QUEST
QUATERNARY SCIENTIFIC

University of Reading

PORTINGBURY HILLS, HATFIELD BROAD OAK, TAKELEY, ESSEX

Environmental Archaeological Analysis Report

NGR: TL 533 204

Site Code: HNA17

Scheduled Monument No: SM EX 98, HA 1002168

Date: 12th March 2018

Written by: Dr D.S. Young
Dr P. Dark
& Dr C.R. Batchelor

QUEST, School of Archaeology, Geography and Environmental Science, Whiteknights, University of Reading, RG6 6AB

Tel: 0118 378 7978 / 8941
Email: d.s.young@reading.ac.uk
http://www.reading.ac.uk/quest

DOCUMENT HISTORY:

REVISION	DATE	PREPARED BY	SIGNED	APPROVED BY	SIGNED	REASON FOR ISSUE
v1	12/03/18	D.S. Young		C.R. Batchelor		First edition

CONTENTS

1. NON-TECHNICAL SUMMARY

Following the results of a geoarchaeological borehole survey and environmental archaeological assessment of the site, pollen analysis was undertaken on a sequence of organic sediments preserved within the ditch associated with the Portingbury Hills earthwork enclosure. The material infilling the ditch is a predominantly silty clay, with occasional sand or gravel clasts, although richly organic sub-units do exist and were recorded within three of the four boreholes (QBH2, QBH3 and QBH4). In boreholes QBH2 and QBH4 two distinct organic units were recorded; in QBH4 the lower of these units was radiocarbon dated to 395 to 205 cal BC (Iron Age; 2345 to 2155 cal BP), whilst the base of the upper organic unit in QBH4 was dated to 370 to 200 cal BC (Iron Age; 2320 to 2150 cal BP). These organic units appear to represent *in situ* organic accumulation, and are thus indicative of waterlogged, boggy conditions within the ditch, supporting the growth of sedge fen type vegetation during the Middle Iron Age. The two radiocarbon dates from these organic sediments thus provide a *terminus ante quem* for the cutting of the ditch, which must have occurred prior to 395 to 205 cal BC (2345 to 2155 cal BP).

The results of the subsequent pollen and micro-charcoal analyses have provided a record of the changing character and extent of woodland and open land around the site during the mid-late Iron Age, including at least two phases of cereal cultivation, separated by a period of woodland regeneration presumably linked with abandonment of the enclosure. In addition, the lowermost sample contained a whipworm egg, probably from the human whipworm, *Trichuris trichiura*, suggesting that human waste was deposited into the ditch at least occasionally. While the pollen sequence reflects predominantly the local vegetation and land use immediately around the Portingbury Hills enclosure, it is interesting to note the considerable difference in composition of the surrounding woodland from that of today, especially the virtual absence of birch and hornbeam.

Considering the wider vegetation history of Hatfield Forest, further pollen analyses from deposits covering a longer chronological period are needed to trace the origins of the characteristic vegetation and landscape of the medieval Forest, and in particular whether any of its woodland might have continuity with the original 'wildwood'.

2. INTRODUCTION

2.1 Site context

This report summarises the findings arising out of the environmental archaeological analysis undertaken by Quaternary Scientific (University of Reading) on samples from a ditch feature at Portingbury Hills, Hatfield Broad Oak, Takeley, Essex (National Grid Reference: TL 533 204; Scheduled Monument No: SM EX 98, HA 1002168; Figure 1). Quaternary Scientific were commissioned by Essex County Council to undertake the investigations. The site lies within Hatfield Forest, a 403.2 hectare biological Site of Special Scientific Interest, National Nature Reserve and Nature Conservation Review site. The Forest contains a variety of historic environment features, including individual earthworks, earthwork complexes, historic buildings and associated below ground archaeology relating to the human occupation, exploitation and use of the Forest during the medieval, post medieval and modern periods (Essex County Council, 2016). Selected features within Hatfield Forest may pre-date the medieval period, with an Iron Age date speculated for Portingbury Hills (Essex County Council, 2016). Portingbury Hills itself is an earthwork enclosure consisting of three features: a hill and mound connected by a zig-zag causeway (formed by two parallel ditches) to another rectangular enclosure, measuring 30 by 21 metres and surrounded by a large ditch with a bank of up to 11 metres wide (Huggins, 1978).

The British Geological Survey (BGS) show the area of Hatfield Forest underlain by superficial deposits of Quaternary Till (Diamicton), overlying Thames Group (Clay, Silt, Sand And Gravel) bedrock (http://mapapps.bgs.ac.uk/geologyofbritain/home.html). Waterlogged deposits are thought to have accumulated in a number of areas of the Forest, including in the valley of the Shermore Brook, and in the ditch of Portingbury Hills (Essex County Council, 2016).

The results of a recent programme of geoarchaeological borehole survey and environmental archaeological assessment at the site (Young & Batchelor, 2017), undertaken in orer to investigate the sequence of sediments preserved within the ditch, revealed that the sediments in to which the ditch was cut was a stoney clay and silt, equivalent to the 'natural chalky boulder clay' described by Wilkinson (1978) at the base of their trench B, and the superficial geology of Quaternary Till (Diamicton) shown in this area by the BGS. The material infilling the ditch is a predominantly silty clay, with occasional sand or gravel clasts, although richly organic sub-units were recorded within three of the four boreholes (QBH2, QBH3 and QBH4). These richly organic units are described variously as very organic clay, very organic silt or silty peat; in boreholes QBH2 and QBH4 two distinct organic units were recorded, with only one identified in QBH3. In QBH4 the lower of these units (94.49 to 94.44m OD), described as a very dark grey moderately humified silty, herbaceous peat was radiocarbon dated to 395 to 205 cal BC (Iron Age; 2345 to 2155 cal BP). The base of the upper organic unit in QBH4 (94.99 to 94.68m OD), described as very organic silt or an organic sandy silt, was dated to 370 to 200 cal BC (Iron Age; 2320 to 2150 cal BP). These organic units appear to represent *in situ* organic accumulation, and are thus indicative of waterlogged, boggy conditions within the ditch, supporting the growth of sedge fen type vegetation during the Middle Iron Age (see Young & Batchelor, 2017).

Towards the base of the organic sequence a relatively open environment dominated by grasses and herbaceous taxa was recorded in the palaeobotanical assessment (Young & Batchelor, 2017), indicative of a relatively open meadow-type environment, with evidence for cereal cultivation/crop processing and associated disturbed ground weed taxa. Scrub woodland dominated by hazel with sporadic oak, birch and ash is likely to have been growing in the vicinity of the site. In the overlying samples the pollen assemblage is similar, although the ratio of herbaceous to arboreal taxa is variable, with the herbaceous assemblage in some samples far outweighed by trees and shrubs, which tended to be dominated by oak and hazel. Throughout this period, occasional aquatic species and sedges are recorded alongside alder and willow, suggesting the growth of these wetland-type plants either within or on the margins of the feature, or within other nearby damp environments (see Young & Batchelor, 2017).

1.2 Geoarchaeological, Palaeoenvironmental & Archaeological Potential

The results of the previous environmental archaeological investigation and the associated radiocarbon dating of the organic sediments have improved our knowledge of the chronology and palaeoenvironmental history of the Portingbury Hills site. Previous excavation of the site (Wilkinson, 1978) provided tentative evidence for an Iron Age date; the two new radiocarbon dates for the organic sediments provide a *terminus ante quem* for the cutting of the ditch, which must have occurred prior to 395 to 205 cal BC (2345 to 2155 cal BP; see Young & Batchelor, 2017). In addition, the identification of organic-rich, waterlogged deposits within the ditch at Portingbury Hills, and the subsequent programme of radiocarbon dating and environmental archaeological assessment, has confirmed the potential for the site to contribute to a more detailed understanding of vegetation history and landscape evolution in Hatfield Forest, and the age and nature of the human activity associated with Portingbury Hills itself.

In particular, there is the potential to increase knowledge and understanding of the interactions between hydrological change, human activity, vegetation succession and environmental change in this area of Hatfield Forest. Significant vegetation changes include the early Holocene/early Mesolithic transition from pine-dominated to mixed-deciduous dominated woodland; the late Mesolithic/Neolithic decline of elm woodland, the Neolithic colonisation and decline of yew woodland; the late Neolithic/early decline of wetland and dryland woodland. Such investigations are carried out through the assessment/analysis of palaeoecological remains (e.g. pollen, plant macrofossils & insects) and radiocarbon dating. In addition, soils and peat represent potential areas that might have been utilised or even occupied by prehistoric people, evidence of which may be preserved in the archaeological (e.g. features and structure) and palaeoenvironmental record (e.g. changes in vegetation composition).

1.3 Aims & Objectives

Further analysis of the pollen assemblage recorded within borehole QBH4 was recommended following the results of the environmental archaeological assessment (Young & Batchelor, 2017), in order to provide a more detailed vegetation reconstruction during the infilling of the ditch and of nearby human activities. In particular, further identification of the herbaceous assemblage within these samples was recommended, in order to help characterise the vegetation history of the site in more detail, and provide a better understanding of the different phases of human activity identified during the assessment. A programme of environmental archaeological analysis of the pollen samples from borehole QBH4 was therefore undertaken, with samples extracted to assess their suitability for additional radiocarbon dating towards the top of the organic sequence.

