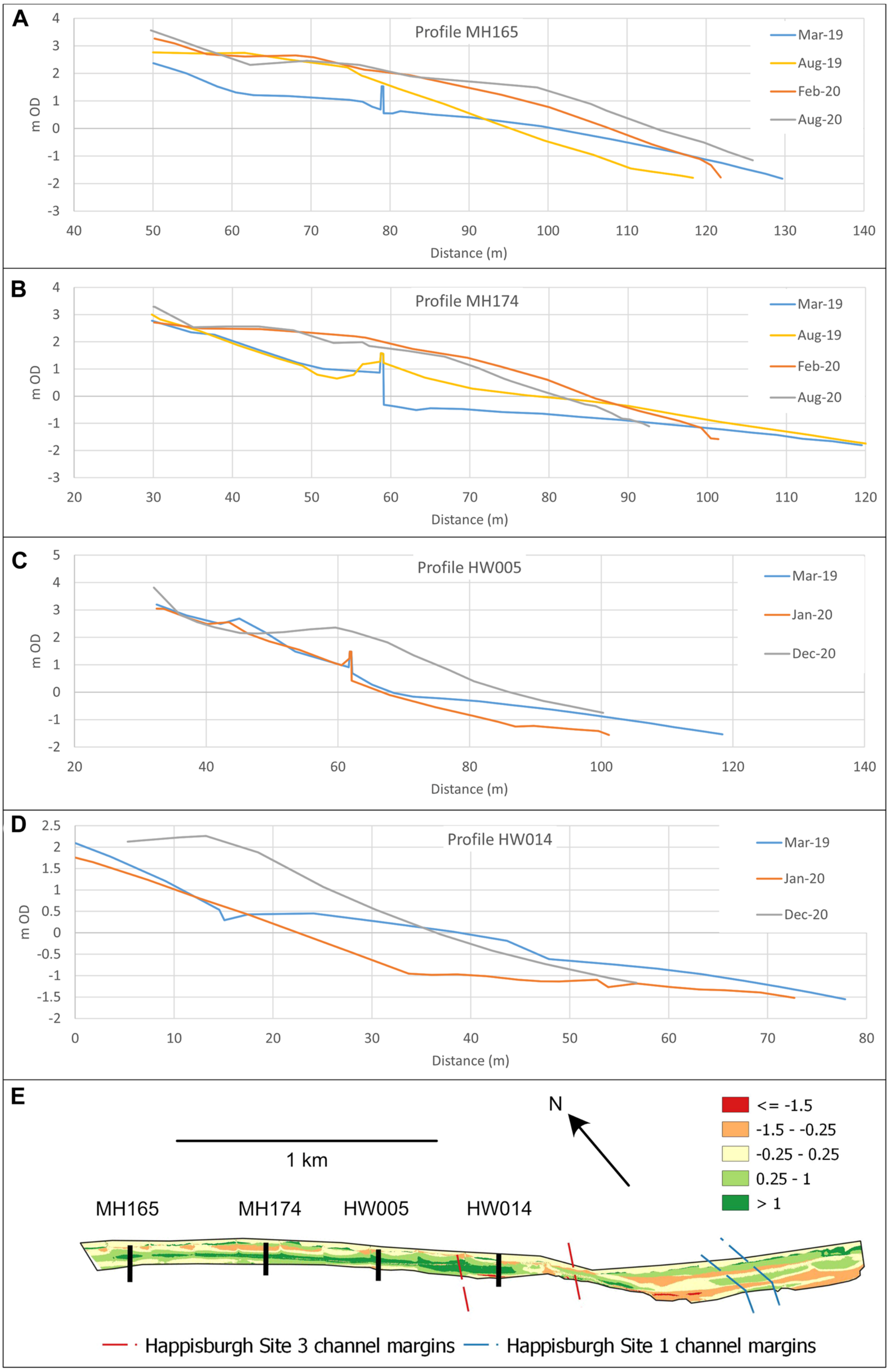

Figure 11. Changes in beach elevation beyond the southeastern edge of the sandscaping area. A–D: biannual beach profiles from 2015 to 2020. E: comparison of LiDAR surveys showing changes in beach level (in metres) between 13 November 2019 and 18 December 2020. See Fig. 1 for location of beach profiles. Data courtesy of Channel Coastal Observatory. [Color figure can be viewed at wileyonlinelibrary.com]

during the formation of Unit 3b. A further possibility is that the handaxes, given their typological similarity to British late Middle Palaeolithic handaxes, are derived from unrecognized Devensian deposits akin to Units 5 and/or 6. To further consider these scenarios, it is necessary to place the Palaeo-Yare record in the context of Middle Palaeolithic north-west Europe.

The Palaeo-Yare record in its regional context

In the regional context of southern and eastern England, the Middle Palaeolithic can be subdivided into an early phase spanning late MIS 9 to early MIS 6, and a late phase during MIS 3 (e.g. Pettitt & White, 2012; Ashton & Scott, 2016). Lithic assemblages assigned to the early Middle Palaeolithic (EMP) are characterized by Levallois technology and are best represented in the Thames Valley (e.g. Ebbsfleet, Crayford, Creffield Road; see Table 7 for site details and references). When in primary context the assemblages do not contain handaxes and have been dated to either late MIS 8/early MIS 7 or late MIS 7/early MIS 6 (White et al., 2006; Scott et al., 2011). Where context is less clear, there is often a distinction in condition between Levallois material and any handaxes from the same set of deposits. The exception is Botany Pit, Purfleet, where 'Proto Levallois' artefacts were recovered with several handaxes from deposits correlated with late MIS 9/early MIS 8 (Schreve et al., 2002; White & Ashton, 2003; Bridgland et al., 2013; Rawlinson et al., 2021). The EMP record is much more limited outside the Thames valley (Ashton et al., 2018) but, where contextual and/or dating information is available, it conforms to the patterning of the Thames record (Scott, 2011; Davis et al., 2016, 2021b; Rawlinson et al., 2021).

The late Middle Palaeolithic (LMP) record of Britain is characterized by a distinctive form of handaxe, the bout coupé (or flat-butted cordate), which is known from sites and numerous isolated findspots across southern Britain (Tyldesley, 1987; White & Jacobi, 2002). Where dated, these handaxes can be attributed to MIS 3 or a broader Devensian context (White & Jacobi, 2002; White & Pettitt, 2011). Leaving the single finds aside, they occur in assemblages dominated by handaxes and virtually no evidence of Levallois, with the bout coupés being one end of a continuum of variation of cordiform planforms. These assemblages are assigned to the Mousterian of Acheulean Tradition (MTA) of western Europe (Wragg Sykes, 2010; Ruebens & Wragg Sykes, 2016).

The record of Levallois artefacts in East Anglia is remarkably poor. For Norfolk, Suffolk and for Essex outside the Thames catchment, TERPS records 131 Levallois artefacts from 47 findspots, but only six locations have more than three pieces (Table 5; Wessex Archaeology, 1996, 1997). Little is known about context or age of most findspots, and even for the larger assemblages there is limited information. The catchment of the River Yare is typical of much of East Anglia, with six isolated findspots and three Levallois pieces noted from Mill Gravel Pit at Keswick, mapped as Terrace 1. The two Levallois flakes and a core are intermixed with 175 Lower Palaeolithic handaxes and little is known of age (Sainty, 1933; Wessex Archaeology, 1997).