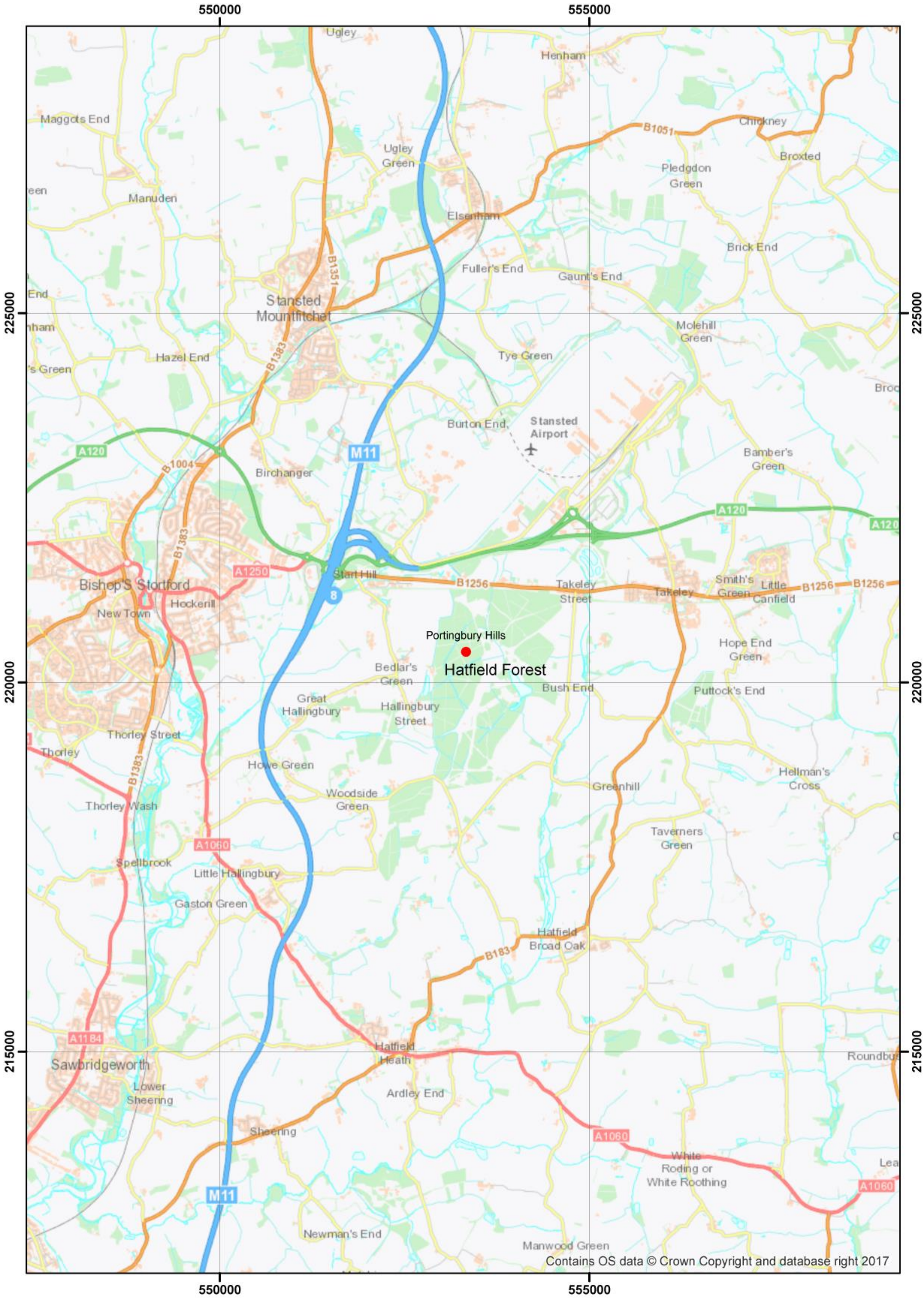

Figure 1: Location of Portingbury Hills, Hatfield Broad Oak, Takeley, Essex. Figure provided by Essex County Council.

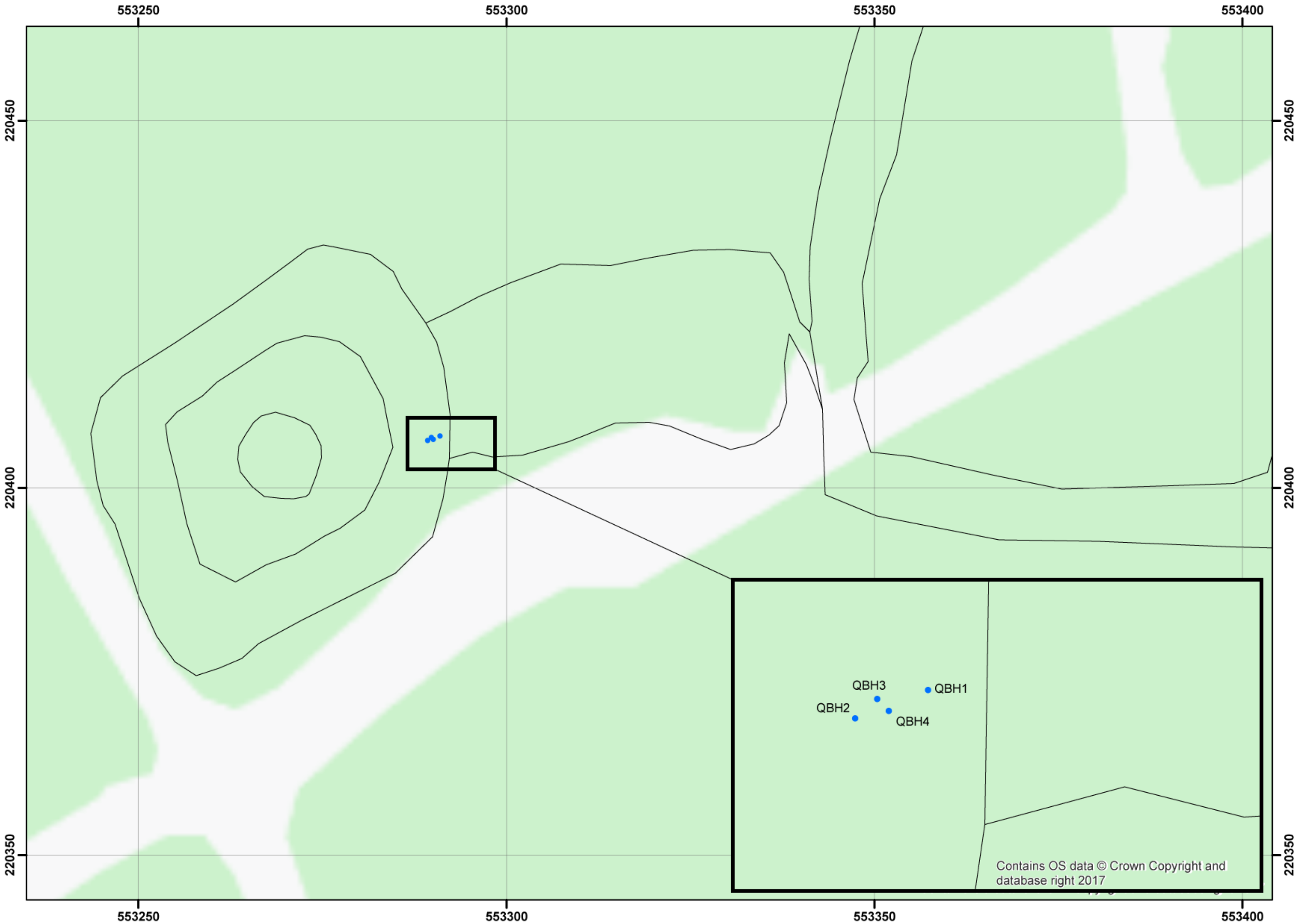

Figure 2: Location of the geoarchaeological boreholes at Portingbury Hills, Hatfield Broad Oak, Takeley, Essex. Survey data provided by Essex County Council/Historic England.

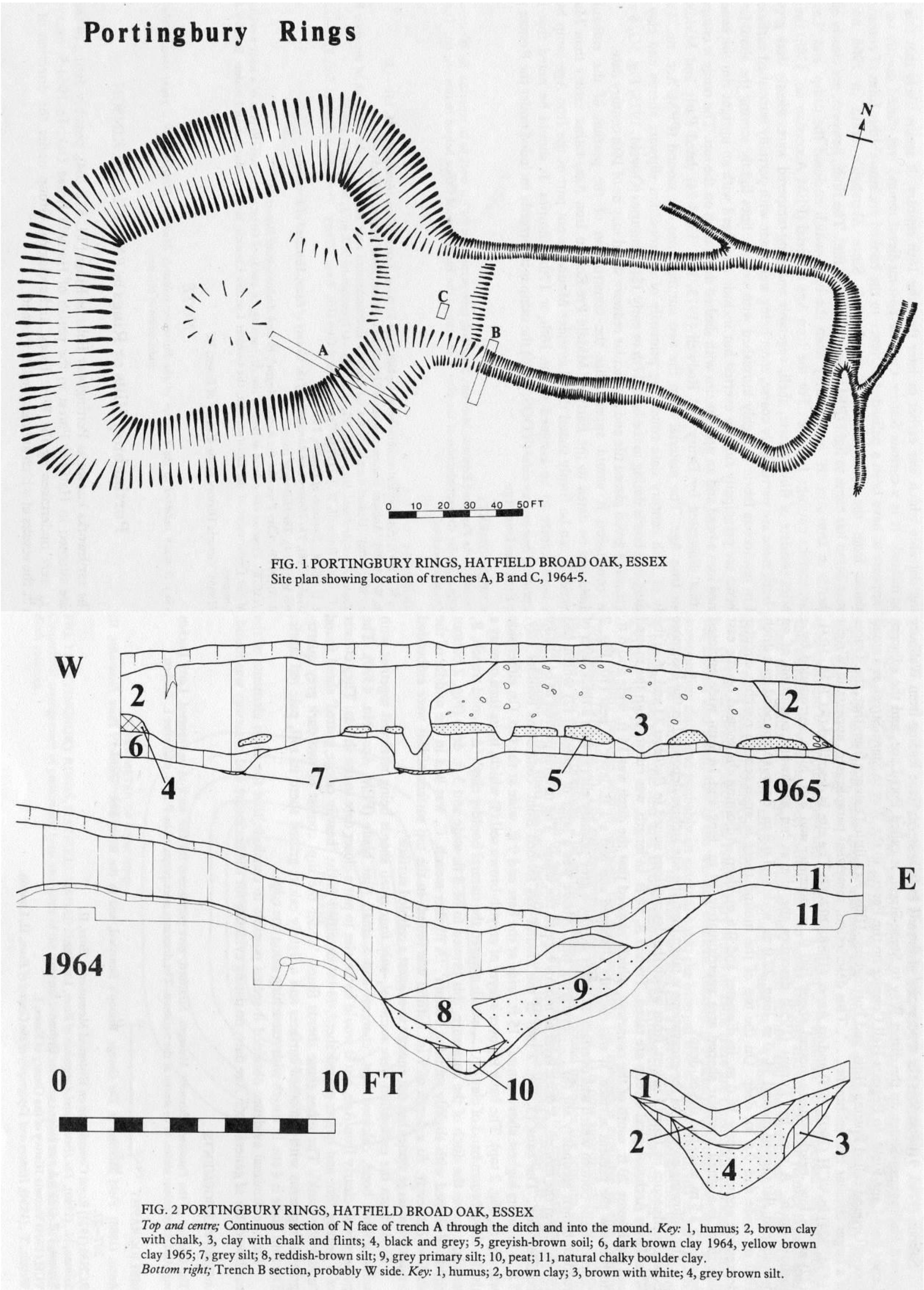

Figure 3: Results of the Portingbury Rings excavation as shown by Wilkinson (1978).

3. METHODS

3.1 Previous investigations (Field investigations and lithostratigraphic descriptions)

A total of four geoarchaeological boreholes (boreholes QBH1 to QBH4) were put down within the ditch feature at Portingbury Hills in October 2017 by Quaternary Scientific (Figure 2) during the environmental archaeological assessment (Young & Batchelor, 2017). The borehole core samples were recovered using an Eijkelkamp window sampler and gouge set using an Atlas Copco TT 2-stroke percussion engine. This coring techniques provide a suitable method for the recovery of continuous, undisturbed core samples and provides sub-samples suitable for not only sedimentary and microfossil assessment and analysis, but also macrofossil analysis. Spatial co-ordinates for each borehole were obtained using a Leica Differential GPS (see Table 1). Laboratory-based lithostratigraphic descriptions of the new borehole samples was carried out using standard procedures for recording unconsolidated sediment and peat, noting the physical properties (colour), composition (gravel, sand, clay, silt and organic matter) and inclusions (e.g. artefacts). The procedure involved: (1) cleaning the samples with a spatula or scalpel blade and distilled water to remove surface contaminants; (2) recording the physical properties, most notably colour; (3) recording the composition e.g. gravel, fine sand, silt and clay; (4) recording the degree of peat humification, and (5) recording the unit boundaries e.g. sharp or diffuse. The results are displayed in Tables 2 to 5 and in Figure 4.

Old Woman's Weaver Marsh

Additional attempts were made at coring in the area of the Old Woman's Weaver Marsh (centred on National Grid Reference 553596, 220817). Due to the dense nature of the vegetation in this area, hand-coring equipment (a Russian/D-section auger) was used, although many of these came down on to a stoney clay thought to represent the Quaternary Till (Diamicton) (see Discussion).

Table 1: Spatial data for the new geoarchaeological boreholes

Name	Easting	Northing	Elevation (m OD)
QBH1	553290.95	220407.06	96.40
QBH2	553289.31	220406.42	96.55
QBH3	553289.80	220406.86	96.47
QBH4	553290.07	220406.58	96.40

3.2 Organic matter determinations

A total of 28 subsamples from borehole QBH4 were taken for determination of the organic matter content during the environmental archaeological assessment (Young & Batchelor, 2017; Table 6 and Figure 4). These records were important as they can identify increases in organic matter possibly associated with more terrestrial conditions. The organic matter content was determined by standard procedures involving: (1) drying the sub-sample at 110^{0}C for 12 hours to remove excess moisture; (2) placing the sub-sample in a muffle furnace at 550°C for 2 hours to remove organic matter (thermal oxidation), and (3) re-weighing the sub-sample obtain the 'loss-on-ignition' value. The samples were then re-weighed after 2 hours at 950°C for determination of the calcium carbonate content (see Bengtsson & Enell, 1986).

3.3 Radiocarbon dating

Two subsamples of unidentified twig wood (<2-3 years old) were extracted from towards the base of the two organic-rich units within borehole QBH4 for radiocarbon dating during the environmental archaeological assessment (Young & Batchelor, 2017). The samples were submitted for AMS radiocarbon dating to the BETA Analytic Radiocarbon Dating Facility, Miami, Florida. The results have been calibrated using OxCal v4.2 (Bronk Ramsey, 1995; 2001 and 2007) and the IntCal13 atmospheric curve (Reimer *et al*., 2013). Following the results of the assessment and recommendation of further pollen analysis (see Young & Batchelor, 2017), samples were extracted from towards the top of the organic sequence (94.99 to 94.89m OD) for radiocarbon dating, in order to improve the chronological mode for the sequence. Unfortunately, no macrofossil remains suitable for dating were identified in these samples, and it was decided not to pursue humin/humic acid dating of a bulk sample, on the basis of the dates already available for the sequence. The results of the radiocarbon dating are displayed in Figure 4 and in Table 7.

3.4 Pollen analysis

Initial assessment

Eight subsamples from borehole QBH4 were extracted for an initial assessment of pollen content, as detailed in Young & Batchelor (2017). The pollen was extracted as follows: (1) sampling a standard volume of sediment (1ml); (2) adding two tablets of the exotic clubmoss *Lycopodium clavatum* to provide a measure of pollen concentration in each sample; (3) deflocculation of the sample in 1% Sodium pyrophosphate; (4) sieving of the sample to remove coarse mineral and organic fractions (>125µ); (5) acetolysis; (6) removal of finer minerogenic fraction using Sodium polytungstate (specific gravity of 2.0g/cm^3); (7) mounting of the sample in glycerol jelly. Each stage of the procedure was preceded and followed by thorough sample cleaning in filtered distilled water. Quality control is maintained by periodic checking of residues, and assembling sample batches from various depths to test for systematic laboratory effects. The assessment procedure carried out by Young & Batchelor (2017) consisted of scanning the prepared slides, and recording the concentration and preservation of pollen grains and spores, and the principal taxa on four transects (10% of the slide).

Analysis

The results of this assessment indicated a high concentration and preservation of remains in all samples assessed, with the exception of basal sample 94.15m OD (2.25m bgl). Pollen and micro-charcoal analyses were therefore undertaken on the remaining seven samples. Five of these samples came from relatively organic layers within the ditch fill, radiocarbon-dated to the mid-late Iron Age, while the uppermost and basal samples were from predominantly inorganic sediments. A minimum of 300 identifiable pollen grains and Pteridophyte (fern) spores was counted for all samples. Pollen and spores were identified using the keys of Moore *et al.* (1991) and by comparison with the reference collection in the Department of Archaeology, University of Reading. Vascular plant nomenclature follows Stace (1991) and pollen and spore nomenclature follows Bennett *et al.* (1994). The criteria of Andersen (1979) were used in identification of cereal pollen, with allowance made for the effect on pollen grain size of the chosen pollen preparation method and mounting medium (i.e. a sample of hazel (*Corylus avellana*) pollen grains from the Hatfield pollen slides was measured, compared with the standard *Corylus* size used by Andersen, and a correction factor (1.4) applied in comparing the dimensions of relatively large Poaceae grains with Andersen's criteria). Unidentifiable deteriorated pollen grains and spores were classified according to the categories of Cushing (1967). The results of the pollen analysis are shown in Figure 5.

Pollen percentage calculations are based on a sum including all identifiable pollen grains and Pteridophyte spores, excluding pollen of obligate aquatics. Calculations for obligate aquatics are based on the main sum plus sum of aquatics, while calculations for the different categories of unidentifiable pollen grains are based on the main sum plus the sum of unidentifiable grains.

Micro-charcoal

Micro-charcoal particles present on the pollen slides were counted at the same time as the pollen grains. A known quantity of exotic marker spores (*Lycopodium clavatum*) had been added to the samples (of known volume) during the preparation procedure, so that by counting the number of *Lycopodium* spores seen during charcoal counting it was possible to estimate the total number of charcoal particles in a unit volume of sediment. The results of the micro-charcoal analysis are shown in Figure 6.

3.5 Macrofossil assessment

A total of three small bulk samples were extracted from borehole QBH4 during the environmental archaeological assessment (Young & Batchelor, 2017) for the recovery of macrofossil remains including waterlogged plant macrofossils, wood, insects and Mollusca. The extraction process involved the following procedures: (1) removing a sample of either 5 or 10cm in thickness; (2) measuring the sample volume by water displacement, and (3) processing the sample by wet sieving using 300μm and 1mm mesh sizes. Each sample was scanned under a stereozoom microscope at x7-45 magnifications, and sorted into the different macrofossil classes. The concentration and preservation of remains was estimated for each class of macrofossil (Table 9). Preliminary identifications of the waterlogged seeds (Table 10) have been made using modern comparative material and reference atlases (e.g. Cappers *et al.,* 2006; NIAB, 2004). Nomenclature used follows Stace (2005).