The sites with better age constraint include Barnham Heath in late Middle Pleistocene terrace deposits of the Little Ouse. The assemblage includes eight Levallois flakes and cores, together with over 500 Lower Palaeolithic handaxes, which are typically more rolled and stained, suggesting that they pre-date the Levallois element (Table 5). This is also the case at Jordan's Pit, Brundon, on the River Stour, where the assemblage included 20 Levallois artefacts and 11 more abraded handaxes, the deposits being attributed to MIS 7 (Table 5). An MIS 7 age has also been suggested for Stutton in the Stour estuary, where the assemblage includes seven Levallois artefacts found on the foreshore, having being eroded from adjacent low cliffs of alluvial brickearth and gravel (Table 5). The age of the other sites is less clear; Southacre, in the Nar Valley, produced 31 handaxes, three Levallois cores and nine Levallois flakes from a solifluction or outwash deposit of unknown age (Table 5). Finally, mixed assemblages of Lower to Upper Palaeolithic material, including Levallois, were recovered from gravel pits beneath the floodplain of the River Gipping at Bramford Road and Hadleigh Road in Ipswich (Table 5).

The two Ipswich assemblages also include bout coupé handaxes, which can be attributed to the LMP, but as with the remaining assemblages, their original context is unclear. There

Table 5. Principal EMP and LMP sites in East Anglia in approximate chronological order

Site	Levallois artefacts	Mid. Pal. handaxes	Age	Notes	References
Barnham Heath, Little Ouse Valley, Suffolk	8		MIS 9–7?	Mid-terrace gravel with Levallois mixed with more abraded handaxes. Age suggested from mid-terrace position	Wymer, 1985; Rawlinson, 2021
Brundon, Stour Valley, Suffolk	20		MIS 7	Fluvial gravel with possible land-surface. Levallois mixed with more abraded handaxes. Age based on mammalian biostratigraphy and U-series dates	Moir and Hopwood, 1939; Szabo and Collins, 1975; Schreve, 2001; Scott, 2011;
Stutton, Stour Estuary, Suffolk	7		MIS 7	Mixed assemblage of Levallois and handaxes, eroded from low cliff on edge of foreshore. Age based on mammalian biostratigraphy	Spencer, 1953, 1970; Schreve, 2001
Clacton	200+		MIS 7/6	Recovered from beach replenishment	Bynoe, 2018; Bynoe et al., 2022.
Area 240	30+	36+	MIS 7/6	Recovered from wharf monitoring and seabed sampling	Tizzard et al., 2014, 2015
BWCMS – Walcott	83	16	MIS 7/6 and (?) MIS 4/3	Recovered from beach replenishment	This paper
Lynford, River Wissey, Norfolk		60	MIS 4/3	Devensian palaeochannel with mammoth remains excavated with fresh condition artefact assemblage. Age based on stratigraphy and OSL dates	Boismier et al., 2012; White, 2012
Southacre, Nar Valley, Norfolk	12		?	Found with handaxes in solifluction or outwash deposit	Sainty, 1935; Sainty and Watson, 1944; Wymer, 1999
Bramford Rd, River Gipping, Ipswich	20	4+	?	Mixed assemblage with handaxes and Upper Palaeolithic artefacts from gravels and peaty loam below floodplain	Moir, 1918, 1931; White and Jacobi, 2002
Hadleigh Rd, River Gipping, Ipswich	12	1+	?	Mixed assemblage with handaxes and Upper Palaeolithic artefacts from gravels and peaty loam below floodplain	Moir, 1918, 1931; White and Jacobi, 2002

are 20 other suggested bout coupé findspots for East Anglia, but nearly all are isolated finds with little known about their context. The only well-stratified LMP site is Lynford Quarry, dated to MIS 4/3, where excavation of a palaeochannel of the River Wissey recovered mammoth remains and a fresh condition artefact assemblage, including distinctive cordiform handaxes (Table 5). These provide the closest parallel to the cordiform handaxes in the BWCMS assemblage (Table 6).

The offshore Middle Palaeolithic record is considerably richer than onshore. Alongside reports of Levallois artefacts recovered through fishing, dredging or other commercial operations in the southern North Sea (Glimmerveen et al., 2004; Mol et al., 2006; Peeters et al., 2009), the largest collection has been found at Clacton in similar circumstances to that of the BWCMS material. Collectors have recovered over 200 Levallois artefacts following a beach replenishment scheme that exploited sediments located c. 19 km off the coast at Felixstowe (Table 5). The sediments have been dated by OSL to MIS 7/6, and the freshness of the artefacts suggests a primary context site. The assemblage includes at least 200 Levallois flakes and cores, and shows greater technological variety than the Palaeo-Yare collections. There are significant numbers of Levallois points and blades, and frequent use of unipolar, bipolar, convergent unipolar and convergent flaking surface preparation. A small number of pointed handaxes have also been found, but these are rolled and appear to be a derived element of the assemblage, potentially reworked from older deposits.

In summary, the Middle Palaeolithic record of East Anglia and adjacent submerged areas provides evidence to help interpret the Palaeo-Yare assemblages. Using the sites with better age constraint, it is consistent with a division between EMP assemblages with Levallois and LMP assemblages with cordiform handaxes. From this perspective, the BWCMS material would seem most likely to be mixed assemblages, with the Levallois material representing EMP and the cordiform handaxes LMP occupation of the Palaeo-Yare. This would imply that the cordiform handaxes derive from Units 5 and/or 6, or an equivalent Devensian deposit, which has so far not been identified in the mapping of Areas 228, 511 and 512. So how does the BWCMS assemblage compare with the broader record from northwest Europe?

The EMP and northwest Europe

The technological and cultural signatures of the EMP in the rest of Britain, northern France, Belgium and the Netherlands are more complex than for southern and eastern England. Many sites from MIS 8 to early MIS 6 are dominated by Levallois archaeology with no evidence of handaxes. These include Maastricht-Belvédère (Netherlands), Kesselt-Op de Schans and Veldwezelt Hezerwater (Belgium), and Biache-Saint-Vaast, Therdonne, Etricourt-Manancourt, Le Pucheuil (A/C) and Tourville-la-Rivière (France; see Table 7 for references).

However, there are several sites that have both Levallois technology and handaxes. These include Pontnewydd Cave in north Wales, Mesvin IV in Belgium, Gentelles (CLG, CSI) and Port-Pignot in France, and La Cotte de St Brelade on Jersey. Finally, there are a series of sites containing handaxes, but no Levallois, including Harnham in southern England, and Gouzeaucourt, Longavesnes, Gentelles (LBP, LGC, LBN) and Ranville in northern France (see Table 7 for references).

From Table 7 it can be seen that there is no clear chronological or regional patterning, which may in part be due to the resolution of the dating. However, conclusions that can be drawn are that handaxe manufacture was a persistent technology that was used in northwest Europe throughout the EMP, and that there was a myriad of local variation, whether due to raw materials, site situation or cultural choice. The form of the handaxes varies both within and between sites, but there does appear to be a preponderance of ovate, cordiform and amygdaloid (elongated cordiform) morphologies, some of which are quite similar to the BWCMS assemblage.