4. RESULTS, INTERPRETATION & DISCUSSION OF THE LITHOSTRATIGRAPHIC DESCRIPTIONS & RADIOCARBON DATING

The results of the lithostratigraphic descriptions are displayed in Tables 2 to 5 and in Figure 4. The full sequence of sediments recorded in the boreholes comprises:

Unit 1 - Topsoil (humic)
Unit 2 - Ditch fill – predominantly silty/clayey with some organic-rich (peaty) units
Unit 3 - Diamicton – clayey, gravelly with some cobble-sized clasts

4.1 Diamicton

The basal unit recorded within the boreholes was a stoney clay and silt, with frequent gravel or cobble sized clasts of chalk, recorded at between 93.78 and 93.40m OD in borehole QBH4. This unit was not reached in boreholes QBH1 to QBH3, but is considered to represent the 'natural' surface in to which the ditch was cut, and equivalent to the 'natural chalky boulder clay' described by Wilkinson (1978) at the base of their trench B and the superficial geology of Quaternary Till (Diamicton) shown by the BGS.

4.2 Ditch fill

The material infilling the ditch was recorded in boreholes QBH1 to QBH4 as a predominantly silty clay with occasional sand or gravel clasts, although organic sub-units were present in boreholes QBH2, QBH3 and QBH4. This material is consistent with the infilling of the ditch by a combination of both low-energy alluvial and colluvial processes, with finer material being washed in to the ditch from its edge and the adjacent mound and possibly redistributed under waterlogged conditions. Although no conclusively anthropogenic material was identified in the boreholes, some of the sediment may also have been dumped in to the ditch over time.

The highly organic units in boreholes QBH2, QBH3 and QBH4 are described variously as very organic clay, very organic silt or silty peat; in boreholes QBH2 and QBH4 two distinct organic units were recorded, with only one identified in QBH3. In QBH4 the lower of these units (94.49 to 94.44m OD), described as a very dark grey moderately humified silty, herbaceous peat (up to 30% organic content), was radiocarbon dated to 395 to 205 cal BC (Iron Age; 2345 to 2155 cal BP). The base of the upper organic unit in QBH4 (94.99 to 94.68m OD), described as very organic silt or an organic sandy silt (although recorded by loss-on-ignition analysis as up to 52% organic), were radiocarbon dated to 370 to 200 cal BC (Iron Age; 2320 to 2150 cal BP).

In the absence of any evidence for disturbance/redistribution of these deposits, the organic units recorded within boreholes QBH2 to QBH4 appear to represent *in situ* organic accumulation, and are thus indicative of waterlogged, boggy conditions within the ditch, supporting the growth of sedge fen type vegetation during the Middle Iron Age.

4.3 Topsoil

The modern topsoil at the site is described as an organic rich, clayey soil, for which the underlying silty and clayey sediments of the ditch fill form the parent material.

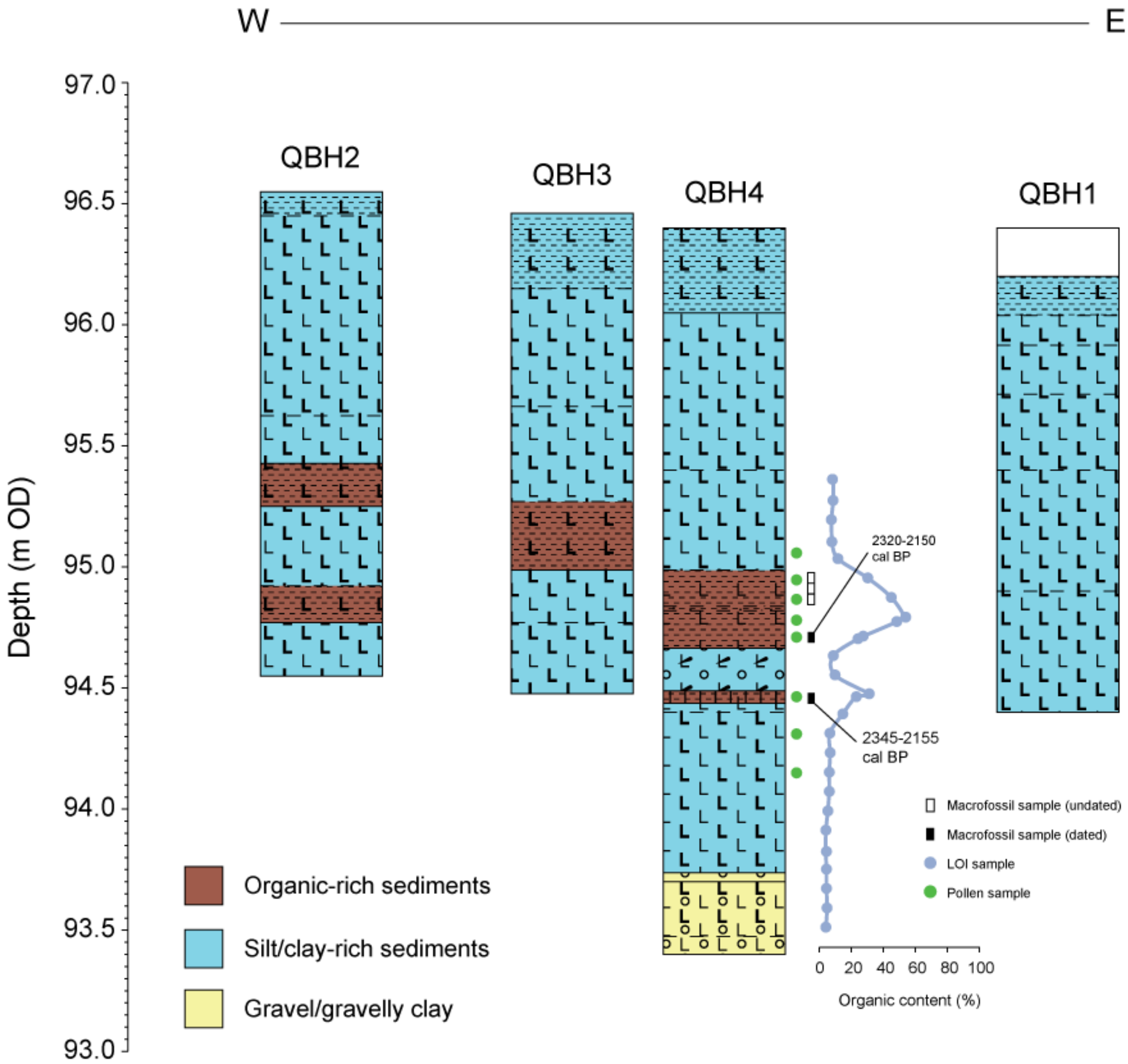

Figure 4: Results of the lithostratigraphic descriptions, organic content analysis (LOI) and radiocarbon dating of borehole QBH4, Portingbury Hills, Hatfield Broad Oak, Takely, Essex.

Table 2: Lithostratigraphic description of borehole QBH1, Portingbury Hills, Hatfield Broad Oak, Takely, Essex

Depth (m OD)	Depth (m bgl)	Description	Stratigraphic group
96.40 to 96.20	0.00 to 0.20	VOID	TOPSOIL
96.20 to 96.04	0.20 to 0.36	Very dark grey organic-rich, clayey topsoil. Diffuse contact in to:	
96.04 to 95.92	0.36 to 0.48	As3 Ag1; dark grey silty clay with modern rooting. Diffuse contact in to:	DITCH FILL
95.92 to 95.72	0.48 to 0.68	As3 Ag1 Ga+ Gg+; grey mottled reddish brown silty clay with traces of sand and occasional chalk fragments. Diffuse contact in to:	
95.72 to 95.40	0.68 to 1.00	As3 Ag1; grey with occasional reddish brown silty clay. Blocky. Diffuse contact in to:	
95.40 to 94.90	1.00 to 1.50	As3 Ag1 Gg+; grey/reddish brown silty clay with occasional chalk fragments. Diffuse contact in to:	
94.90 to 94.40	1.50 to 2.00	As3 Ag1 Gg+; grey silty clay with occasional chalk fragments. Orange mottling. Becoming firmer with depth.	

Table 3: Lithostratigraphic description of borehole QBH2, Portingbury Hills, Hatfield Broad Oak, Takely, Essex

Depth (m OD)	Depth (m bgl)	Description	Stratigraphic group
96.55 to 96.45	0.00 to 0.10	Very dark grey organic-rich, clayey topsoil. Diffuse contact in to:	TOPSOIL
96.45 to 95.63	0.10 to 0.92	As3 Ag1 Gg+; greyish brown silty clay with chalk fragments and iron staining. Blocky. Diffuse contact in to:	DITCH FILL
95.63 to 95.43	0.92 to 1.12	As3 Ag1; grey soft silty clay. Variously blocky to massive. Very sharp contact in to:	
95.43 to 95.25	1.12 to 1.30	Sh2 As2; very dark grey very organic clay grading in to As3 Sh1 organic clay. Sharp contact in to:	
95.25 to 94.93	1.30 to 1.62	As3 Ag1 Gg+; grey soft silty clay. Variously blocky to massive. Occasional chalk clasts >3cm in diameter. Diffuse contact in to:	
94.93 to 94.77	1.62 to 1.78	Sh2 As2 Dl+; very dark grey very organic clay with occasional detrital wood. Very sharp contact in to: Very sharp contact in to:	
94.77 to 94.55	1.78 to 2.00	As3 Ag1; grey silty clay. Firm and blocky.	

Table 4: Lithostratigraphic description of borehole QBH3, Portingbury Hills, Hatfield Broad Oak, Takely, Essex

Depth (m OD)	Depth (m bgl)	Description	Stratigraphic group
96.47 to 96.17	0.00 to 0.30	Very dark grey organic-rich, clayey topsoil. Diffuse contact in to:	TOPSOIL
96.17 to 95.67	0.30 to 0.80	As3 Ag1 Gg+; greyish brown silty clay with occasional chalk fragments. Diffuse contact in to:	DITCH FILL
95.67 to 95.27	0.80 to 1.20	Ag3 As1 Sh+; grey silty clay with traces of organic matter. Diffuse contact in to:	

95.27 to 94.99	1.20 to 1.48	As3 Sh1; dark grey organic clay grading to Sh3 As1 clayey peat. Very sharp contact in to:	
94.99 to 94.77	1.48 to 1.70	Ag3 As1 Ga+ Gg+; soft grey silty clay with occasional chalk fragments and traces of sand. Diffuse contact in to:	
94.77 to 94.47	1.70 to 2.00	As3 Ag1 Gg+ Dl+; grey silty clay with occasional chalk fragments and detrital wood/rooting.	

Table 5: Lithostratigraphic description of borehole QBH4, Portingbury Hills, Hatfield Broad Oak, Takely, Essex

Depth (m OD)	Depth (m bgl)	Description	Stratigraphic group
96.40 to 96.05	0.00 to 0.35	Very dark grey organic-rich, clayey topsoil. Sharp contact in to:	TOPSOIL
96.05 to 95.40	0.35 to 1.00	As3 Ag1 Gg+; greyish brown silty clay with occasional chalk fragments and iron staining. Blocky. Diffuse contact in to:	DITCH FILL
95.40 to 94.99	1.00 to 1.41	As3 Ag1 Gg+; greyish brown silty clay with occasional small (<10mm) chalk clasts. Frequent iron staining. Diffuse contact in to:	
94.99 to 94.84	1.41 to 1,56	Sh2 Ag2 As+; very dark grey very organic silt with traces of clay and some small charcoal fragments (<5mm). Diffuse contact in to:	
94.84 to 94.82	1.56 to 1.58	Ag2 Sh1 Ga1 Gg+; dark greyish brown organic, sandy clay with occasional small chalk clasts (<5mm). Diffuse contact in to:	
94.82 to 94.68	1,58 to 1.72	Sh2 Ag2 As+; very dark grey very organic silt with traces of clay. Sharp contact in to:	
94.68 to 94.49	1.72 to 1.91	Ag2 Dh1 Gg1 As+; dark greyish brown gravelly silt with detrital herbaceous material and occasional Mollusca fragments. Sharp contact in to:	
94.49 to 94.44	1.91 to 1.96	Sh2 Th^{2}1 Ag1; humo. 2; very dark grey moderately humified silty, herbaceous peat. Sharp contact in to:	
94.44 to 94.40	1.96 to 2.00	Ag2 As2 Dh+ Gg+; greyish brown silt and clay with traces of detrital herbaceous material/rooting and occasional gravel clasts. Diffuse contact in to:	
94.40 to 93.78	2.00 to 2.62	Ag2 As2 Dh+ Gg+; greyish brown silt and clay with traces of detrital herbaceous material/rooting and occasional gravel clasts. Iron staining. Sharp contact in to:	
93.78 to 93.75	2.62 to 2.65	Chalk cobble	DIAMICTON
93.75 to 93.47	2.65 to 2.93	As2 Ag1 Gg1; yellowish brown silty, gravelly clay. Clasts are chalk, <10mm, rounded to sub-angular. Diffuse contact in to:	
93.47 to 93.40	2.93 to 3.00	Gg2 As1 Ag1; silty clayey chalk gravel. Chalk clasts are angular, 20-30mm in diameter.	

Table 6: Results of the borehole QBH4 organic matter determinations, Portingbury Hills, Hatfield Broad Oak, Takely, Essex

Depth (m OD)		Organic matter content (%)
From	To	
95.35	95.34	7.80
95.27	95.26	7.74
95.19	95.18	6.63
95.11	95.10	6.85
95.10	95.09	6.96
95.03	95.02	10.78
94.95	94.94	29.74
94.87	94.86	44.69
94.79	94.78	52.74
94.77	94.76	48.20
94.71	94.70	26.79
94.70	94.69	23.60
94.63	94.62	7.85
94.55	94.54	8.94
94.47	94.46	30.86
94.46	94.45	22.35
94.39	94.38	13.80
94.31	94.30	5.61
94.23	94.22	5.83
94.15	94.14	5.26
94.07	94.06	5.23
93.99	93.98	4.32
93.91	93.90	3.15
93.83	93.82	3.04
93.75	93.74	3.42
93.67	93.66	3.50
93.59	93.58	3.87
93.51	93.50	3.16

Table 7: Results of the borehole QBH4 radiocarbon dating, Portingbury Hills, Hatfield Broad Oak, Takely, Essex

Laboratory code / Method	Material and location	Depth (m OD)	Uncalibrated radiocarbon years before present (yr BP)	Calibrated age BC/AD (BP) (2-sigma, 95.4% probability)	δ13C (‰)
BETA 475525 / AMS	Twig wood; organic unit	94.73 to 94.68	2210 ± 30	370 to 200 cal BC (2320 to 2150 cal BP)	-26.8
BETA 475526 / AMS	Twig wood; organic unit	94.49 to 94.44	2250 ± 30	395 to 205 cal BC (2345 to 2155 cal BP)	-25.3

5. RESULTS & INTERPRETATION OF THE POLLEN ANALYSIS

Samples were prepared for pollen assessment at regular intervals through the most organic-rich deposits of borehole QBH4 during the previous environmental archaeological assessment of the site (Young & Batchelor, 2017). The results of this assessment indicated a high concentration and preservation of remains in all samples assessed, with the exception of basal sample 94.15m OD (2.25m bgl). Pollen and micro-charcoal analyses were therefore undertaken on the remaining seven samples. Five of these samples came from relatively organic layers within the ditch fill, radiocarbon-dated to the mid-late Iron Age, while the uppermost and basal samples were from predominantly inorganic sediments.

Pollen percentages for all taxa reaching >0.5% of the pollen sum are shown in Figure 5. The presence of rarer taxa and abundance of micro-charcoal are shown in Figure 6. Although it is conventional to divide pollen sequences into local pollen assemblage zones, reflecting the changing proportions of the predominant taxa, the data here are discussed in relation to the stratigraphic horizons (as identified in the assessment report) as the depositional history of the ditch fill has clearly been a key determinant of pollen sources to the sediments.

Most samples contained abundant pollen, but preservation was variable and a high proportion of corroded and/or crumpled grains occurred in the three uppermost samples, in excess of 20% of the pollen count in these samples being so deteriorated as to be unidentifiable. It is likely that this reflects water-table fluctuations in the ditch, combined with deposition of relatively poorly preserved pollen, perhaps derived from soil erosion.

Before attempting to interpret the pollen data it is necessary to consider the sources of pollen to the deposits. A key factor in interpreting pollen assemblages from archaeological contexts such as the Portingbury Hills enclosure ditch is that the pollen assemblages may reflect both natural deposition from vegetation growing on and around the site and on-site activities such as crop processing, dumping of waste etc. Furthermore, the predominant sources of pollen will have changed through time. Immediately after the ditch was dug it will have begun to infill with material eroding from the ditch sides and surrounding soils, producing 'primary silts' containing a mixture of redeposited (relatively poorly preserved) pollen derived from this soil erosion, plus airborne pollen from surrounding vegetation. As the ditch sides stabilised and became colonised by vegetation, the rate of secondary pollen deposition will have declined, pollen from contemporary vegetation becoming predominant, but this would represent a mixture of pollen from local plants growing in the ditch and elsewhere on the site itself, as well as from vegetation further away and any contribution from on-site activities.

For a small ditch such as that under consideration here, most 'natural' pollen deposition is likely to originate from plants growing within a few tens of metres of the site, but different species vary considerably in pollen production and dispersal (e.g. Broström *et al*. 2008). Many trees, including birch (*Betula*), oak (*Quercus* spp.) and hazel (*Corylus avellana*), produce large amounts of wind-dispersed pollen, and may be well represented in a pollen sequence even at a distance of several hundred metres from the parent tree. Some trees, however, produce much less pollen, or pollen that is not widely dispersed by wind. Pollen of willows (*Salix* spp.), for example, tends to be deposited very close to the parent tree, but is often abundant in pollen sequences as willows commonly grow close to the sort of waterlogged deposits sought by pollen analysts. Ash (*Fraxinus excelsior*), an important component of the Hatfield Forest woods today, is a low pollen producer and strongly under-represented in pollen samples, as is maple (*Acer campestre*), so that pollen analysis is unfortunately unable to shed light on the long-term development of all of the Forest's diverse woodland stand types.

Of the herbs, most grasses are prolific producers of wind-dispersed pollen, but cereals are self-pollinated, releasing very little pollen into the air, and are thus strongly under-represented in the pollen record. Even very low percentage of cereal pollen can indicate local cultivation, but in on-site contexts such as this there is also the possibility that the pollen has been transported to the site in the hulls of cereals grown elsewhere, and then dispersed by threshing (see Robinson and Hubbard 1977). Other plant materials that may have been brought from elsewhere, and provide potential sources of imported pollen, include other plant foods such as legumes and brassicas, hay for animal fodder or bedding, and straw for thatch. A further possibility is raised by the discovery of an egg of the intestinal parasite, whipworm (*Trichuris*), in the lowermost sample analysed: that some of the pollen represents food remains deposited in the ditch in sewage. The limited extent to which pollen of most food plants other than cereals can be identified (often only to family level) means that the potential contribution of food remains to the deposits must remain uncertain in the absence of significant assemblages of macroscopic plant remains (which are more usually identifiable to species level).

Sample 2.09m bgl/94.31m OD

The lowermost sample analysed was from silt/clay deposits 53cm above the base of the ditch fill, the previous assessment having determined that countable levels of pollen were absent lower down in the sequence. This sample was dominated by pollen of open-ground taxa, especially grasses (Poaceae), these reaching in excess of 40% of the pollen sum. Pollen of cereals, both *Avena-Triticum* group (which includes oat (*Avena*) species and wheat (*Triticum*) species, apart from *T. monococcum*) and *Hordeum* group (which includes barley (*Hordeum vulgare*), *T. monococcum* and a few native grasses), suggests cultivation of cereals nearby, and/or processing of cereals grown elsewhere. There is also pollen of a range of other plants indicative of open and disturbed ground, including ribwort plantain (*Plantago lanceolata*), knotgrass (*Polygonum*), sorrel (*Rumex* spp.), and common knapweed (*Centaurea nigra*). The relatively high values for micro-charcoal probably derive predominantly from hearths within the enclosure, although burning of local vegetation is also possible. Local woodland was dominated by oak (*Quercus*) and hazel (*Corylus avellana*), with willow (*Salix*) on wetter ground.