The Palaeo-Yare, North Sea Basin and northwest Europe

If the BWCMS assemblage is representative of at least one population extending their range from mainland northwest Europe, what understanding do we have of the now submerged landscapes and connections with the Palaeo-Yare? The landscape would have varied as sea level rose and fell, changing the palaeogeography of the southern North Sea. The palaeoenvironmental and sedimentary evidence from Units 3b, 4 and 5 of the Palaeo-Yare indicates an estuarine or near-coastal depositional environment at times during MIS 7/6 and late MIS 5, whereas the Unit 6 deposits indicate a fluvial setting during MIS 3 (Tizzard et al., 2014; Table 1). This may be indicative of the relative position of the coastline during a period of lower sea level, and the emergence of dry land to the east of the Palaeo-Yare during the Devensian. Recent modelling of the evolution of the southern North Sea has suggested the existence of an emergent land area across the Southern Bight during the later Middle Pleistocene,

Table 6. Comparison of mean elongation (width/length), refinement (thickness/width), edge shape (tip width/butt width) and profile shape (tip thickness/butt thickness) (after Roe 1969), between central and east East Anglian handaxe assemblages. References: (1) this study; (2) White (2012); (3) Davis (unpublished data); (4) Roe (1969); (5) White, (1998); (6) Davis et al., (2021a).

Site/assemblage	*n*	MIS	Elongation	Refinement	Edge shape	Profile shape	Reference
Palaeo-Yare	19	7–6?	0.71 ± 0.080	0.38 ± 0.06	0.76 ± 0.14	0.70 ± 0.17	1
Palaeo-Yare (cordiforms only)	11	7–6?	0.73 ± 0.05	0.35 ± 0.05	0.76 ± 0.07	0.66 ± 0.12	1
Lynford B-ii	40	4/3	0.73 ± 0.07	0.35 ± 0.10	0.76 ± 0.12	0.64 ± 0.14	2
Barnham Heath	97	9?	0.59 ± 0.12	0.56 ± 0.14	0.80 ± 0.23	0.64 ± 0.21	3
Broomhill Pit	45	9?	0.62 ± 0.09	0.51 ± 0.12	0.65 ± 0.14	0.53 ± 0.15	3
Redhill	57	9?	0.59 ± 0.09	0.51 ± 0.11	0.66 ± 0.17	0.55 ± 0.16	3
Whitlingham	142	9?	0.6	0.54 ± 0.11	0.69	0.53 ± 0.17	4, 5
Elveden	74	11	0.63	0.46 ± 0.09	0.75	0.86 ± 0.22	4, 5
Hoxne	111	11	0.63	0.48 ± 0.09	0.56		4
Santon Downham	96	11?	0.67 ± 0.11	0.43 ± 0.10	0.74 ± 0.19	0.65 ± 0.15	3
High Lodge Bed E	70	13	0.65 ± 0.09	0.42 ± 0.10	0.83 ± 0.11	0.80 ± 0.15	6
Warren Hill	197	13+15	0.67 ± 0.10	0.44 ± 0.12	0.83 ± 0.13	0.80 ± 0.17	6
Brandon Fields	113	15+13	0.62 ± 0.10	0.56 ± 0.14	0.75 ± 0.18	0.65 ± 0.18	6
Maidscross Hill	162	15+13	0.61 ± 0.11	0.55 ± 0.16	0.77 ± 0.14	0.69 ± 0.18	6

Table 7. Sites of northwest Europe dated to MIS 8–6.

Site	Region/country	Context	MIS	Levallois	Handaxes	Main refs
Levallois sites						
Ebbsfleet/Baker's Hole	Thames, UK	Fluvial	Early MIS 7	Yes	No	Scott et al., 2010; Scott, 2011; Wenban-Smith et al., 2020
Thurrock, Lion Pit Tramway	Thames, UK	Fluvial	Early MIS 7	Yes	No	Schreve et al., 2006; Scott, 2011
Creffield Road, Acton	Thames, UK	Top of fluvial sediments	Early MIS 7	Yes	No	Scott, 2011
Yiewsley/West Drayton	Thames, UK	Top of fluvial sediments	Early MIS 7	Yes	No	Scott, 2011
Crayford	Thames, UK	Fluvial	Late MIS 7	Yes	No	Schreve, 2001; Scott, 2011
Maastricht-Belvédère	Limburg, Netherlands	Fluvial	MIS 7	Yes	No	Roebroeks, 1988; De Loecker and Roebroeks, 2012
Kesselt-Op de Schans	Limburg, Belgium	Top of fluvial sand sealed by loess	MIS 8	Yes	No	Van Baelen et al., 2017
Veldwezelt Hezerwater	Limburg, Belgium	Loess–soil sequence	MIS 7	Yes	No	Bringmans, 2006
Biache-Saint-Vaast	Hauts de France, France	Fluvial	MIS 7	Yes	No	Tuffreau, 1988; Hérisson, 2012
Etricourt-Manancourt	Hauts de France, France	Loess sequence	MIS 7	Yes	No	Hérisson et al., 2016
Salouel	Hauts de France, France	Fluvial	Late MIS 8/ early MIS 7	Yes	No	Ameloot-Van der Heijden et al., 1996
Therdonne	Picardie, France	Sealed palaeosol	Late MIS 7	Yes	No	Locht et al., 2010; Hérisson, 2012
Le Pucheuil (A/C)	Normandy, France	Loess infilling doline	MIS 7	Yes	No	Delagnes and Ropars, 1996; Delagnes, 1993
Tourville-la-Rivière	Normandy, France	Fluvial	Late MIS 7, early MIS 6	Yes	No	Cliquet, 2013
Gouberville – la Lande du Nau	Normandy, France	Raised beach	MIS 6	Yes	No	Coutard and Cliquet, 2005
Levallois/handaxe sites						
Mesvin IV	Hinaut, Belgium	Fluvial	MIS 8	Yes	Asymmetric 'Micoquian or Keilmesser forms'	Ryssaert, 2006; Di Modica et al., 2016
Gentelles (CLG, CSI)	Hauts de France, France	Doline	Late MIS 9, early MIS 8	Rare Levallois	Laceolates, cordiforms, amygdaloides	Tuffreau et al., 2001, 2008
Osièrs à Bapaume (series B)	Hauts de France, France	Doline	MIS 6	Yes	Eight handaxes, but now unlocated. An amygdaloide illustrated in Tuffreau 1976	Tuffreau, 1976; Koehler, 2008
Le Pucheuil (B)	Normandy, France	Loess infilling doline	Late MIS 7	Yes	Handaxe tip and manufacturing flakes	Delagnes and Ropars, 1996; Delagnes, 1993
Port-Pignot, Fermanville	Normandy, France	Raised beach	late MIS 7	Yes	Handaxes include amygdaloides and cleavers	Michel et al., 1982; Coutard and Cliquet, 2005
Digueville	Normandy, France	Raised beach	Late MIS 7/ early MIS 6	Yes	Thick handaxes on pebbles	Cliquet, 2013
La Cotte de St Brelade, Level A	Jersey	Cave	Early MIS 6	Yes	70 handaxes, mainly nucleiforms and amygdaloides	Callow and Cornford, 1986
Pontnewydd Cave	North Wales, UK	Cave	MIS 7	Yes	Yes	Green, 1984; Aldhouse-Green et al., 2012