As noted above, a single egg of a whipworm – an intestinal parasite affecting humans and several other mammals - was recorded during pollen counting, its size (length 52.5µm without polar plugs, width 24.5μm) consistent with identification as the human whipworm (*Trichuris trichiura*) (see Dark, 2011 for discussion of size criteria for identification of whipworm eggs in pollen samples). This suggests that human waste entered the ditch on at least one occasion, but further analyses would be needed to determine whether the ditch was purposefully used for sewage disposal.

Sample 1.93m bgl/94.47m OD

This sample, from a 5cm-thick layer (1.91-1.96m below ground level) of relatively organic sediment dated 2250±30 BP (BETA 475526; 395-205 cal BC), shows a decline in the pollen percentages of grasses, ribwort plantain and other herbs, while cereal pollen is absent. Micro-charcoal declines also. There are significant increases in pollen percentages of hazel and willow, suggesting an expansion in the extent of local woodland on both well-drained and wetter soils, although oak did not increase at the same time. Together these changes suggest abandonment of the enclosure and surrounding open (presumably farmed) land, at least some of which began to revert to woodland. The thin organic layer from which this sample derived was overlain by 19cm of gravelly silt, unsuitable for pollen analysis, and then a further layer of more organic sediment.

Samples 1.45, 1.53, 1.62 and 1.69 m bgl/94.95, 94.87, 94.78 and 94.71m OD

The second organic-rich deposit spans a depth of 31cm, and includes a thin layer of more sandy material (1.56-1.58m), perhaps representing an episode of particularly intense local soil erosion. The base of this organic deposit was radiocarbon-dated to 2210±30 BP (BETA 475525; 370-200 cal BC), overlapping with the age range of the stratigraphically lower sample. This may suggest relatively rapid accumulation of the intervening deposits, but the existence of a 'plateau' in the radiocarbon calibration curve centred on 2200 BP means that remains deposited up to two centuries apart may produce effectively identical radiocarbon ages.

The two samples preceding deposition of the thin sandy layer (1.69 and 1.62m) show particularly high percentages of oak pollen, rising to over 55% in the upper of the samples, accompanied by a decline of hazel. Willow is less abundant than previously, while grasses and other herbs remain at similar percentages to those in the first organic layer. It seems that the overall extent of woodland and open land remained largely unchanged, but that oak had come to dominate the local woodland canopy. This could represent successional changes within the woodland, or changing management practices (e.g. length of coppice rotation). The first sample above the sandy layer is significantly different from those preceding it, most notably in the decline of oak by more than half to less than 20% of the pollen sum and increase of grass pollen to over 30%. Pollen of cereals is present, again suggesting local cultivation and/or processing of crops. It is possible that the sandy material derived from increased soil erosion due to clearance of the oak-dominated woodland and ploughing local soils, the increased proportion of unidentifiable deteriorated pollen present in this and later samples perhaps reflecting secondary pollen inputs from this soil mobilisation. This phase of cereal cultivation may have been short-lived, however, as cereal pollen is absent from the following pollen sample, and grasses and other herbs of open and disturbed ground, including ribwort plantain, also decline. There are hints that this may have been in response to increasingly wet conditions: willow began to increase at 1.53m, rising to over 30% of the pollen sum at 1.45m, accompanied by a slight increase of alder (*Alnus glutinosa*). The sample from 1.53m also shows an increase of sedges (Cyperaceae), meadowsweet (*Filipendula*) and ferns (Pteropsida), suggesting areas of poorly drained soils locally. Probably this reflects a change in local hydrological conditions as a consequence of extensive removal of woodland and consequent rise in the water table, but a response to a more widespread episode of late Iron Age climatic deterioration - as recently suggested by analyses of oak ring-width series from central Europe (Büntgen *et al*. 2011) - is also possible.

Sample 1.29m OD/95.11m OD

This sample comes from silty clay deposits overlying the uppermost organic-rich layer. Most of the pollen grains were deteriorated, over 20% being so badly crumpled or corroded that they were unidentifiable. This may reflect the input of a substantial proportion of redeposited pollen in eroded soil (which was probably also the source of the large quantity of micro-charcoal), but the frequent iron staining of the deposits noted in the assessment report suggests that they were subject to oxidation, which is highly detrimental to pollen preservation.

Increases of oak and hazel suggest some recovery of woodland on well-drained soils, but grass pollen percentages remain relatively high, indicating the persistence of substantial areas of open land. Cereal pollen is not recorded, although the poor state of pollen preservation (especially crumpling) of much of the Poaceae pollen means that it may not have been detected.

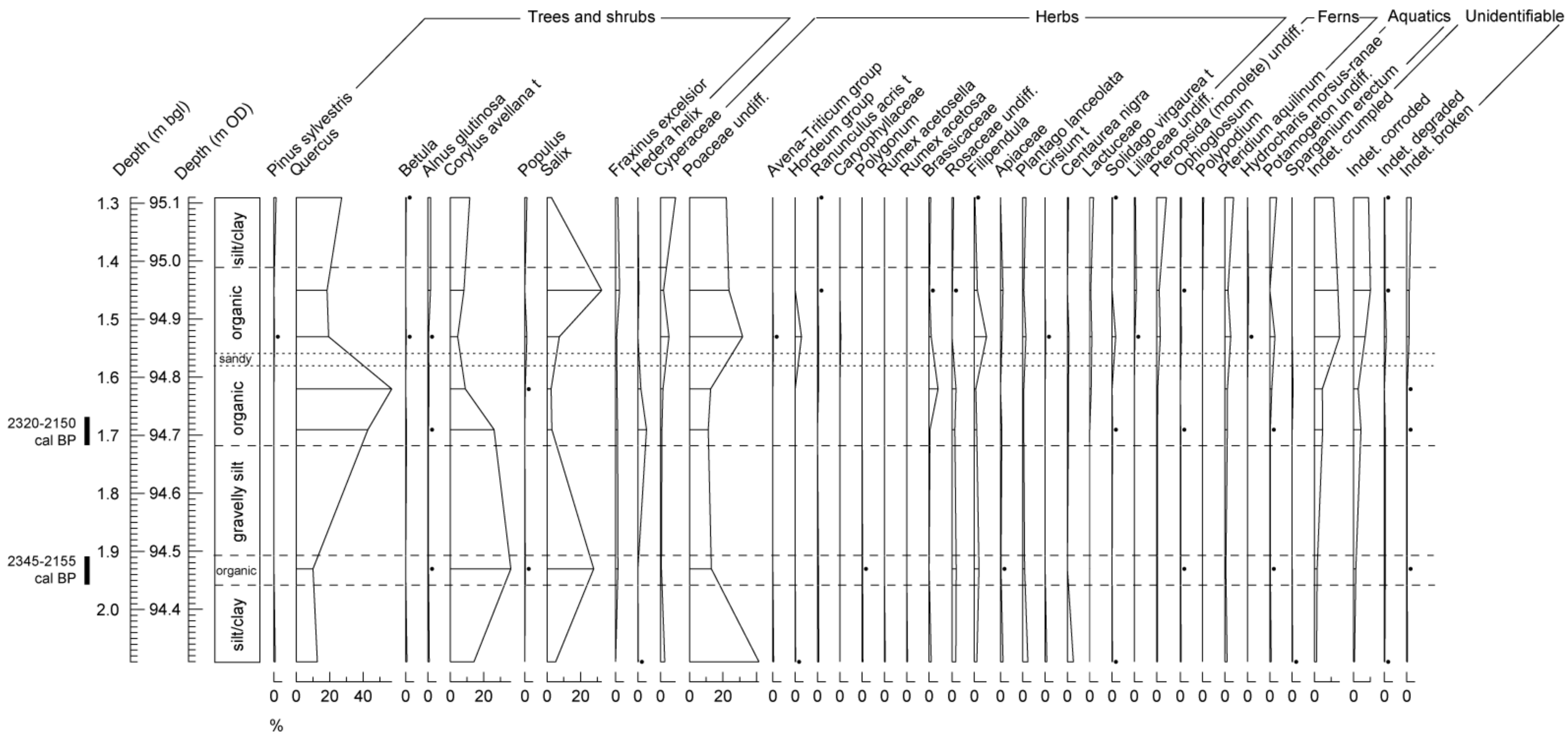

Figure 5: Pollen percentage diagram from Portingbury Hills, Hatfield Forest, showing taxa reaching >0.5% of the pollen sum. For pollen sums see text. Dots indicate values <0.5%.

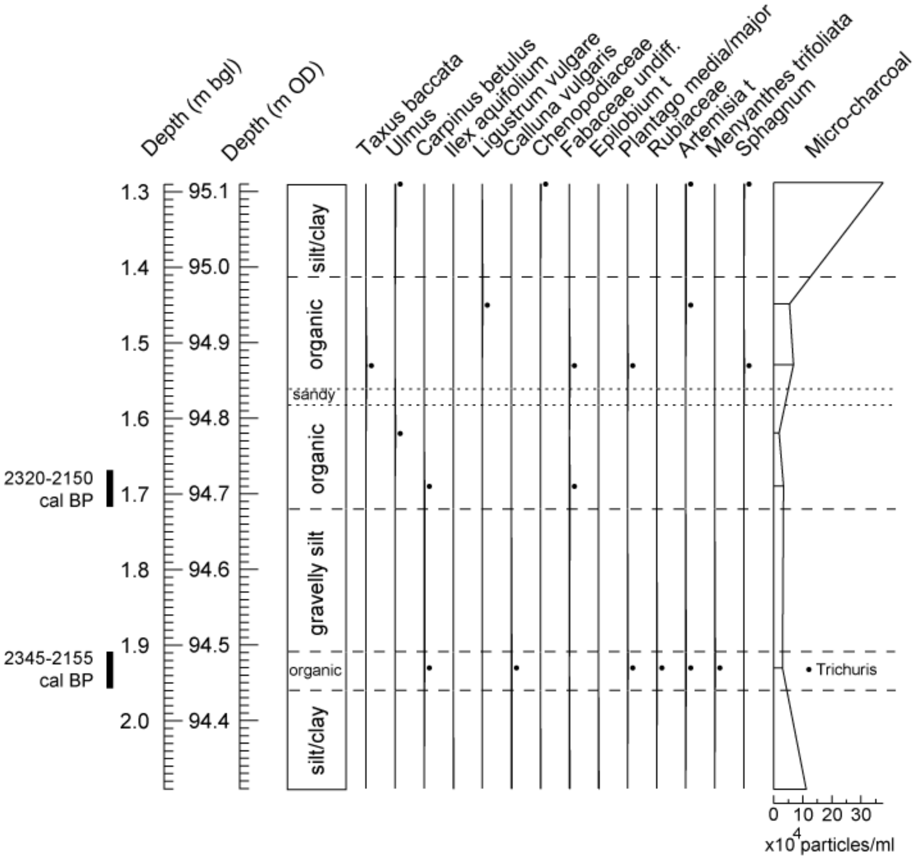

Figure 6: Pollen diagram showing the presence of rare taxa (<0.5% of the pollen sum), and abundance of micro-charcoal in the ditch sequence from Portingbury Hills, Hatfield Forest. Presence of the *Trichuris* ovum is also indicated.

6. RESULTS & INTERPRETATION OF THE MACROFOSSIL ASSESSMENT

A total of three small bulk samples were extracted and processed for the recovery of macrofossil remains, including waterlogged plant macrofossils, wood, insects and Mollusca, during the environmental archaeological assessment (Table 9). The samples were focussed on the organic-rich units within borehole QBH4. An additional two samples were extracted from towards the top of the organic sequence (94.99-94.89m OD) during the subsequent analysis, in order to identify additional macrofossil material suitable for radiocarbon dating.

Macrofossil preservation was relatively low within all five of the samples from borehole QBH4, with no identifiable macrofossils found in the uppermost samples (94.99 to 94.84m OD). Waterlogged wood was found in low to moderate quantities in the two lower samples (94.73 to 94.68 and 94.49 to 94.44m OD), along with low quantities of insect remains. Waterlogged seeds were identified in low concentrations in the sample from 94.49 to 94.44m OD, along with low quantities of charcoal that may be suitable for identification (2-4mm in diameter).

The seed assemblage (Table 10) in the samples from QBH4 is too small to attempt a full environmental interpretation, but the species present (*Sambucus nigra/racemosa* (elder) and *Ranunculus repens* (creeping buttercup)) in the sample from 94.49 to 94.44m OD are consistent with a damp environment either in or on the margins of the ditch. No macrofossil material suitable for radiocarbon dating was identified within the two additional samples extracted for dating.

Table 9: Results of the macrofossil assessment of samples from borehole QBH4, Portingbury Hills, Hatfield Broad Oak, Takely, Essex

				Charred					Waterlogged			Mollusca		Bone			
Depth (m OD)	Unit	Volume processed (ml)	Fraction	Charcoal (>4mm)	Charcoal (2-4mm)	Charcoal (<2mm)	Seeds	Chaff	Wood	Seeds	Sedge remains (e.g. stems/roots)	Whole	Fragments	Large	Small	Fragments	Insects
94.99 to 94.94	Ditch fill	50	>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-	-
94.94 to 94.89		50	>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-	-
94.89 to 94.84		50	>300µm	-	-	-	-	-	-	-	-	-	-	-	-	-	-
94.73 to 94.68		50	>300µm	-	-	-	-	-	4	-	-	-	-	-	-	-	1
94.49 to 94.44		50	>300µm	-	1	-	-	-	2	1	-	-	-	-	-	-	1

Key: 0 = Estimated Minimum Number of Specimens (MNS) = 0; 1 = 1 to 25; 2 = 26 to 50; 3 = 51 to 75; 4 = 76 to 100; 5 = 101+

Table 10: Results of the seed identifications from borehole QBH4, Portingbury Hills, Hatfield Broad Oak, Takely, Essex

Depth (m OD)	Unit	Seed identification		Quantity
		Latin name	Common name	
94.99 to 94.94	Ditch fill	-	-	-
94.94 to 94.89		-	-	-
94.89 to 94.84		-	-	-
94.73 to 94.68		-	-	-
94.49 to 94.44		*Sambucus nigra/racemosa* *Ranunculus repens*	elder creeping buttercup	1 3

7. DISCUSSION & CONCLUSIONS

The aims of the environmental archaeological assessment and subsequent analysis at the Portingbury Hills site were (1) to clarify the nature of the sub-surface stratigraphy, and to investigate the nature, depth, extent and date of any organic/peat deposits within the ditch feature; (2) to investigate whether the sequences contain any artefact or ecofact evidence for prehistoric or historic human activity; (3) to investigate whether the sequences contain any evidence for natural and/or anthropogenic changes to the landscape (wetland and dryland) in this area of Hatfield Forest.

Sedimentary history and chronology

The full sequence of sediments within the ditch at Portingbury Hills was recorded within borehole QBH4, put down during the initial geoarchaeological and environmental archaeological assessment of the site (see Young & Batchelor, 2017). The sediments in to which the ditch was cut are recorded at the base of QBH4 as a stoney clay and silt, equivalent to the 'natural chalky boulder clay' described by Wilkinson (1978) at the base of their trench B, and the superficial geology of Quaternary Till (Diamicton) shown in this area by the BGS. The material infilling the ditch is a predominantly silty clay, with occasional sand or gravel clasts, although richly organic sub-units do exist and were recorded within three of the four boreholes (QBH2, QBH3 and QBH4). These richly organic units are described variously as very organic clay, very organic silt or silty peat; in boreholes QBH2 and QBH4 two distinct organic units were recorded, with only one identified in QBH3. In QBH4 the lower of these units (94.49 to 94.44m OD), described as a very dark grey moderately humified silty, herbaceous peat was radiocarbon dated to 395 to 205 cal BC (Iron Age; 2345 to 2155 cal BP). The base of the upper organic unit in QBH4 (94.99 to 94.68m OD), described as very organic silt or an organic sandy silt, was dated to 370 to 200 cal BC (Iron Age; 2320 to 2150 cal BP). These organic units appear to represent *in situ* organic accumulation, and are thus indicative of waterlogged, boggy conditions within the ditch, supporting the growth of sedge fen type vegetation during the Middle Iron Age.

Unfortunately, no macrofossil material suitable for radiocarbon dating was identified from towards the top of the organic sequence of sediments within the ditch (94.99 to 94.89m OD). However, the results of the environmental archaeological investigation and the associated radiocarbon dating of the organic sediments have improved our knowledge of the chronology and palaeoenvironmental history of the Portingbury Hills site. Previous excavation of the site (Wilkinson, 1978) provided tentative evidence for an Iron Age date. The two new radiocarbon dates for the organic sediments provide a *terminus ante quem* for the cutting of the ditch, which must have occurred prior to 395 to 205 cal BC (2345 to 2155 cal BP).

Vegetation history

The results of the environmental archaeological analysis of the pollen sequence from the Portingbury Hills ditch provides an indication of local land use around the enclosure, and the changing composition of the surrounding woodland during the mid-late Iron Age, with the proviso that some tree and shrub taxa that may well have been prominent in this woodland are either strongly under-represented in the pollen record (notably ash), or have pollen grains that are not routinely distinguishable from those of other plants in the same family (such as hawthorn (*Crataegus* spp.) and blackthorn (*Prunus spinosa*), which are grouped into the Rosaceae pollen count, along with bramble (*Rubus fruticosus*) and crab apple (*Malus sylvestris*) etc.).

Two periods of local farming are indicated, both probably including cereal cultivation as well as grazing of livestock. The first episode probably occurred soon after construction of the enclosure, but was followed by a period of woodland regeneration, which may have occurred on both abandoned agricultural land and in the enclosure itself. A further period of agricultural activity, presumably linked with reoccupation of the enclosure, may have been cut short by increasingly wet conditions. These may have been triggered by hydrological changes linked with woodland clearance, although a response to more widespread climatic deterioration in the late Iron Age is also possible. In terms of implications for the origins of the surrounding woodland, the presence of the enclosure itself obviously indicates that at least some of this is secondary and post-Iron Age in origin. The evidence for farming from the pollen sequence suggest, however, that Iron Age woodland clearance may have been more widespread, and that some of the present woodland of Hatfield Forest may have regenerated on former agricultural land between the end of the Iron Age and the medieval period. A similar situation has been found for the Forest of Shotover and Stowood in Oxfordshire, where a complete Holocene pollen sequence from waterlogged deposits in an area of ancient woodland (Sidlings Copse) indicated that the original woodland was largely cleared by the end of the Bronze Age, and that at least some of the woodland of the medieval Forest originated from regeneration in the late Anglo-Saxon period (Day, 1990; 1993).

Although the Portingbury Hills pollen sequence does not itself provide direct evidence for the character of the pre-Iron Age woodland, it does offer a hint of significant earlier human activity in the area. Pollen sequences from lowland England show that the original relatively undisturbed woodland present when agriculture began in the Neolithic period was dominated by lime (*Tilia*) (Grant *et al*., 2011). As grazing by domestic livestock and woodland clearance increased, lime declined dramatically, often during the late Neolithic period and Bronze Age, as at Sidlings Copse, but occasionally much later, as at Epping Forest, where it has been radiocarbon dated to the Roman period (Grant and Dark, 2006; Dark, 2017, 24-25). The fact that the Portingbury Hills sequence contains no trace of lime pollen may indicate that the woodland around the site evidenced in the lowermost pollen sample was already secondary, the original prehistoric woodland having been cleared at an earlier date.