(*Continued*)

Table 7. (*Continued*)

Site	Region/country	Context	MIS	Levallois	Handaxes	Main refs
Handaxe sites						
Gouzeaucourt (R/D, G and H)	Hauts de France, France	Late Middle Pleistocene loess in solution hollow	MIS 8–6?	Early reports of Levallois now interpreted as handaxe manufacturing flakes	3 main assemblages of ovates, limandes, cordiforms	Tuffreau and Bouchet, 1985; Marcy, 1989; Tuffreau et al., 2008
Longavesnes	Hauts de France, France	Late Middle Pleistocene loess in solution hollow	MIS 8–6?	Early reports of Levallois now interpreted as handaxe manufacturing flakes	Ovates, limandes, cordiforms	Ameloot-Van der Heijden, 1993
Gentelles (LBP, LGC, LBN)	Hauts de France, France	Doline	Early MIS 6	No	Laceolates, cordiforms, amygdaloides	Tuffreau et al., 2001, 2008
Ranville (B)	Normandy, France	Karstic fissure	MIS 7	No	2 cordiforms and a handaxe tip	Cliquet dir., 2008; Cliquet and Lautridou, 2009
Harnham	Solent river catchment, UK	Fluvial	MIS 8	No	Yes	Bates et al., 2014

which may have only been overtopped at the absolute peak interglacial highstands of sea level (Hijma et al., 2012). Britain may therefore have been connected to mainland Europe for long periods of both the EMP and LMP.

If this reconstruction is correct, then the EMP occupants of the Palaeo-Yare would have encountered an estuarine environment located on a northern coastline that stretched southeast across the Southern Bight to mainland Europe. The probable southern coastline of this land area and the fluvial palaeogeography correspond with the source of the Clacton dredged material, 19 km offshore from Felixstowe. Of importance, this may have resulted in different coastal connections from northwest Europe: a northerly route via the Palaeo-Yare into East Anglia, and a more southerly route into the Thames Valley. The evidence seems to add to the spatial analysis of the British EMP where there appears to be a general trend towards occupation in the lower reaches of the rivers of southeast England, with exploitation of the richer and more varied resources of estuarine and coastal areas, and emphasizing the peripheral position of Britain at the northwestern edge of Middle Palaeolithic Europe (Ashton et al., 2018).

It remains unclear whether the handaxes in the BWCMS assemblage reflect an EMP population with an extended range into the Palaeo-Yare, either as part of, or distinct from, a population using Levallois technology, or whether they represent a much later LMP population. Only further mapping and recovery of archaeological material from Devensian deposits in the Palaeo-Yare will answer this question. Identifying potential routeways for different EMP populations with different archaeological signatures also requires more work in these offshore zones to develop these ideas further. The archaeological signatures from these areas have probably been amplified through the replenishment schemes at Bacton and Clacton, with enhanced visibility from tidal sorting on a beach and hundreds of hours of searching by collectors. However, this does not detract from their importance for mapping occupation of the southern North Sea Basin, and the possible connections to northwest Europe, as well as contributing to understanding of the Middle Palaeolithic record in Britain.

The future of work around Happisburgh, other coastal areas and the offshore zone

The emplacement and subsequent redistribution of dredged sediments at Bacton/Walcott has significant ramifications for the Lower Palaeolithic sites at Happisburgh, where the excavation of CF-bF deposits at Site 1 (Lewis et al., 2019) and Site 3 (Parfitt et al., 2010) has provided important information on the early human occupation of northwest Europe and contributed to understanding early human adaptation to northern latitudes, and the emergence of the Acheulean. However, there are several important questions still to be answered. Both sites produced relatively small lithic assemblages, and at Site 3 in particular, the full range of the lithic technology of this early pioneer population remains to be determined. Erosion of the CF-bF has provided more material which, through detailed collection and recording by local collectors, can sometimes be linked back to *in situ* deposits (Bynoe et al., 2021). Importantly, handaxes have been collected from the beach around Site 3 and in Area D to the northwest, but their source(s) and age are unclear. The introduction of a Middle Palaeolithic assemblage to this area is certainly complicating matters, but as has been shown (above and Appendix S1), there are key differences that should enable future discoveries to be assigned to either the Palaeo-Yare or the CF-bF with a reasonable degree of confidence. This will require ongoing communication between collectors, local authorities and researchers, to encourage and support good collecting and recording practice.

The extraction of marine aggregate resources also has implications for understanding the Palaeolithic record. Archaeological potential, and the presence, distribution and character of Palaeolithic material can be determined across large areas of a submerged landscape through established protocols for reporting archaeological finds and wharf monitoring, which cover the typical marine aggregate dredging operations for the supply of construction aggregates (Wessex Archaeology, 2013, 2015, 2021). However, the situation at Bacton and Clacton has highlighted to the industry the need for additional mitigation measures that address the specific requirements of beach replenishment projects (e.g. large volumes of sediment dredged over a short period of time from multiple licence areas, including rarely dredged areas/sedimentary units, delivered directly to the foreshore; Wessex Archaeology, in prep.). The Crown Estate, British Marine Aggregate Producers Association (BMAPA) and Historic England have commissioned new guidance to supplement the existing reporting protocol that applies to marine aggregate resources delivered to wharves (Wessex Archaeology, in prep.).

It may be the case that archaeology is at times distributed at such low densities and the means to identify areas of higher archaeological potential is limited that situations like that at Bacton–Walcott are inevitable. Nevertheless, it is clear that frequent monitoring of the beach over the months that followed the sandscaping project was crucial for capturing archaeological data. Fortunately, an existing community of collectors, with well-established links to the PAS and to researchers, meant that the resources and expertise were available to recover and record finds. Integration of GNSS data of dredging areas and deposition zones on the beach, with recording of find locations, was critical for establishing links between the artefacts and potential source areas in the submerged valley of the Palaeo-Yare. As a reactive response, the post-sandscaping work at Bacton and Walcott can act as a model for best practice, albeit one that came about from a set of informal relationships rather than a formal written scheme of investigation.

Conclusion

The BWCMS has provided a salutary warning to those regulating, advising, funding and undertaking such large-scale coast defence projects, highlighting the importance of having full schemes of investigation prior to sediment extraction of submerged palaeolandscapes for use in coastal protection schemes. Despite this, a reactive programme of work with dedicated local collectors has given new insights into the Middle Palaeolithic occupation of the southern North Sea Basin. Differences in technology and condition have enabled the identification of a Middle Palaeolithic assemblage of Levallois cores and flakes, and a set of distinctive cordiform handaxes that come from fluvial sediments of the Palaeo-Yare. By relating the find locations of the artefacts to the distribution of the dredged sediments and their source areas, it is likely that much of the assemblage originated in deposits that have been OSL dated to MIS 7 to 6. However, there are also Devensian and Holocene sediments in neighbouring areas of the Palaeo-Yare. The Levallois material fits well with an EMP attribution. The closest parallel for the cordiform handaxes is the LMP site of Lynford, but similar handaxe forms are also known from EMP sites in neighbouring areas of Europe. The limitations of working with dredged sediments means that it remains unclear at present whether the Levallois material and cordiform handaxes are part of one or more phases of EMP occupation, or a mix of EMP and LMP archaeology. Future work targeting the Devensian deposits of the Palaeo-Yare could help to distinguish between these interpretations. The work, both here and from an EMP location 19 km offshore from Felixstowe, also found by diligent collecting of artefacts from beach replenishment material, illustrates the preservation and richness of these late Middle Pleistocene landscapes and their importance for understanding the routeways through, and the occupation of, the southern North Sea Basin.

Acknowledgements. We are grateful to Stuart Churchley of Historic England and Mark Russell of the BMAPA for their comments on an earlier draft of this paper. Thanks also to BMAPA and Wessex Archaeology for providing access to the reports from the Palaeo-Yare Catchment Assessment project and the Palaeo-Yare geology shapefiles, Kathryn Price for assisting with some of the lithic recording, and to Jason Gibbons and Norfolk PAS for facilitating access to artefacts sent to PAS. We are grateful for funding from the Calleva Foundation for the Pathways to Ancient Britain Project, and North Norfolk District Council for funding for the Palaeolithic Artefact Discoveries from the Sandscaping area project.

Conflict of Interest—No authors involved in any part of this work have any conflicts of interest that could be perceived as influencing their objectivity.

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.

Appendix S1. Distribution and character of lithic material collected from the foreshore between Bacton and Horsey, 2013–2021.

Abbreviations. AEZ, archaeological exclusion zone; BMAPA, British Marine Aggregate Producers Association; BWCMS, Bacton to Walcott Coastal Management Scheme; CF-bF, Cromer Forest-bed Formation; ECAEB, East Coast aggregate extraction block; EMP, Early Middle Palaeolithic; GNSS, global navigation satellite system; GPS, global positioning system; LMP, Late Middle Palaeolithic; MIS, Marine Isotope Stage; MTA, Mousterian of Acheulean Tradition; OSL, optically stimulated luminescence; PAS, Portable Antiquities Scheme; PAB, Pathways to Ancient Britain project; TERPS, The English Rivers Palaeolithic Survey.

References

Aldhouse-Green, S., Peterson, R. & Walker, E. (2012) *Neanderthals in Wales: Pontnewydd and the Elwy Valley Caves*. Oxbow Books.

Ameloot-Van der Heijden, N. (1993) L'ensemble lithique du gisement de Longavesnes (Somme): illustration d'un problème de reconnaissance du débitage levallois dans une industrie à bifaces de la phase ancienne du Paléolithique moyen. *Bulletin de la Société préhistorique française*, 90, 257–264.

Ameloot-Van der Heijden, N., Dupuis, C., Munaut, A.V. & Puissegur, J.J. (1996) Le gisement paléolithique moyen de Salouel (Somme, France). *L'Anthropologie*, 100, 555–573.

Amkreutz, L. & van der Vaart-Verschoof, S. (Eds). (2022) *Doggerland. Lost world under the North Sea*. Leiden: (English translation) Sidestone Press.

Ashton, N.M. (1998) The taphonomy of the flint assemblages. In: Ashton, N.M., Lewis, S.G. & Parfitt, S.A. (Eds.) *Excavations at the Lower Palaeolithic Site at East Farm, Barnham, Suffolk, 1989–1994. British Museum Occasional Paper Number 125*. London: British Museum Press. pp. 183–204.

Ashton, N.M., Lewis, S.G., De Groote, I. et al. (2014) Hominin footprints from Early Pleistocene deposits at Happisburgh, UK. *PLoS One*, 9, e88329.

Ashton, N.M., Harris, C.R.E. & Lewis, S.G. (2018) Frontiers and routeways from Europe: the Early Middle Palaeolithic of Britain. *Journal of Quaternary Science*, 33, 194–211. Available at: https://doi.org/10.1002/jqs.3015

Ashton, N.M. & Scott, B. (2016) The British Middle Palaeolithic. *Quaternary International*, 411A, 62–76.

Bates, M.R., Wenban-Smith, F.F., Bello, S.M., Bridgland, D.R., Buck, L.T., Collins, M.J. et al. (2014) Late persistence of the Acheulian in southern Britain in an MIS 8 interstadial: evidence from Harnham, Wiltshire. *Quaternary Science Reviews*, 101, 159–176. Available at: https://doi.org/10.1016/j.quascirev.2014.07.002

Boëda, E. (1995) Levallois: a volumetric construction, methods, a technique. In: Dibble, H.L. & Bar-Yosef, O. (Eds.) *The definition and interpretation of Levallois technology*. Madison: Prehistory Press. pp. 41–67.

Boismier, B., Gamble, C. & Coward, F. (2012) *Neanderthals among Mammoths: Excavations at Lynford Quarry, Norfolk*. English Heritage.

Bridgland, D.R., Harding, P., Allen, P., Candy, I., Cherry, C., George, W. et al. (2013) An enhanced record of MIS 9 environments, geochronology and geoarchaeology: data from construction of the High Speed 1 (London–Channel Tunnel) rail-link and other recent investigations at Purfleet, Essex, UK. *Proceedings of the Geologists' Association*, 124, 417–476. Available at: https://doi.org/10.1016/j.pgeola.2012.03.006

Bringmans, P.M.M.A. (2006) Seven well-preserved in-situ Middle Palaeolithic open-air sites in a loess-soil "climate-calender" sequence at Veldwezelt-Hezerwater, Belgium. *Notae Praehistoricae*, 26, 9e18.

Busschers, F.S., van Balen, R.T., Cohen, K.M., Kasse, C., Weerts, H.J.T., Wallinga, J. et al. (2008) Response of the Rhine-Meuse fluvial system to Saalian ice-sheet dynamics. *Boreas*, 37, 377–398.

Bynoe, R. (2018) The submerged archaeology of the North Sea: Enhancing the Lower Palaeolithic record of northwest Europe. *Quaternary Science Reviews*, 191, 1–14. Available at: https://doi.org/10.1016/j.quascirev.2018.05.002

Bynoe, R., Ashton, N.M., Grimmer, T., Hoare, P., Leonard, J., Lewis, S.G. et al. (2021) Coastal curios? An analysis of ex situ beach finds for mapping new Palaeolithic sites at Happisburgh, UK. *J. Quaternary Sci*, 36, 191–210. Available at: https://doi.org/10.1002/jqs.3270

Bynoe, R., Dix, J. & Sturt, F. (2016) Of mammoths and other monsters: Historic approaches to the submerged Palaeolithic. *Antiquity*, 90(352), 857–875. Available at: https://doi.org/10.15184/aqy.2016.129

Bynoe, R., Grant, M.J. & Dix, J.K. (2022) Strategic Support for Marine Development Management: Palaeolithic archaeology and landscape reconstruction offshore. Historic England Research Report Series no. 90/2022.

Callow, P. & Cornford, J.-M. (1986) La Cotte de Sainte Brelade (Jersey) 1961–1978. Excavations by C.B.M. Mc Burney. Geobooks.

Cliquet, D. dir. (2008) Le site pléistocène moyen recent de Ranville (Calvados - France) dans son contexte environnemental. Analyse du fonctionnement d'une aire de boucherie soutirée par un réseau karstique. ERAUL, p. 119.