Old Woman's Weaver Marsh

During the fieldwork stage of the environmental archaeological assessment (Young & Batchelor, 2017) additional attempts were made at coring in the area of the Old Woman's Weaver Marsh (centred on National Grid Reference 553596, 220817). Due to the dense nature of the vegetation in this area, hand-coring equipment was used to attempt several boreholes in the vicinity of this site. However, each of these boreholes came down on to what appeared to be stoney clay, overlain by a thin humic topsoil. An additional, more intensive programme of geoarchaeological survey using a powered auger may be able to identify organic deposits in this area, although on the basis of the hand-cored boreholes, the superficial geology appears to be the Quaternary Till (Diamicton).

Considering the vegetation history of Hatfield Forest as a whole, pollen analysis of a longer chronological sequence of deposits, if one can be identified, might enable a further investigation of the origin of its medieval woodland, and the development of the varied woodland types present today. Hornbeam (*Carpinus betulus*) is now common in the Forest, yet is present only in very low levels in just two of the samples from Portingbury Hills. Birch (*Betula*), a prolific producer of well-dispersed pollen, is also barely represented, yet is abundant in the Forest today. In this case an explanation is less elusive: Oliver Rackham (1989, 224) suggests that the rise of birch is a recent phenomenon, resulting from twentieth-century woodland management practices. Hatfield Forest as it appears today evidently reflects a long history of changing interactions between climate, vegetation, fungal pathogens, human activity, and animals (domestic and wild), factors that can be expected to continue to shape it well into the future.

8. REFERENCES

Andersen, S.T. (1979) Identification of wild grass and cereal pollen, *Danmarks Geologiske Undersøgelse* Arbok 1978, 69-92

Bennett, K.D., Whittington, G. & Edwards, K.J. (1994) Recent plant nomenclatural changes and pollen morphology in the British Isles, *Quaternary Newsletter* 73, 1-6

Bronk Ramsey C. (1995) Radiocarbon Calibration and Analysis of Stratigraphy: The OxCal Program, *Radiocarbon* 37 (2), 425-430.

Bronk Ramsey C. (2001) Development of the Radiocarbon Program OxCal, *Radiocarbon* 43 (2a), 355-363.

Bronk Ramsey, C. (2007) Deposition models for chronological records. *Quaternary Science Reviews* (INTIMATE special issue; 27(1-2), 42-60.

Broström, A. and 14 others (2008) Pollen productivity estimates of key European plant taxa for quantitative reconstruction of past vegetation: a review. *Vegetation History and Archaeobotany* 17, 461-478

Büntgen, U. and 11 others (2011) 2500 years of European climate variability and human susceptibility. *Science* 331, 578-582

Cappers, R.T.J., Bekker R.M. & Jans J.E.A. (2006) *Digital Seed Atlas of the Netherlands*. Groningen Archaeological Series 4. Barkhuis, Netherlands

Cushing, E.J. (1967) Evidence for differential pollen preservation in late Quaternary sediments in Minnesota, *Review of Palaeobotany and Palynology* 4, 87-101

Dark, P. (2017) The environment of southern Roman Britain. In: D. Bird (ed.), *Agriculture and Industry in South-Eastern Roman Britain*. Oxford: Oxbow, pp. 15-34

Dark, P. (2011) The pollen and trichurid ova from pit 5251. In: M. Fulford & A. Clarke, *Silchester: City in Transition. The mid-Roman occupation of Insula IX* c. *A.D. 125-250/300. A report on excavations undertaken since 1997*. Britannia Monograph Series no. 25. London: Society for the Promotion of Roman Studies, pp. 294-300

Day, S.P. (1990) *History and Palaeoecology of Woodlands in the Oxford Region*. Unpublished D.Phil. thesis, University of Oxford

Day, S.P. (1993) Woodland origin and 'ancient woodland indicators': a case-study from Sidlings Copse, Oxfordshire, UK. *The Holocene* 3, 45-53

Grant, M. & Dark, P. (2006) *Re-evaluating the concept of woodland continuity and change in Epping Forest: new evidence from Lodge Road*. Unpublished report for the Corporation of London

Grant, M.J., Waller, M.P. & Groves, J.A. (2011) The *Tilia* decline: vegetation change in lowland Britain during the mid and late Holocene. *Quaternary Science Reviews* 30, 394-408

Moore, P.D., Webb, J.A. & Collinson, M.E. (1991) *Pollen Analysis*. Oxford: Blackwell Scientific.

NIAB (2004) *Seed Identification Handbook Agriculture, Horticulture & Weeds. 2nd edition*. NIAB, Cambridge.

Philp, B. (1993) *An Outline Report on an Archaeological Evaluation Excavation at the Land at the Rear of 72-88 Bellot Street, Greenwich, London SE10.* SELAU Unpublished Report.

Rackham, O. (1989) *The Last Forest*. London: Dent

Reille, M. (1992) *Pollen et spores D'Europe et D'Afrique du Nord*. Laboratoire de Botanique historique et Palynologie, Marsaille.

Reimer, P.J., Bard, E., Bayliss, A., Beck, J.W., Blackwell, P.G., Bronk Ramsey, C., Buck, C.E., Edwards, R.L., Friedrich, M., Grootes, P.M., Guilderson, T.P., Haflidason, H., Hajdas, I., Hatté, C., Heaton, T.J., Hoffmann, D.L., Hogg, A.G., Hughen, K.A., Kaiser, K.F., Kromer, B., Manning, S.W., Niu, M., Reimer, R.W., Richards, D.A., Scott, E.M., Southon, J.R., Turney, C.S.M., and van der Plicht, J., (2013) IntCal13 and Marine13 radiocarbon age calibration curves, 0-50,000 years cal BP. *Radiocarbon* 55: 1869-1887.

Robinson, M. & Hubbard, R.N.L.B. (1977) The transport of pollen in the bracts of hulled cereals, *Journal of Archaeological Science* 4, 197-199

Stace, C. (1991) *New Flora of the British Isles*. Cambridge: Cambridge University Press

Stace, C. (2005) *New Flora of the British Isles. Cambridge*: Cambridge University Press.

Tröels-Smith, J. (1955) Karakterisering af løse jordater (Characterisation of unconsolidated sediments), *Danm. Geol. Unders.,* Ser IV 3, 73.

Wilkinson, P. (1978) Portingbury Hills or Rings. *Essex Archaeological Society Transactions* 10: 221-224.

Young, D.S. & Batchelor, C.R. (2017) Portingbury Hills, Hatfield Broad Oak, Takeley, Essex. Environmental Archaeological Assessment Report. *Quaternary Scientific (QUEST) Unpublished Report November 2017; Project Number 149/16.*

9. OASIS FORM

OASIS ID: quaterna1-311454

Project details

Project name	Portingbury Hills, Hatfield Forest
Short description of the project	Following the results of a geoarchaeological borehole survey and environmental archaeological assessment of the site, pollen analysis was undertaken on a sequence of organic sediments preserved within the ditch associated with the Portingbury Hills earthwork enclosure. The material infilling the ditch is a predominantly silty clay, with occasional sand or gravel clasts, although richly organic sub-units do exist and were recorded within three of the four boreholes. In one of these the lower of the organic units was radiocarbon dated to 395 to 205 cal BC, whilst the base of the upper organic unit was dated to 370 to 200 cal BC. These organic units appear to represent in situ organic accumulation, and are thus indicative of waterlogged, boggy conditions within the ditch, supporting the growth of sedge fen type vegetation during the Middle Iron Age. The two radiocarbon dates from these organic sediments thus provide a terminus ante quem for the cutting of the ditch, which must have occurred prior to 395 to 205 cal BC (Iron Age). The results of the subsequent pollen and micro-charcoal analyses have provided a record of the changing character and extent of woodland and open land around the site during the mid-late Iron Age, including at least two phases of cereal cultivation, separated by a period of woodland regeneration presumably linked with abandonment of the enclosure. In addition, the lowermost sample contained a whipworm egg, probably from the human whipworm, Trichuris trichiura, suggesting that human waste was deposited into the ditch at least occasionally. While the pollen sequence reflects predominantly the local vegetation and land use immediately around the Portingbury Hills enclosure, it is interesting to note the considerable difference in composition of the surrounding woodland from that of today, especially the virtual absence of birch and hornbeam.
Project dates	Start: 01-09-2017 End: 12-03-2018
Previous/future work	Yes / Not known
Any associated project reference codes	HNA17 - Sitecode
Any associated	SM EX 98 - SM No.

project reference codes	
Type of project	Environmental assessment
Monument type	PEAT Iron Age
Significant Finds	PEAT Iron Age
Survey techniques	Landscape

Project location

Country	England
Site location	ESSEX UTTLESFORD TAKELEY Portingbury Hills
Postcode	CM22 7TP
Site coordinates	TL 533 204 51.860624324546 0.226490410054 51 51 38 N 000 13 35 E Point

Project creators

Name of Organisation	Quaternary Scientific (QUEST)
Project brief originator	Essex County Council
Project design originator	D.S. Young
Project director/manager	D.S. Young
Project supervisor	C.R. Batchelor

Project archives

Physical Archive recipient	Essex HER
Physical Contents	"Environmental"
Digital Archive Exists?	No
Paper Archive recipient	Essex HER
Paper Contents	"Environmental","Stratigraphic"

Paper Media available	"Report"
Entered by	Daniel Young (d.s.young@reading.ac.uk)
Entered on	12 March 2018