Cliquet, D. (2013) Les occupations paléolithiques en Normandie dans leur contexte chronostratigraphique: «bribes archéologiques». *Quaternaire*, 24, 315–358.

Cliquet, D. & Lautridou, J.P. (2009) Les occupations humaines du Pléistocène moyen de Normandie dans leur cadre environnemental. *Quaternaire*, 20, 303–320.

Coutard, S. & Cliquet, D. (2005) Chronostratigraphie des formations pléistocènes et peuplement paléolithique en contexte littoral: le Val de Saire (Normandie). *Bulletin de la Société préhistorique française*, 477–499.

Davis, R.J., Ashton, N.M., Hatch, M.T., Hoare, P.G. & Lewis, S.G. (2021a) Palaeolithic archaeology of the Bytham River: Human occupation of Britain during the early Middle Pleistocene and its European context. *Journal of Quaternary Science*, 36, 526–546. Available at: https://doi.org/10.1002/jqs.3305

Davis, R.J., Ashton, N.M., Hatch, M., Hosfield, R. & Lewis, S.G. (2021b) Lower and early Middle Palaeolithic of Southern England: the evidence from the River Test. *Journal of Palaeolithic Archaeology*, 4, 23. Available at: https://doi.org/10.1007/s41982-021-00096-3

Davis, R.J., Hatch, M., Ashton, N.M., Hosfield, R.T. & Lewis, S.G. (2016) The Palaeolithic record of Warsash, Hampshire, UK: implications for late Lower and early Middle Palaeolithic occupation history of Southern Britain. *Proceedings of the Geologists' Association*, 127, 558–574. Available at: https://doi.org/10.1016/j.pgeola.2016.09.005

Delagnes, A. (1993) Un mode de production inédit au Paléolithique moyen dans l'industrie du niveau 6e du Pucheuil (Seine-Maritime). *Paléo*, 5, 111–120. Available at: https://doi.org/10.3406/pal.1993.1106

Delagnes, A. & Ropars, A. (1996) Paléolithique moyen en pays de Caux (Haute-Normandie). Le Pucheuil, Ettouteville: deux gisements de plein air en milieu loessique (Documents d'Archéologie Française).

De Loecker, D. & Roebroeks, W. (2012) Beyond '15-minutes': revisiting the late Middle Pleistocene archaeological record of Maastricht-Belvédère (The Netherlands). *Analecta Praehistorica Leidensia*, 43/44, 349e367.

Di Modica, K., Toussaint, M., Abrams, G. & Pirson, S. (2016) The Middle Palaeolithic from Belgium: Chronostratigraphy, territorial management and culture on a mosaic of contrasting environments. *Quaternary International*, 411(Part A), 77–106. Available at: https://doi.org/10.1016/j.quaint.2015.12.072

Gibbard, P.L. (1988) The history of the great northwest European rivers during the past three million years. *Philosophical Transactions of the Royal Society, London Series*, B318, 559–602. Available at: https://doi.org/10.1098/rstb.1988.0024

Gibbard, P.L. (1995) The formation of the Strait of Dover. In: Preece, R.C. (Ed.) *Island Britain: a Quaternary Perspective*. London: Geological Society Special Publication 96. pp. 15–26.

Glimmerveen, J., Mol, D., Post, K., Reumer, J.W.F., van der Plicht, H., de Vos, J. et al. (2004) The North Sea Project: the first palaeontological, palynological and archaeological results. In: Flemming, N.C. (Ed.) *Submarine Prehistoric Archaeology of the North Sea*. York: CBA Research Report 141. p. 43e52.

Glimmerveen, J., Mol, D. & van der Plicht, H. (2006) The Pleistocene reindeer of the North Sea — initial palaeontological data and archaeological remarks. *Quaternary International*, 142/143, 242–6.

Green, H.S. (1984) *Pontnewydd Cave: A Lower Palaeolithic Hominid site in Wales*. Cardiff: National Museum of Wales.

Gupta, S., Collier, J.S., Palmer-Felgate, A. & Potter, G. (2007) Catastrophic flooding origin of shelf valley systems in the English Channel. *Nature (London, United Kingdom)*, 448, 342–345. Available at: https://doi.org/10.1038/nature06018

Gupta, S., Collier, J.S., Garcia-Moreno, D. et al. (2017) Two-stage opening of the Dover Strait and the origin of island Britain. *Nature Communications*, 8, 15101.

HR Wallingford. (2002) *Southern North Sea Sediment Transport Study - Phase 2 - Sediment Transport Report (including executive summary, report figures and appendices). Technical Report.* HR Wallingford.

Hérisson, D. (2012) Etude des comportements des premiers Néandertaliens du Nord de la France: les occupations saaliennes des gisements de Biache-Saint-Vaast et de Therdonne. Thèse de doctorat. Université de Lille, Villeneuve-d'Ascq.

Hérisson, D., Brenet, M., Cliquet, D., Moncel, M.-H., Richter, J., Scott, B. et al. (2016) The emergence of the Middle Palaeolithic in north-western Europe and its southern fringes. *Quaternary International*, 411, 233–283. Available at: https://doi.org/10.1016/j.quaint.2016.02.049

Hijma, M.P., Cohen, K.M., Roebroeks, W., Westerhoff, W.E. & Busschers, F.S. (2012) Pleistocene Rhine–Thames landscapes: geological background for hominin occupation of the southern North Sea region. *Journal of Quaternary Science*, 27, 17–39. Available at: https://doi.org/10.1002/jqs.1549

Koehler, H. (2008) L'apport du gisement des Osiers à Bapaume (Pas-de-Calais) au débat sur l'émergence du Paléolithique moyen dans le Nord de la France. *Bulletin de la Société préhistorique française*, 105, 709–735.

Lewis, S.G., Ashton, N.M., Field, M., Hoare, P.G., Kamermans, H., Knul, M. et al. (2019) Human occupation of northern Europe in MIS 13: Happisburgh Site 1 (Norfolk, UK) and its European context. *Quaternary Science Reviews*, 211, 34–58. Available at: https://doi.org/10.1016/j.quascirev.2019.02.028

Limpenny, S.E., Barrio Froja'n, C., Cotterill, C. et al. (2011) *The East Coast Regional Environmental Characterisation*. Cefas Open. MEPF.

Locht, J.-L., Antoine, P., Hérisson, D., Gadebois, G. & Debenham, N. (2010) Une occupation de la phase ancienne du Paléolithique moyen à Therdonne (Oise). Chronostratigraphie, production de pointes Levallois et réduction des nucléus. *Gallia préhistoire*, 52, 1–32.

Marcy, J.-L. (1989) L'outillage sur éclat du gisement acheuléen de la vallée du Muid à Gouzeaucourt (Nord): Premiers résultats. In: Tuffreau, A. (Ed.) *Paléolithique et Mésolithique Du Nord de La France*. Nouvelles Recherches, Villeneuve-d'Ascq. pp. 31–41.

Marshall, P. (2020) *Seeing beneath the sea – Palaeolithic finds from Aggregate Area 240. Scientific Dating of Pleistocene Sites: Guidelines for Best Practice*. English Heritage

Michel, D., Coutard, J.P., Ozouf, J.-C., Helluin, M. & Pellerin, J. (1982) Le gisement préhistorique de Port-Pignot à Fermanville (Manche). *Gallia Préhistoire*, 25, 1–77.

Missiaen, T., Fitch, S., Harding, R., Muru, M., Fraser, A., De Clercq, M. et al. (2021) Targeting the Mesolithic: Interdisciplinary approaches to archaeological prospection in the Brown Bank area, southern North Sea. *Quaternary International*, 584, 141–151. Available at: https://doi.org/10.1016/j.quaint.2020.05.004

Moir, J.R. (1918) An Early Mousterian 'floor' discovered at Ipswich. *Man*, 18(60), 98–100.

Moir, J.R. (1931) Ancient man in the Gipping-Orwell Valley, Suffolk. *Proceedings of the Prehistoric society of East Anglia*, 6, 182–221.

Moir, J.R. & Hopwood, A.T. (1939) Excavations at Brundon, Suffolk (1935–1937). *Proceedings of the Prehistoric Society*, 5, 1–32.

Mol, D., Post, K., Reumer, J.W.F., van der Plicht, J., de Vos, J., van Geel, B. et al. (2006) The Eurogeul — first report of the palaeontological, palynological and archaeological investigations of this part of the North Sea. *Quaternary International*, 142/143, 178–85.

Moncel, M.-H., Ashton, N., Arzarello, M., Fontana, F., Lamotte, A., Scott, B. et al. (2020) Early Levallois core technology between marine isotope stage 12 and 9 in Western Europe. *Journal of Human Evolution*, 139, 102735.

Parfitt, S.A., Ashton, N.M., Lewis, S.G., Abel, R.L., Coope, G.R., Field, M.H. et al. (2010) Early Pleistocene human occupation at the edge of the boreal zone in northwest Europe. *Nature (London, United Kingdom)*, 466, 229–233. Available at: https://doi.org/10.1038/nature09117

Peeters, H., Murphy, P. & Flemming, N. (2009) *North Sea prehistory research and management framework*. Amersfoort: Rijksdienst voor Cultureel Erfgoed; Swindon: English Heritage.

Pettitt, P. & White, M. (2012) *The British Palaeolithic: Human Societies at the Edge of the Pleistocene World*. Abingdon: Routledge.

Rawlinson, A., Dale, L., Ashton, N., Bridgland, D. & White, M. (2021) Flake tools in the European Lower Paleolithic: A case study from MIS 9 Britain. *Journal of Human Evolution*, 165, 103153. Available at: https://doi.org/10.1016/j.jhevol.2022.103153

Roe, D.A. (1969) British Lower and Middle Palaeolithic handaxe groups. *Proceedings of the Prehistoric Society*, 34, 1–82.

Roebroeks, W. (1988) *From find scatters to early hominid behaviour. A study of Middle Paleolithic riverside settlements at Maastricht-Belvédère (The Netherlands)*. Leiden: Analecta Praehistorica Leidensia 21. Leiden University Press.

Roebroeks, W. (2014) Terra incognita: The Palaeolithic record of northwest Europe and the information potential of the southern North Sea. *Netherlands Journal of Geosciences - Geologie En Mijnbouw*, 93(1–2), 43–53. Available at: https://doi.org/10.1017/njg.2014.1

Ruebens, K. & Wragg Sykes, R.M. (2016) Spatio-temporal variation in late Middle Palaeolithic Neanderthal behaviour: British bout coupé handaxes as a case study. *Quaternary International*, 411(Part A), 305–326. Available at: https://doi.org/10.1016/j.quaint.2015.04.037

Ryssaert, C. (2006) Some new insights in an old collection: lithic technology at Mesvin IV. *Notae Praehistoricae*, 26, 91–99.

Sainty, J.E. (1933) Some Norfolk Palaeolithic discoveries. *Proceedings of the Prehistoric Society of East Anglia*, 7(2), 171–177.

Sainty, J.E. (1935) Three Combe-Capelle handaxes from Norfolk. *Proceedings of the Prehistoric Society*, 1, 98–100.

Sainty, J.E. & Watson, A.Q. (1944) Palaeolithic implements from Southacre. *Norfolk Archaeology*, 28, 183–186.

Schreve, D.C. (2001) Differentiation of the British late Middle Pleistocene interglacials: the evidence from mammalian biostratigraphy. *Quaternary Science Reviews*, 20(16–17), 1693–1705. Available at: https://doi.org/10.1016/S0277-3791(01)00033-6

Schreve, D.C., Bridgland, D.R., Allen, P., Blackford, J.J., Gleed-Owen, C.P., Griffiths, H.I. et al. (2002) Sedimentology, palaeontology and archaeology of late Middle Pleistocene River Thames terrace deposits at Purfleet, Essex, UK. *Quaternary Science Reviews*, 21, 1423–1464. Available at: https://doi.org/10.1016/S0277-3791(01)00100-7

Schreve, D., Harding, P., White, M., Bridgland, D., Allen, P., Clayton, F. et al. (2006) A Levallois Knapping Site at West Thurrock, Lower Thames, UK: Its Quaternary Context, Environment and Age. *Proceedings of the Prehistoric Society*, 72, 21–52. Available at: https://doi.org/10.1017/S0079497X00000773

Scott, B. (2011) *Becoming Neanderthals*. Oxford: Oxbow Books.

Scott, B. & Ashton, N.M. (2011) The Early Middle Palaeolithic: the European context. In: Ashton, N.M., Lewis, S.G. & Stringer, C.B. (Eds.) *The Ancient Human occupation of Britain*. Amsterdam: Elsevier. pp. 91–112. https://doi.org/10.1016/B978-0-444-53597-9.00007-8

Scott, B., Ashton, N.M., Penkman, K.E.H., Preece, R.C. & White, M. (2010) The position and context of Middle Palaeolithic industries from the Ebbsfleet Valley, Kent, UK. *Journal of Quaternary Science*, 25, 931–944.

Scott, B., Ashton, N.M., Lewis, S.G., Parfitt, S.A. & White, M.J. (2011) Technology and Landscape Use in the Early Middle Palaeolithic of the Thames Valley. In: Ashton, N.M., Lewis, S.G. & Stringer, C.B. (Eds.) *The Ancient Human occupation of Britain*. Amsterdam: Elsevier. pp. 67–89. https://doi.org/10.1016/B978-0-444-53597-9.00006-6

Scott, B., Pope, M., Ashton, N. & Shaw, A. (2019) The Early Middle Palaeolithic of Britain and Jersey: reconnecting the Saalian occupations of the Channel Region, *Préhistoire de l'Europe du Nord-Ouest: mobilités, climats et identités culturelles*. Paris, France: Institut national de recherches archéologiques préventives (INRAP).

Spencer, H.E.P. (1953) Bobbitts Hole, Belstead. Interim Report. *Transactions of the Suffolk Naturalists Society*, 8(2), 53–58.

Spencer, H.E.P. (1970) A Contribution to the Geological History of Suffolk: Part 4. The Interglacial Epochs. *Transactions of the Suffolk Naturalists' Society*, 15, 148–196.

Szabo, B.J. & Collins, D.M. (1975) Ages of fossil bones from British interglacial sites. *Nature (London, United Kingdom)*, 254, 680–682.

Tizzard, L., Bicket, A.R., Benjamin, J. & De Loecker, D.D. (2014) A Middle Palaeolithic site in the southern North Sea: investigating the archaeology and palaeogeography of Area 240. *Journal of Quaernary Science*, 29, 698e710.

Tizzard, L., Bicket, A., De Loecker, D. & Benjamin, J. (2015) *Seabed Prehistory: Investigating the Palaeogeography and Early Middle Palaeolithic Archaeology in the Southern North Sea, vol. 35*. Wessex Archaeology

Toucanne, S., Zaragosi, S., Bourillet, J.F., Cremer, M., Eynaud, F., Van Vliet-Lanoe, B. et al. (2009) Timing of massive 'Fleuve Manche' discharges over the last 350 kyr: insights into the European ice-sheet oscillations and the European drainage network from MIS 10 to 2. *Quaternary Science Reviews*, 28, 1238–1256.

Tuffreau, A. (1976) Les fouilles du gisement Acheuléen supérieur des Osiers à Bapaume (Pas-de-Calais). *Bulletin de la Société préhistorique française*, 73, 231–243. Available at: https://doi.org/10.3406/bspf.1976.8443

Tuffreau, A. (1988) Historique des fouilles effectuées à Biache-Saint-Vaast. In: Tuffreau, A. & Sommé, J. (Eds.) *Le Gisement Paléolithique Moyen de Biache-Saint-Vaast (Pas-de-Calais). Stratigraphie, Environnement, Études Archéologiques (1ère Partie)*. Société Préhistorique Française. p. 15e24.

Tuffreau, A., Antoine, P., Marcy, J.-L. & Segard, N. (2001) Les industries paléolithiques à nombreux bifaces du Mont de l'Evangile à Gentelles (Somme). In: Cliquet, D. (Ed.) *Les Industries Aoutils Bifaciaux Du*

Paléolithique Moyen d'Europe Occidentale. Actes de La Table-Ronde Internationale Organisée À Caen (Basse-Normandie - France) - 14 et 15 Octobre 1999. ERAUL. pp. 29–41.
Tuffreau, A. & Bouchet, J.-P. (1985) Le gisement acheuléen de la Vallée du Muid à Gouzeaucourt (Nord). *Bulletin de la Société préhistorique française*, 82, 291–306.
Tuffreau, A., Lamotte, A. & Goval, E. (2008) Les industries acheuléennes de la France septentrionale. *Anthropologie*, 112, 104–139. Available at: https://doi.org/10.1016/j.anthro.2008.01.003
Tyldesley J.A. (1987) The bout coupé Handaxe: a Typological Problem, *British Archaeological Reports 170*. Oxford.
Van Baelen, A., Van Peer, P., Meijs, E.P.M., Hus, J.J., Lehmkuhl, F., Schulte, P. et al. (2017) *The Lower to Middle Palaeolithic Transition in Northwestern Europe: Evidence from Kesselt-Op de Schans*. Leuven University Press. Available at: https://doi.org/10.2307/j.ctt1whm9j1
Van Kolfschoten, T. & Van Essen, H. (2004) Palaeozoological heritage from the bottom of the North sea. *CBA Res. Rep*, 141, 70.
Velegrakis, A.F., Dix, J.K. & Collins, M.B. (1999) Late Quaternary evolution of the upper reaches of the Solent River, southern England, based on marine geophysical evidence. *Journal of the Geological Society of London*, 156, 73–87. Available at: https://doi.org/10.1144/gsjgs.156.1.0073
Wenban-Smith, F., Stafford, E., Bates, M. & Parfitt, S. (2020) Prehistoric Ebbsfleet: Excavations and research in advance of High Speed 1 and South Thameside Development Route 4, 1989–2003. *Oxford Wessex Archaeology Monograph*, 7.
Wessex Archaeology. (1996) Region 9 (Great Ouse Drainage) and 12 (Yorkshire and the Lincolnshire Wolds), Salisbury, English Rivers Palaeolithic Project Rep. 2.
Wessex Archaeology. (1997) Region 8 (East Anglian Rivers) and 11 (Trent Drainage), Salisbury, English Rivers Palaeolithic Project Rep. 3.
Wessex Archaeology. (2011) Seabed Prehistory: Site Evaluation Techniques (Area 240): Synthesis. Ref 70753.02. http://archaeologydataservice.ac.uk/archives/view/seaprehist_eh_2009/
Wessex Archaeology. (2013) Palaeo-Yare Catchment Assessment. Technical Report. Crown Estate.
Wessex Archaeology. (2015) Palaeo-Yare Operational Sampling conducted under the short-term licencing provisional Written Scheme of Investigation. Interpretive Report. BMAPA.
Wessex Archaeology. (2020) Review of Data from the Bacton Beach Nourishment project. Anglian Offshore Dredging Association.
Wessex Archaeology. (2021) Palaeo-Yare Catchment Monitoring: Interpretative Report. Anglian Offshore Dredging Association.
Wessex Archaeology. (in prep). Marine Archaeological Guidance for Beach Replenishment/Nourishment and Contract Fill Projects. Crown Estate and BMAPA.
White, M.J. (1998) On the significance of Acheulian biface variability in Southern Britain. *Proceedings of the Prehistoric Society*, 64, 15–44.
White, M.J. (2012) The lithic assemblage from Lynford Quarry and its bearing on Neanderthal behaviour in Late Pleistocene Britain. In: Boismier, B., Gamble, C. & Coward, F. *Neanderthals among Mammoths: Excavations at Lynford Quarry, Norfolk*. English Heritage.
White, M.J. & Ashton, N.M. (2003) Lower Palaeolithic Core Technology and the Origins of the Levallois Method in North-Western Europe. *Current Anthropology*, 44, 598–609. Available at: https://doi.org/10.1086/377653
White, M.J. & Jacobi, R.M. (2002) Two Sides to Every Story: Bout Coupé Handaxes Revisited. *Oxford Journal of Archaeology*, 21, 109–133. Available at: https://doi.org/10.1111/1468-0092.00152
White, M.J. & Pettitt, P.B. (2011) The British Late Middle Palaeolithic: an interpretative synthesis of Neanderthal occupation at the North-western edge of the Pleistocene world. *Journal of World Prehistory*, 24, 25e97.
White, M.J., Scott, B. & Ashton, N.M. (2006) The Early Middle Palaeolithic in Britain: archaeology, settlement history and human behaviour. *Journal of Quaternary Science*, 21, 525–541. Available at: https://doi.org/10.1002/jqs.1034
Wragg Sykes, R.M. (2010) Beyond bout coupes: the dynamic role of bifaces in the British Mousterian. *Journal of the Lithics Studies Society*, 31, 20–32.
Wymer, J.J. (1968) *Lower Palaeolithic Archaeology in Britain as represented by the Thames Valley*. London: John Baker.
Wymer, J.J. (1985) *The Palaeolithic Sites of East Anglia*. Norwich: GeoBooks.
Wymer, J.J. (1999) *The Lower Palaeolithic Occupation of Britain (Vol. 1 and 2)*. Salisbury: Wessex Archaeology and English Heritage. Available at: https://doi.org/10.5284/1000063